

Using REDCap and R to Rapidly Produce Biomedical Publications

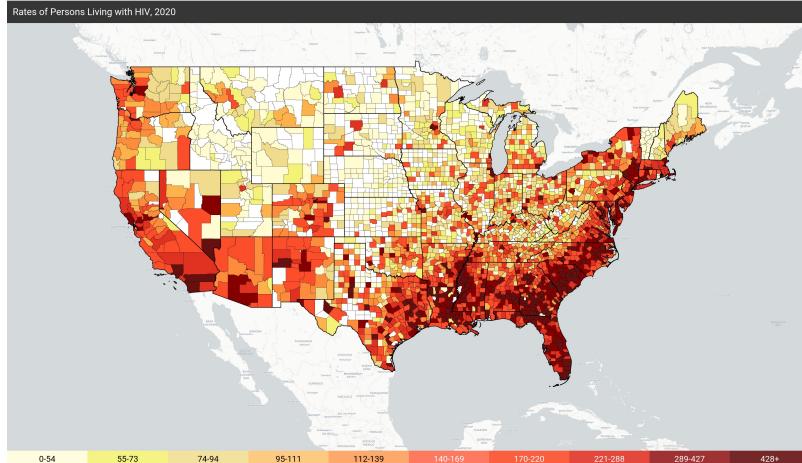
02 - Example

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João Pedro Carmezim Correia, and Will Beasley
May 30, 2023

Infectious Disease Elimination Act

Intersecting Epidemics

- HIV
- hepatitis C
- overdose deaths

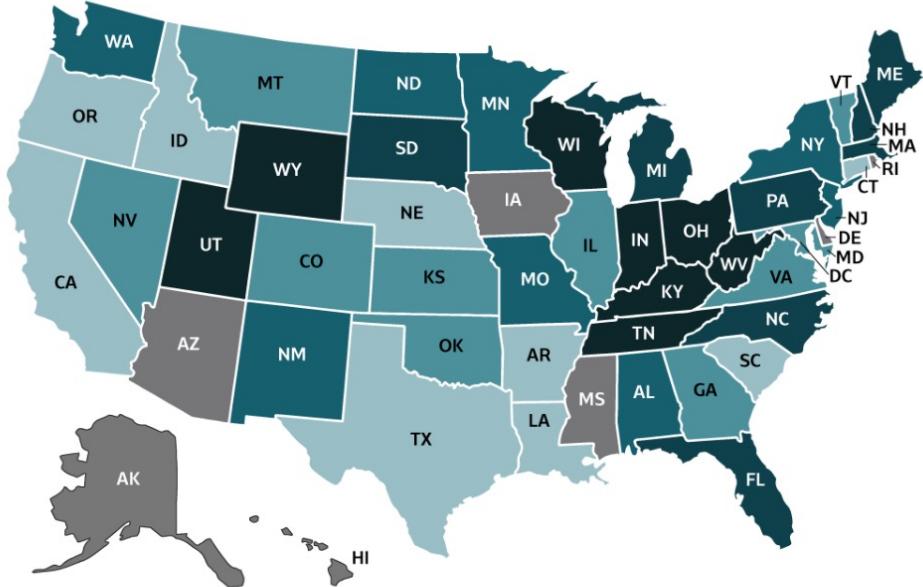


* Data not shown to protect privacy because of a small number of cases and/or a small population.

** State health department, per its HIV data re-release agreement with CDC, requested not to release data to AIDSVu. See Data Methods for more information.

NOTE: There are no county-level maps for Alaska, District of Columbia, and Puerto Rico because there are no counties in these states.

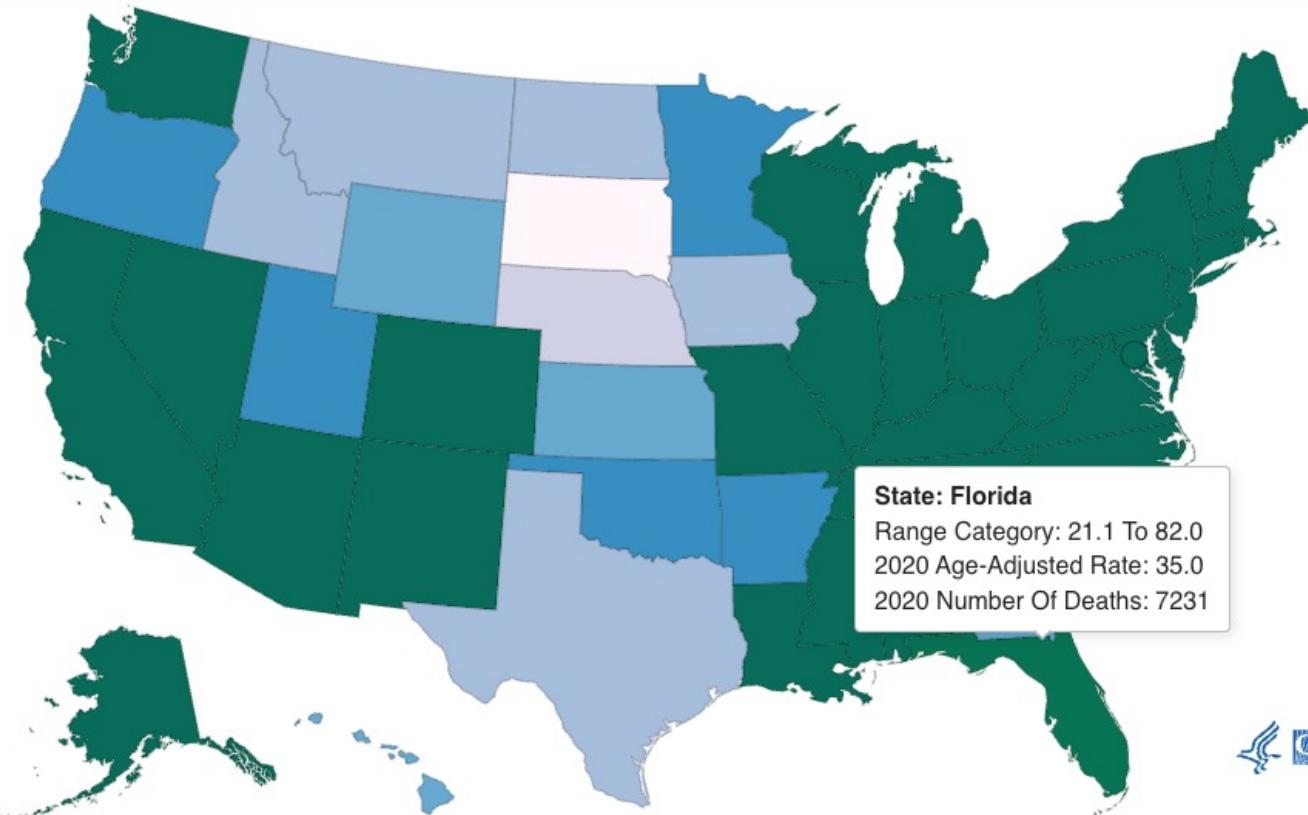
Figure 3.3. Rates of reported acute hepatitis C, by state or jurisdiction — United States, 2018



Color Key	Cases/100,000 Population	States
Light Blue	0-0.3	AR, CA, CT, ID, LA, NE, OR, SC, TX
Medium Blue	>0.3-0.9	CO, GA, IL, KS, MD, MT, NV, OK, VT, VA
Dark Blue	>0.9-1.3	AL, MN, MO, NJ, NM, NY, ND, WA
Very Dark Blue	>1.3-2.2	FL, ME, MA, MI, NH, NC, PA
Black	>2.2-4.0	IN, KY, OH, SD, TN, UT, WV, WI, WY
Grey	Data Not Available	AK, AZ, DE, DC, HI, IA, MS, RI

Source: CDC, National Notifiable Diseases Surveillance System.

Number and Age-adjusted Rates of Drug Overdose Deaths by State, US 2020



Range Category

6.9 to 11.0

11.1 to 13.5

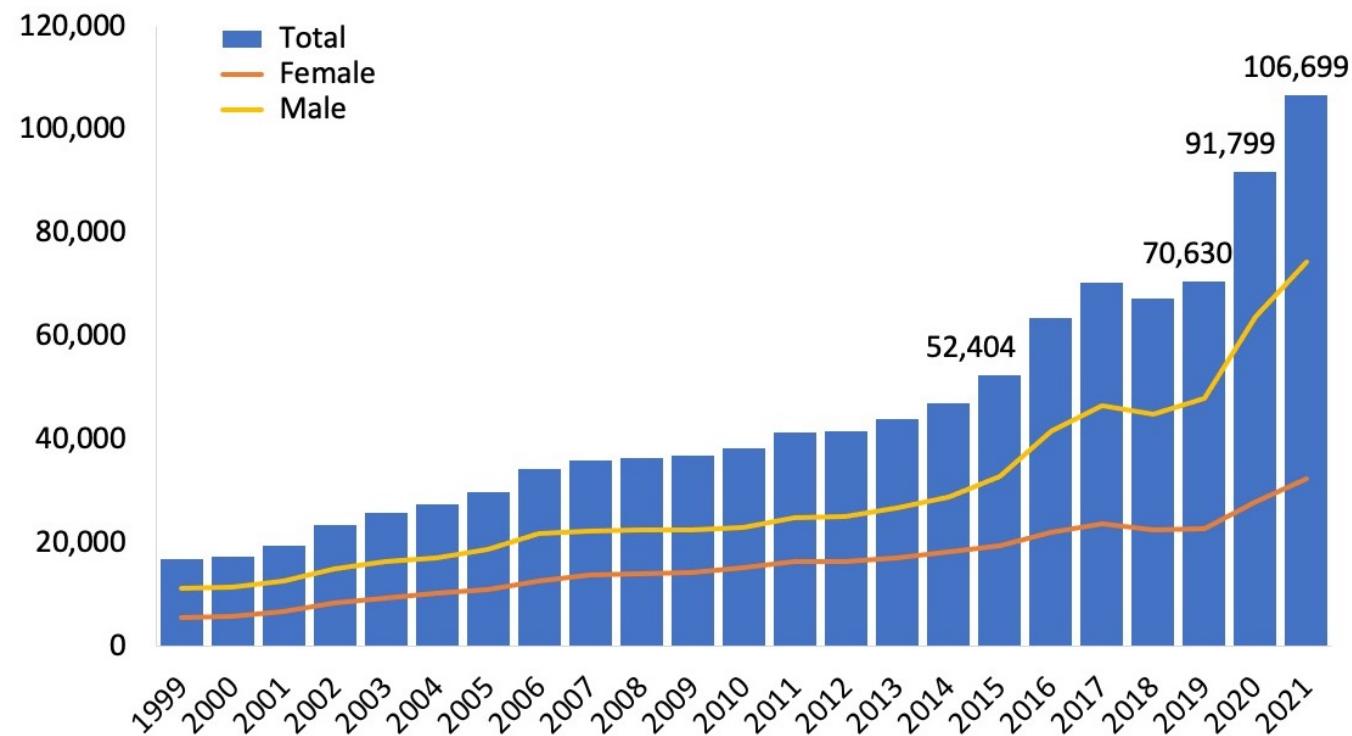
13.6 to 16.0

16.1 to 18.5

18.6 to 21.0

21.1 to 82.0

Figure 1. National Drug-Involved Overdose Deaths*, Number Among All Ages, by Gender, 1999-2021



*Includes deaths with underlying causes of unintentional drug poisoning (X40–X44), suicide drug poisoning (X60–X64), homicide drug poisoning (X85), or drug poisoning of undetermined intent (Y10–Y14), as coded in the International Classification of Diseases, 10th Revision.
Source: Centers for Disease Control and Prevention, National Center for Health Statistics. Multiple Cause of Death 1999-2021 on CDC WONDER Online Database, released 1/2023.

Harm Reduction

<https://www.youtube.com/watch?v=ldTxMIblePk>



NIDA Videos

Addressing Barriers to Care

https://www.youtube.com/watch?v=2d_3DqMEdEg

What is Harm Reduction?

<https://www.youtube.com/watch?v=ikmKxgCTXFA>

Caring for People Who Use Drugs

<https://www.youtube.com/watch?v=7RI72zvO2dU>

IDEA Syringe Services Program

- The Infectious Disease Elimination Act (IDEA) of 2016 was signed into law on July 1, 2016.
- This policy authorized the University of Miami to open the **first** legal syringe services program (or **needle exchange**) in the state of **Florida**
 - decriminalized possession and distribution of syringes for those engaged in the program
 - 5-year, unfunded pilot project, set to end in July, 2021
- Prior to implementation, REDCap was used to build a data collection system to evaluate the pilot program with the sole purpose of **providing data to the legislature** to enhance advocacy efforts for statewide expansion of the program.

Infectious Disease Elimination Act - REDCap

Current Database

- More than 2100 people have been helped.
- Lessons Learned
 - Fixed vs. mobile sites had similar but not identical variables.
 - Services variables were added.
 - Questions were added and some dropped.
 - Not all variables were validated.
- Using new features in REDCap

New Version for the Other Sites

- a single, fixed/mobile project for each county
- Multiple instruments in the project
- follows tidyverse naming convention
- removes dropped content
- Validation on all text
- numeric calculated fields
 - for needle supply by size
- Calculated text and hidden fields using action tags
- Automatic alerts for testing (HIV/Hep C)
 - referrals (smart variables for latest info)
- added supply tracking (not shown here)
- greatly improved aesthetics & organization
 - Custom HTML/CSS
 - Field embedding
- Data Access Groups for locations in a county

Show and Tell - Designer

The screenshot shows the REDCap IDEAS interface for project IDEA - R Medicine 2023 (PID 6753). A purple arrow points from the left sidebar to the 'Designer' link in the top navigation bar.

Project Home and Design

- Project Home
- Project Setup
- Designer** (highlighted by a purple arrow)
- Dictionary
- Codebook

Project status: Development

Data Collection

- Record Status Dashboard
- Add / Edit Records

Show data collection instruments

Applications

- Project Dashboards
- Alerts & Notifications
- Multi-Language Management
- Calendar
- Data Exports, Reports, and Stats
- Data Import Tool

IDEA - R Medicine 2023 PID 6753

Project Home Project Setup Online Designer Data Dictionary Codebook

Create snapshot of instruments VIDEO: How to use this page Last snapshot: 04/04/2023 9:16am

The Online Designer will allow you to make project modifications to fields and data collection instruments very easily using only your web browser. NOTE: While in development status, all field changes will take effect immediately in real time.

Data Collection Instruments

Form options: Form Display Logic

Create a new instrument from scratch
Import a new instrument from the official [REDCap Instrument Library](#)?
Upload instrument ZIP file from another project/user or [external libraries](#)?

Instrument name	Fields	View PDF	Instrument actions
Enrollment	98		Choose action ▾
Daily	129		Choose action ▾

Show and Tell - Repeated

The screenshot shows the REDCap Project Setup interface for the project "IDEA - R Medicine 2023". The left sidebar contains navigation links for My Projects, REDCap Messenger, Project Home and Design, Data Collection, Applications, and Help & Information. The main content area displays the "Project Home" tab with the status "Development" and "Completed steps 6 of 7". The "Main project settings" section includes checkboxes for "Use surveys in this project?", "Use longitudinal data collection with defined events?", and "Modify project title, purpose, etc.". The "Design your data collection instruments" section includes a link to "Online Designer" or "Data Dictionary". The "Enable optional modules and customizations" section includes checkboxes for "Repeatable instruments", "Auto-numbering for records", "Scheduling module (longitudinal only)", "Randomization module", and "Designate an email field for communications". A purple arrow points from the "Repeatable instruments" checkbox in the customization section to the "Repeatable instruments" section in a floating configuration dialog. This dialog has a title "Repeatable instruments" and a descriptive text about collecting repeating data using repeatable instruments or events. It contains a table with columns "Repeat this instrument?", "Instrument name", and "Custom label for repeating instruments (optional)". Two rows are shown: one for "Enrollment" (unchecked) and one for "Daily" (checked). Buttons for "Save" and "Cancel" are at the bottom.

Main project settings

- Enable Use surveys in this project? [?](#)
- Enable Use longitudinal data collection with defined events? [?](#)
- [VIDEO: How to create and manage a survey](#)
- [Modify project title, purpose, etc.](#)

Design your data collection instruments

Add or edit fields on your data collection instruments. This (online method) or by uploading a Data Dictionary (offline method) OR [Download the current Data Dictionary](#).

Go to [Online Designer](#) or [Data Dictionary](#)

Have you checked the [Check For Identifiers](#) page to ensure all identifiers are unique?

Learn how to use [Smart Variables](#), [Piping](#), [Action Tags](#)

Enable optional modules and customizations

- Modify Repeatable instruments [?](#)
- Enable Auto-numbering for records [?](#)
- Enable Scheduling module (longitudinal only) [?](#)
- Enable Randomization module [?](#)
- Enable Designate an email field for communications (if applicable) [?](#)

Repeatable instruments

An excellent way to collect repeating data in REDCap is to use repeatable instruments and/or repeatable events. This is sometimes called one-to-many data collection. Some examples may include but are not limited to the following: data from multiple visits or observations, concomitant medications, adverse events, or repetitive surveys (daily, weekly, etc.).

Below you can specify a data collection instrument to be infinitely repeatable, which means that an instrument can be repeated over and over again (a different number of times for each record) even without enabling REDCap's longitudinal module. Once an instrument is set to repeat, you will see options on the Record Home Page to add another instance of the instrument for the currently selected record. All instances of a repeating instrument will then be displayed as a table near the bottom of the Record Home Page, thus allowing viewing of the instances and easy navigation within them.

Repeat this instrument?	Instrument name	Custom label for repeating instruments (optional) ?
<input type="checkbox"/>	Enrollment	<input type="text"/>
<input checked="" type="checkbox"/>	Daily	<input type="text"/>

[Save](#) [Cancel](#)

Show and Tell - Add Typical

My Projects
REDCap Messenger

Project Home and Design

- Project Home · Project Setup
- Designer · Dictionary · Codebook
- Project status: Development

Data Collection

- Record Status Dashboard
 - View data collection status of all records
- Add / Edit Records
 - Create new records or edit/view existing ones
- Show data collection Instruments

Applications

- Project Dashboards
- Alerts & Notifications
- Multi-Language Management
- Calendar
- Data Exports, Reports, and Stats
- Data Import Tool
- Data Comparison Tool
- Logging and Email Logging
- Field Comment Log
- File Repository
- User Rights and DAGs

IDEA - R Medicine 2023 PID 6753

Add / Edit Records

You may view an existing record/response by selecting it from the drop-down lists below. To create a new record/response, click the button below.

NOTICE: This project is currently in Development status. **Real data should NOT be entered** until the project has been moved to Production status.

Total records: 22

Choose an existing ID Code

-- select record --

+ Add new record

Data Search

Choose a field to search (excludes multiple choice fields)

All fields

Search query

Begin typing to search the project data, then click an item in the list to navigate to that record.

Normally projects sequentially assign record_id values.

Show and Tell - Add

The screenshot shows the 'Add / Edit Records' page for the 'IDEA - R Medicine 2023' project. The left sidebar includes links for 'My Projects', 'REDCap Messenger', 'Project Home and Design' (with 'Project Home', 'Project Setup', 'Designer', 'Dictionary', 'Codebook', and 'Project status: Development'), 'Data Collection' (with 'Record Status Dashboard', 'Add / Edit Records', and 'Show data collection instruments'), and 'Applications' (with various tools like Project Dashboards, Alerts & Notifications, Multi-Language Management, Calendar, Data Exports, Reports, and Stats, Data Import Tool, Data Comparison Tool, Logging, Email Logging, Field Comment Log, File Repository, User Rights and DAGs, and Customize & Manage Locking/E-signatures). The main content area displays the title 'IDEA - R Medicine 2023' with PID 6753. Below it is the heading 'Add / Edit Records'. A note states: 'You may view an existing record/response by selecting it from the drop-down lists below. To create a new record/response, type a new value in the text box below and hit Tab or Enter. To quickly find a record without using the drop-downs, the text box will auto-populate with existing record names as you begin to type in it, allowing you to select it.' A yellow box contains a notice: '⚠️ NOTICE: This project is currently in Development status. **Real data should NOT be entered** until the project has been moved to Production status.' The 'Choose an existing ID Code' section has a dropdown menu labeled '-- select record --'. The 'Enter a new or existing ID Code' section has an empty input field. Below these is a 'Data Search' section with a dropdown 'Choose a field to search' set to 'All fields' and a 'Search query' input field. A purple callout bubble points from the 'Data Search' section to the text: 'IDEA uses previously printed random ID Codes (cards.).'

IDEA uses previously printed random ID Codes (cards.).

Show and Tell - Enrollment

My Projects
REDCap Messenger

Project Home and Design

- Project Home · Project Setup
- Designer · Dictionary · Codebook

Project status: Development

Data Collection

- Record Status Dashboard
 - View data collection status of all records
- Add / Edit Records
 - Create new records or edit/view existing ones

ID Code 8977 Select other record

Applications

- Project Dashboards
- Alerts & Notifications
- Multi-language Management

IDEA - R Medicine 2023 PID 6753

Record Home Page

Record "8977" is a new ID Code. To create the record and begin entering data for it, click any gray status icon below.

The grid below displays the form-by-form progress of data entered for the currently selected record. You may click on the colored status icons to access that form/event.

Legend for status icons:

Status Icon	Description
	Incomplete
	Incomplete (no data saved) ?
	Unverified
	Complete
	Many statuses (all same)
	Many statuses (mixed)

NEW ID Code 8977

Data Collection Instrument	Status
Enrollment	
Daily	

Show and Tell - Enrollment

REDCap®

Logged in as | Log out

My Projects REDCap Messenger

Project Home and Design

- Project Home · Project Setup
- Designer · Dictionary · Codebook
- Project status: Development

Data Collection

- Record Status Dashboard
 - View data collection status of all records
- Add / Edit Records
 - Create new records or edit/view existing ones
- ID Code 8977** Select other record

Data Collection Instruments:

- Enrollment
- Daily +

Lock entire record

Applications

- Project Dashboards
- Alerts & Notifications
- Multi-Language Management
- Calendar
- Data Exports, Reports, and Stats
- Data Import Tool

University of Miami
Office of the Vice Provost for Research

IDEA - R Medicine 2023 PID 6753

Actions: [Modify instrument](#) [Download PDF of instrument\(s\)](#) [Video: Basic data entry](#)

Enrollment

Editing existing ID Code 8977.

ID Code	8977
To rename the record, see the record action drop-down at top of the Record Home Page .	
 MILLER SCHOOL of MEDICINE	
Date * must provide value (H) 2023-04-04 31 Today Y-M-D	
Enrollment Location: * must provide value (H) Mobile	
If this is a mobile visit, where did it occur? * must provide value (H) Miami Beach	
Required Demographics	
Name Initials (H) ---	

Save & Exit Form
Save & ...
- Cancel -

Show and Tell - Daily

REDCap®

Logged in as | Log out

My Projects REDCap Messenger

Project Home and Design

- Project Home · Project Setup
- Designer · Dictionary · Codebook
- Project status: Development

Data Collection

- Record Status Dashboard
- Add / Edit Records
- ID Code 8977** Select other record
- Data Collection Instruments:
 - Enrollment
 - Daily** +
- Lock entire record

Applications

- Project Dashboards
- Alerts & Notifications
- Multi-Language Management
- Calendar
- Data Exports, Reports, and Stats
- Data Import Tool

University of Miami
Office of the Vice Provost for Research

IDEA - R Medicine 2023 PID 6753

Actions: [Modify instrument](#) [Download PDF of instrument\(s\)](#) [Video: Basic data entry](#)

Daily

Current instance: 1

Editing existing ID Code 8977. (Instance #1)

ID Code	8977
 MILLER SCHOOL of MEDICINE	
Miami IDEA Exchange - Daily Log	
Date (Daily)	* must provide value (H) 2023-04-04 Today Y-M-D
Daily Location	* must provide value (H) Mobile
If this is a mobile daily visit, where did it occur?	* must provide value (H) Miami Beach
What type of encounter was this?	<input checked="" type="radio"/> In-person <input type="radio"/> Telehealth <input type="radio"/> Phone <input type="radio"/> Text

Save & Exit Form
Save & ...
- Cancel -

Show and Tell - Naloxone

Naloxone Information

Was person consented for naloxone? * must provide value Yes No

Was naloxone distributed? * must provide value No Yes

Required Referral Information

Referrals (Recommendation) * must provide value

- HIV Test
- HCV Test
- Referral to HIV treatment
- Referral to HCV treatment
- Referral to PrEP
- Referral to Primary Care or FQHC
- Referral to CMHC
- Referral to Detox
- Referral to Residential treatment
- Referral to Shelter
- COVID-19 Test
- IDEA Wound Care
- Other Outpatient treatment
- Referral to other research studies
- Not Referred

Agrees to HIV test today? * must provide value Yes

HIV Test Result * must provide value Positive Negative

Save & Exit Form
Save & ...
- Cancel -

Before and After Field Embedding

Naloxone Information	
Was person consented for naloxone?	<input checked="" type="radio"/> Yes <input type="radio"/> No
Was naloxone distributed?	<input checked="" type="radio"/> Yes <input type="radio"/> No
Type of Narcan Given - Nasal	<input checked="" type="checkbox"/> Nasal
Amount of Narcan - Nasal	1 <input type="button" value="▼"/>
Nasal: Distributed to...	<input checked="" type="radio"/> Participant <input type="radio"/> Family Member
Is this a narcan (nasal) refill?	<input checked="" type="radio"/> Yes <input type="radio"/> No
Reason for Narcan Nasal Refill	<input checked="" type="radio"/> Due to loss <input type="radio"/> Due to use
Date of loss - Nasal	2023-05-20 <input type="button" value="Today"/> Y-M-D
Type of Narcan Given - Auto-Injector	<input checked="" type="checkbox"/> Auto-Injector
Is this a narcan (injectable) refill?	<input checked="" type="radio"/> Yes <input type="radio"/> No
Type of Narcan Given - Injectable	<input checked="" type="checkbox"/> Injectable
Amount of Narcan given - Auto-Injector	1 <input type="button" value="▼"/>
Amount of Narcan given - Injectable	1 <input type="button" value="▼"/>
Auto-Injector: Distributed to...	<input checked="" type="radio"/> Participant

Naloxone Information						
Was person consented for naloxone?	<input checked="" type="radio"/> Yes <input type="radio"/> No					
Was naloxone distributed?	<input checked="" type="radio"/> Yes <input type="radio"/> No					
Instructions: Check the Type of Naloxone Distributed and Fill in the Details to include the amount distributed, to whom distributed, whether it was a refill, the reason for the refill, the date of loss (if applicable), and the number of reversals (if applicable).						
*** IMPORTANT: Record units NOT Boxes (1 BOX = 2 UNITS) ***						
* must provide value						
Type	Amount (Units)	To Who	Refill	Refill Reason	Date of Loss	Reversals
<input checked="" type="checkbox"/> Nasal	1 <input type="button" value="▼"/>	<input checked="" type="radio"/> Participant <input type="radio"/> Family Member	<input checked="" type="radio"/> Yes <input type="radio"/> No	<input checked="" type="radio"/> Due to loss <input type="radio"/> Due to use	2023-05-20 <input type="button" value="Today"/> Y-M-D	
<input type="checkbox"/> Auto-Injector	1 <input type="button" value="▼"/>	<input checked="" type="radio"/> Participant <input type="radio"/> Family Member	<input checked="" type="radio"/> Yes <input type="radio"/> No	<input checked="" type="radio"/> Due to loss <input type="radio"/> Due to use	2023-05-20 <input type="button" value="Today"/> Y-M-D	
<input checked="" type="checkbox"/> Injectable	1 <input type="button" value="▼"/>	<input checked="" type="radio"/> Participant <input type="radio"/> Family Member	<input checked="" type="radio"/> Yes <input type="radio"/> No	<input checked="" type="radio"/> Due to loss <input type="radio"/> Due to use	2023-05-20 <input type="button" value="Today"/> Y-M-D	
Total	3 <input type="button" value="▼"/> View equation					<input type="button" value="View equation"/>

Field Embedding with Branching Logic

- Add all the fields that may appear.
- Add a Descriptive Text field.
- Design the appearance with *What You See Is What You Get* (WYSIWYG) tools.
 - *Rich Text Editor* controls for text and drawing grids
 - Embed variables in the grid with { thingy } references

Field Embedding with Branching Logic

Add Field Add Matrix of Fields Import from Field Bank

Variable: da_narcan_grid Branching logic: [da_narcan_given]=1 Contains embedded fields

Instructions: Check the Type of Naloxone Distributed and Fill in the Details to include the amount distributed, to whom distributed, whether it was a refill, the reason for the refill, the date of loss (if applicable), and the number of reversals (if applicable).

*** IMPORTANT: Record units **NOT Boxes (1 BOX = 2 UNITS)** ***

* must provide value

Type	Amount (Units)	To Who	Refill	Refill Reason	Date of Loss	Reversals
{da_narcan_nasal}	{da_narcan_nasal_amt}	{da_narcan_who_nasal}	{da_narcan_refill_nasal}	{da_narcan_refill_nasal_why}	{da_narcan_nasal_loss_date}	{da_narcan_reversal_nasal}
{da_narcan_ai}	{da_narcan_ai_amt}	{da_narcan_who_ai}	{da_narcan_refill_ai}	{da_narcan_refill_ai_why}	{da_narcan_ai_loss_date}	{da_narcan_reversal_ai}
{da_narcan_inject}	{da_narcan_inject_amt}	{da_narcan_who_inject}	{da_narcan_refill_inject}	{da_narcan_refill_inject_why}	{da_narcan_inject_loss_date}	{da_narcan_reversal_inject}
Total	{da_narcan_total}					{da_narcan_reversal_total}

Add Field Add Matrix of Fields Import from Field Bank

Variable: da_narcan_nasal Branching logic: [da_narcan_given] = 1 Field is embedded elsewhere on page

Type of Narcan Given - Nasal Nasal

Add Field Add Matrix of Fields Import from Field Bank

Field is embedded elsewhere on page

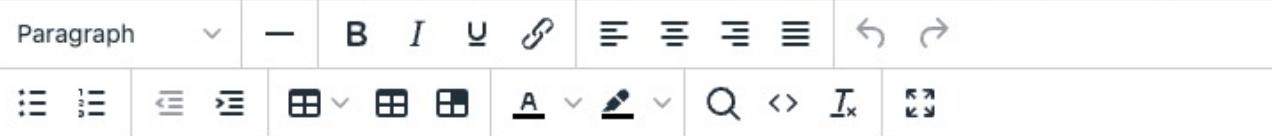
WYSIWYG - Pretty Data Collection

Edit Field ×

You may add a new project field to this data collection instrument by completing the fields below and clicking the Save button at the bottom. When you add a new field, it will be added to the form on this page. For an overview of the different field types available, you may view the [Field Types video \(4 min\)](#).

Field Type: Descriptive Text (with optional Image/Video/Audio/File Attachment) ▼

Field Label Use the Rich Text Editor ?



Instructions: Check the Type of Naloxone Distributed and Fill in the Details to include the amount distributed, to whom distributed, whether it was a refill, the reason for the refill, the date of loss (if applicable), and the number of reversals (if applicable).

*** IMPORTANT: Record units **NOT Boxes (1 BOX = 2 UNITS)** ***



Type	Amount (Units)	To Who	Refill	Refill Reason
{da_narcan_nasal}	{da_narcan_nasal_amt}	{da_narcan_who_nasal}	{da_narcan_refill_nasal}	{da_narcan_re}
{da_narcan_ai}	{da_narcan_ai_amt}	{da_narcan_who_ai}	{da_narcan_refill_ai}	{da_narcan_re}
{da_narcan_inject}	{da_narcan_inject_amt}	{da_narcan_who_inject}	{da_narcan_refill_inject}	{da_narcan_re}

Variable Name (utilized in logic, calcs, and exports)
 Enable auto naming of variable based upon its Field Label?
ONLY letters, numbers, and underscores

How to use Smart Variables Piping Field Embedding

Optional file attachment, image, audio, or video:

Embed an external video (provide video URL) ?

e.g. <https://youtube.com/watch?v=E1cCuWMupz0>,
<https://vimeo.com/62730281>, <http://example.com/movie.mp4>

Display format of video: Inline Inside popup
- or -

Attach an image, file, or embedded audio
Upload file

Display format of attachment on page:
 Link
 Inline image
 Audio file (play in embedded player on page)
[Compatibility notice for embedded audio](#)

Integrating with R

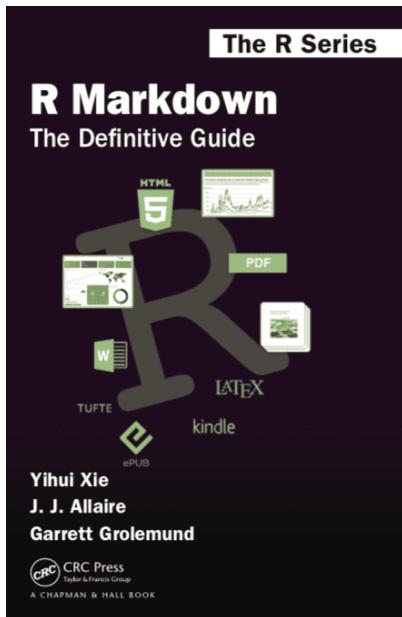
rUM

- I teach in a medical school (i.e., smart people who are not programmers).
- I teach `r` at UM, so to support my students, I give them `rUM`.
- It has menu-driven tools to add R Markdown code or to add complete projects.
- The projects contain:
 - Quarto or R Markdown paper shells for manuscripts
 - full-featured YAML header
 - code to add used packages to the paper bibliography
 - an aggressive `.gitignore` file
 - a data folder

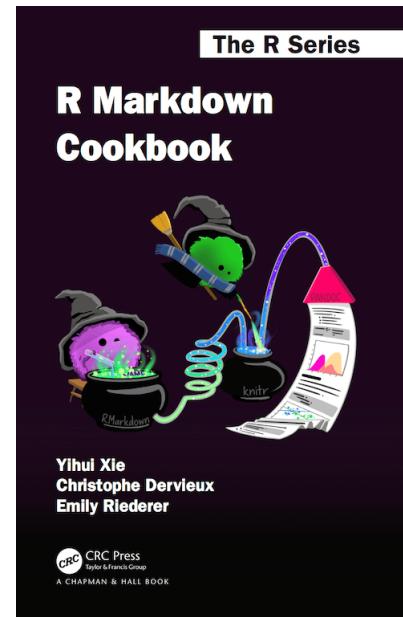
rUM Uses Posit's Brilliance

- rUM uses the Quarto and R Markdown magic that Yihui Xie and his colleagues at Posit/RStudio and around the world have created.

<https://quarto.org/>



[R Markdown: The Definitive Guide](#)



[R Markdown Cookbook](#)

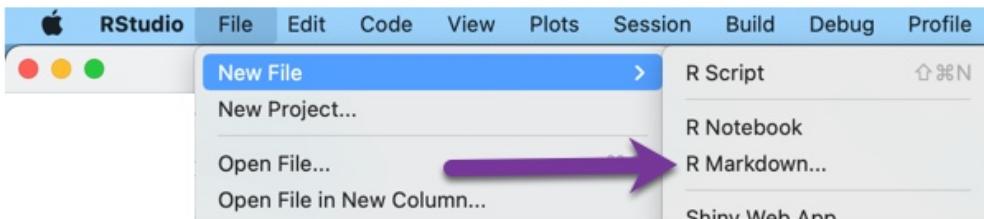
Using rUM

- Install with `remotes::install_cran("rUM")` or `install.packages("rUM")`.
- Completely stop and restart all your instances of RStudio. There are hooks into the graphical user interface, so you need a FULL restart. Expect problems if you just try to restart R.

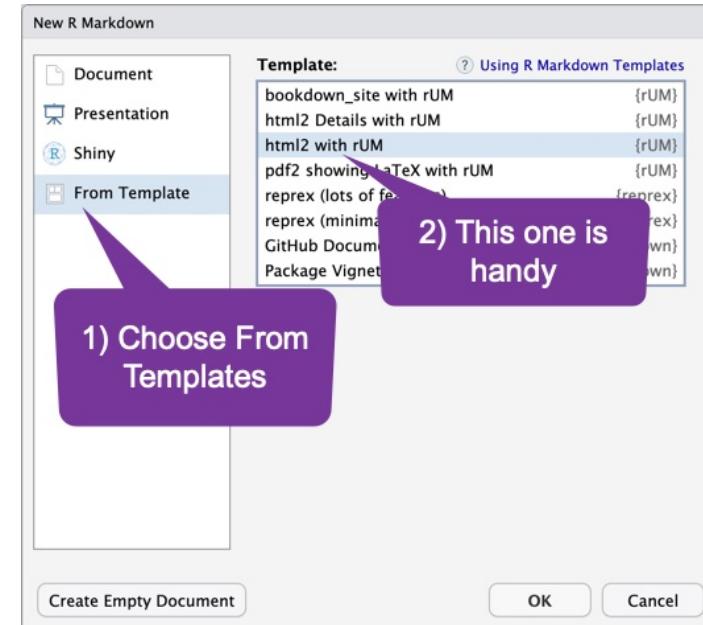
Add a Splash of rUM

- rUM has a bunch of headers that include YAML and setup instructions. A header is setup code that "always" appears at the top of a program.

1) From the RStudio file menu, choose R Markdown...



2) Choose From Template and then choose "html2 with rUM":



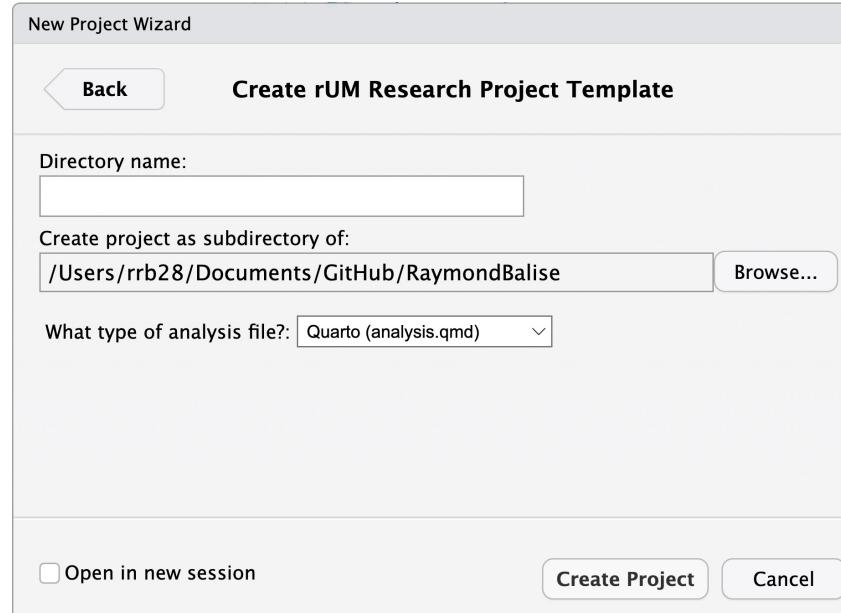
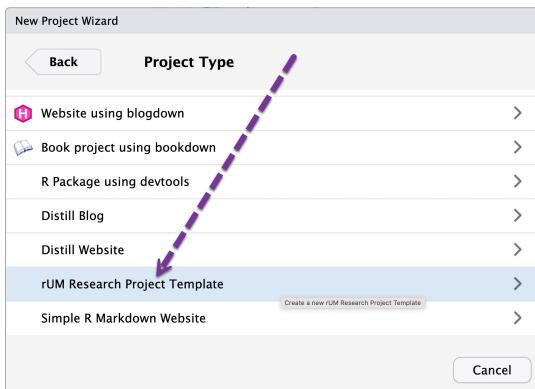
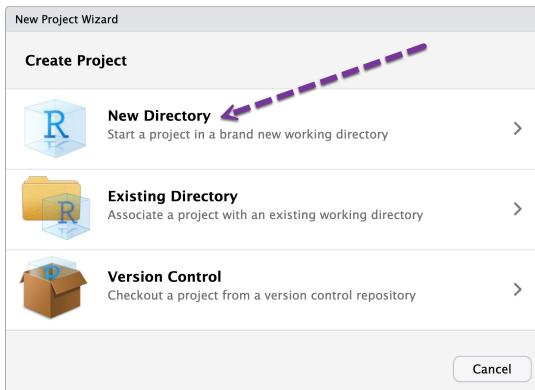
```
---
```

```
title: "html2"
author: "name"
date: "`r Sys.Date()`"
output:
  bookdown::html_document2
---
```

```
```{r setup, include=FALSE}
knitr::opts_chunk$set(
 # These options can be set to FALSE (capitalization matters).
 echo = TRUE, # show code
 message = TRUE, # show messages
 warning = TRUE, # show warnings
 error = TRUE, # show errors
 comment = "", # don't show ## with printed output
)
```



# Make a rUM Infused Project



```
rUM::make_project(
 path,
 type = c("Quarto (analysis.qmd)", "R Markdown (analysis.Rmd)")
)
```

The sections (with code) are waiting.

An aggressive .gitignore file.

Format for your favorite journal.

---

```
title: "your_title_goes_here"
author: "your_name_goes_here"
date: `r Sys.Date()`
format:
 html:
 self-contained: true
knitr:
 opts_chunk: ##### set global options #####
 collapse: true # keep code from blocks together (if shown)
 echo: false # don't show code
 message: true # show messages
 warning: true # show warnings
 error: true # show error messages
 comment: "" # don't show ## with printed output
 R.options:
 digits: 3 # round to three digits
editor: visual
```

(Top Level) Quarto

Console Terminal Background Jobs

R 4.2.2 · ~/Desktop/blah/

R is free software and comes with ABSOLUTELY NO WARRANTY.  
You are welcome to redistribute it under certain conditions.  
Type 'license()' or 'licence()' for distribution details.

Natural language support but running in an English locale

R is a collaborative project with many contributors.  
Type 'contributors()' for more information and  
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or  
'help.start()' for an HTML browser interface to help.  
Type 'q()' to quit R.

> |

Environment History Connections Tutorial

Files Plots Packages Help Viewer Presentation

New Folder New Blank File Delete Rename More

Name Size Modified

Name	Size	Modified
..	1.4 KB	Apr 6, 2023, 7:51 AM
.gitignore	780.7 KB	Apr 6, 2023, 7:58 AM
analysis.html	1.5 KB	Apr 6, 2023, 7:58 AM
analysis.qmd	276 B	Apr 6, 2023, 7:51 AM
blah.Rproj	4.6 KB	Apr 6, 2023, 7:58 AM
data	1 B	Apr 6, 2023, 7:51 AM
packages.bib	5.5 KB	Apr 6, 2023, 7:51 AM
R		
references.bib		
the-new-england-journal-of-medicine.csl		

# R Markdown

```

```

```
title: "your_title_goes_here"
author: "your_name_goes_here"
date: "`r Sys.Date()`"
output:
 bookdown::html_document2:
 number_sections: false
bibliography: [references.bib, packages.bib]
csl: the-new-england-journal-of-medicine.csl

```

```
{r setup, echo=FALSE}
knitr::opts_chunk$set(
 ##### set global options #####
 echo = FALSE, # don't show code
 collapse = TRUE, # keep code from blocks together (if shown)
 message = TRUE, # show messages
 warning = TRUE, # show warnings
 error = TRUE, # show error messages
 comment = "" # don't show ## with printed output
)

R's default rounding is to show 7 digits. This rounds results to 3 digits.
options(digits = 3)
```

```
{r tidyverse, echo=FALSE}
library(conflicted)
conflict_prefer("filter", "dplyr", quiet = TRUE)
conflict_prefer("lag", "dplyr", quiet = TRUE)
suppressPackageStartupMessages(library(tidyverse))

suppress ``summarise()`` has grouped output by " messages
options(dplyr.summarise.inform = FALSE)
```

# Quarto

```

```

```
title: "your_title_goes_here"
author: "your_name_goes_here"
date: "`r Sys.Date()`"
format:
 html:
 self-contained: true
knitr:
 opts_chunk: ##### set global options #####
 collapse: true # keep code from blocks together (if shown)
 echo: false # don't show code
 message: true # show messages
 warning: true # show warnings
 error: true # show error messages
 comment: "" # don't show ## with printed output
 R.options:
 digits: 3 # round to three digits
 editor: visual
 bibliography: [references.bib, packages.bib]
 csl: the-new-england-journal-of-medicine.csl

```

```
{r}
#| label: tidyverse
#| echo: false

library(conflicted)
conflict_prefer("filter", "dplyr", quiet = TRUE)
conflict_prefer("lag", "dplyr", quiet = TRUE)

suppressPackageStartupMessages(library(tidyverse))

suppress ``summarise()`` has grouped output by " messages
options(dplyr.summarise.inform = FALSE)
```

# The Default Output

your\_title\_goes\_here

AUTHOR

your\_name\_goes\_here

PUBLISHED

May 19, 2023

## Introduction

## Methods

Analyses were conducted with R version 4.3.0 with the `tidyverse` (2.0.0), `rUM` (1.0.2), `table1` (1.4.3) packages used to preprocess and summarize data.<sup>1–5</sup>

## Results

## Conclusion

NEJM reference style

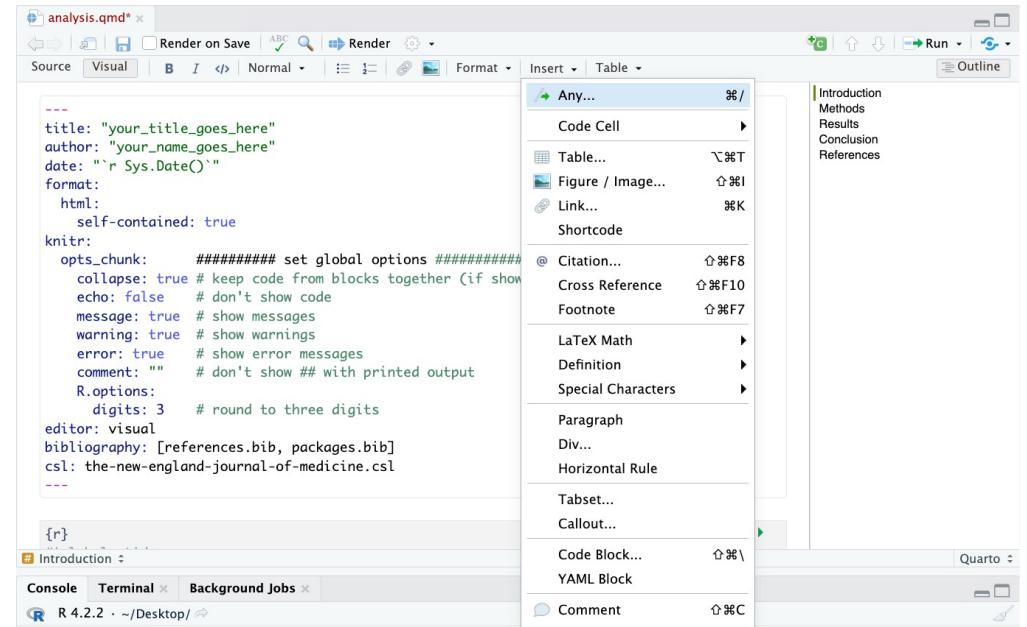
## References

1. R Core Team. R: A language and environment for statistical computing [Internet]. Vienna, Austria: R Foundation for Statistical Computing; 2023. Available from: <https://www.R-project.org/>
2. Wickham H. Tidyverse: Easily install and load the tidyverse. 2023.
3. Wickham H, Averick M, Bryan J, et al. [Welcome to the tidyverse](#). Journal of Open Source Software 2019;4(43):1686.
4. Balise R, Odom G, Grealis K, Cardozo F. rUM: R templates from the university of miami. 2023.
5. Rich B. table1: Tables of descriptive statistics in HTML [Internet]. 2023. Available from: <https://github.com/benjaminrich/table1>

# Visual Editor to Do Stuff

- point-and-click formatting
- basic tables
- images
- add references/citations

In the Visual Editor, typing  / on Mac or cmd / on Linux/Windows is very useful.



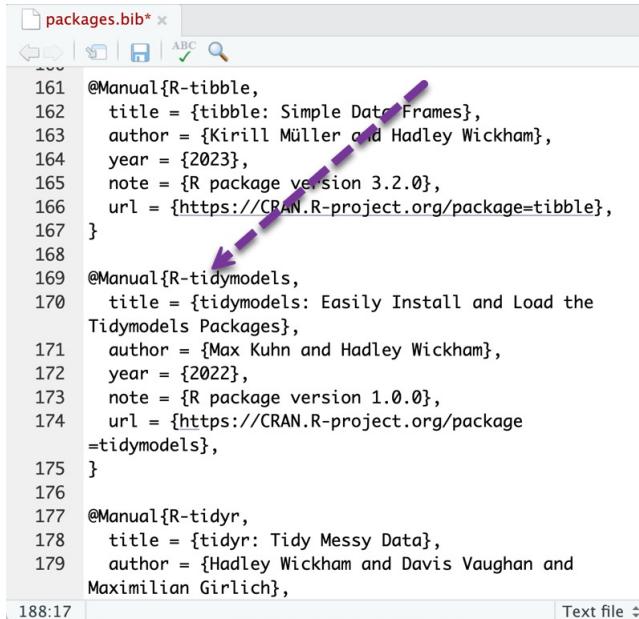
# The Bibliography

- The bibliography section of the template has code to find the packages used in the R Markdown or Quarto file and add them to the "packages.bib" file.

```
automatically create a bib database for loaded R packages & rUM
knitr::write_bib(
 c(
 .packages(),
 "rUM",
 "table1"
),
 "packages.bib"
)
```

# Use Package

- Say you add `library(tidymodels)` to your analysis file.
- After you "knit" or "render" once, the package details will be added to the "packages.bib" file.



```
packages.bib* x
161 @Manual{R-tibble,
162 title = {tibble: Simple Data Frames},
163 author = {Kirill Müller and Hadley Wickham},
164 year = {2023},
165 note = {R package version 3.2.0},
166 url = {https://CRAN.R-project.org/package=tibble},
167 }
168
169 @Manual{R-tidymodels,
170 title = {tidymodels: Easily Install and Load the
171 Tidymodels Packages},
172 author = {Max Kuhn and Hadley Wickham},
173 year = {2022},
174 note = {R package version 1.0.0},
175 url = {https://CRAN.R-project.org/package
176 =tidymodels},
177
178 @Manual{R-tidyr,
179 title = {tidyr: Tidy Messy Data},
180 author = {Hadley Wickham and Davis Vaughan and
181 Maximilian Girlich},
```

# Reference It

- You can copy and paste the reference examples that are in the *Methods* (or point and click) to add it to the text in your methods section.

```
@Manual{R-tidymodels,
 title = {tidymodels: Easily Install and Load the
Tidymodels Packages},
 author = {Max Kuhn and Hadley Wickham},
 year = {2022},
 note = {R package version 1.0.0},
 url = {https://CRAN.R-project.org/package
=tidymodels},
}
```

Analyses were conducted with `r stringr::word(R.Version()\$version.string, 1, 3)` with the `tidyverse` (`r packageVersion("tidyverse")`), `rUM` (`r packageVersion("rUM")`), `table1` (`r packageVersion("table1")`) packages used to preprocess and summarize data. [R-base; R-tidyverse; tidyverse2019; R-rUM; R-table1]. Modeling was done with the `tidymodels` ecosystem. [R-tidymodels]

## Methods

Analyses were conducted with R version 4.2.2 with the `tidyverse` (2.0.0), `rUM` (1.0.2), `table1` (1.4.3) packages used to preprocess and summarize data.<sup>1-5</sup>. Modeling was done with the `tidymodels` ecosystem.<sup>6</sup>

## Results

## Conclusion

### References

1. R Core Team. R: A language and environment for statistical computing [Internet]. Vienna, Austria: R Foundation for Statistical Computing; 2022. Available from: <https://www.R-project.org/>
2. Wickham H. Tidyverse: Easily install and load the tidyverse [Internet]. 2023. Available from: <https://CRAN.R-project.org/package=tidyverse>
3. Wickham H, Averick M, Bryan J, et al. [Welcome to the tidyverse](#). Journal of Open Source Software 2019;4(43):1686.
4. Balise R, Odom G, Greolis K, Cardozo F. rUM: R templates from the university of miami. 2023.
5. Rich B. table1: Tables of descriptive statistics in HTML [Internet]. 2023. Available from: <https://github.com/benjaminrich/table1>
6. Kuhn M, Wickham H. Tidymodels: Easily install and load the tidymodels packages [Internet]. 2022. Available from: <https://CRAN.R-project.org/package=tidymodels>

# Reference Style

By default, the style is set to be New England Journal of Medicine. That is controlled by one line in the YAML header

```
csl: the-new-england-journal-of-medicine.csl
```

and a details file that you can get from here: <https://www.zotero.org/styles>

## Zotero Style Repository

Here you can find [Citation Style Language](#) 1.0.2 citation styles for use with [Zotero](#) and other CSL 1.0.2–compatible software. For more information on using CSL styles with Zotero, see the [Zotero wiki](#).

Style Search      Format: numeric  
JAMA      Fields: medicine  
 Show only unique styles

2 styles found:

- [JAMA \(The Journal of the American Medical Association\)](#) (2013-06-03 16:58:03)
- [JAMA Dermatology](#) (2013-04-29 23:55:49)

Save the CSL file into the project directory and tweak the YAML.

# .gitignore

- I teach workflows that use git and GitHub to students in the medical school. So rUM infused projects include my very aggressive **.gitignore** file. It attempts to block common dataset formats (Excel, Python, R, SAS, SPSS, STATA, text, and zip files). Take a look and tell me if I am missing anything.

```
Version 2022-08-12

History files
.Rhistory
.Rapp.history

Session Data files
.RData
*.RData

User-specific files
.Ruserdata

Example code in package build process
*-Ex.R

Output files from R CMD build
/*.tar.gz
```

# REDCap R Packages/Tools

# Summary of REDCap Processing Packages - History

- Info was current on May 29th, 2023.

	<b>REDCapExporter</b>	<b>tidyREDCap</b>	<b>REDCapTidieR</b>	<b>REDCapDM</b>
CRAN Downloads	15,840	15,207	2,390	1,618
First CRAN Release	2019-12-22	2020-01-14	2022-09-21	2022-12-22
Latest CRAN Release Date	2021-02-02	2023-05-29	2023-05-18	2023-03-31
Latest GitHub Update Date	2021-03-05	2023-05-29	2023-05-26	2023-03-31

# Summary of REDCap Processing Packages

Feature	REDCapExporter	tidyREDCap	REDCapTidieR	REDCapDM
API Export Project into a R package	✓	✗	✗	✗
Manually Export and Load into R	✗	✓	✗	✓
API Export a Single Table	✗	✓	✗	✗
API Export All Tables	✗	✓	✓	✓
Use>Show Field Labels	✗	✓	✓	✓
Summary Tables Choose One Questions	✗	✓	✗	✗
Summary Tables Choose All Questions	✗	✓	✗	✗
Convert Checked/Unchecked to Yes/No Yes/No/Unknown	✗	✓	✗	✗
Tools for Querying Logical Expressions	✗	✗	✗	✓
Tools for Counting Longitudinal Events	✗	✗	✗	✓
Recalcualte Calculated Fields	✗	✗	✗	✓
Split Data by Event/Form	✗	✗	✗	✓
Summarize Metadata	✗	✗	✓	✗

# One Package to Rule Them All - **REDCapR**

- **REDCapR** - Has all the functionality to push and pull all kinds of data into and out of REDCap.

# REDCap Processing with tidyREDCap

# What tidyREDCap Does

## 1. Easy imports into R from REDCap

- `import_instruments()` imports all data with labels (i.e., the text that appears on the survey page).

## 2. Summarize categorical variables

- `make_choose_one_table()` makes a summary of a choose-one question.
- `make_choose_all_table()` shows counts of all the options chosen from choose-all questions.
- `make_binary_word()` shows response patterns from choose-all questions.

<https://raymondbalise.github.io/tidyREDCap/>

# Import Everything with **tidyREDCap::import\_instruments()**

- `tidyREDCap` allows you to pull in all the instruments by adding a `tidyREDCap::import_instruments()` call. All you need is the **URL** for your copy of REDCap and your **API** token.
- **Do not save your API token in your code.** It is way too easy to accidentally give away your password.
- There are good options to securely store your API keys. If you work on an secure/encrypted machine, a fair alternative is to store your API keys in your *R environment* file. I use: `usethis::edit_r_environ()`

# Store Your API Token

- Copy the token (password text) from REDCap.

The screenshot shows the REDCap Applications page. On the left, there's a sidebar with various project management tools like Project Dashboards, Alerts & Notifications, Multi-Language Management, Calendar, Data Exports, Reports, and Stats, Data Import Tool, Data Comparison tool, Logging and Email Logging, Field Comment Log, File Repository, User Rights and DAGs, Customize & Manage Locking/E-signatures, Data Quality, API and API Playground, and External Modules. A large purple arrow points from the sidebar towards the right panel. The right panel is titled "Your API token for project 'IDEA - R Medicine 2023'". It contains a warning message: "The API token below is ONLY for you and will work ONLY with this project. This token allows special access to REDCap data and should NOT be shared with others. If you think your token has been compromised, then please contact your REDCap administrator immediately AND either delete or regenerate your token by using the buttons below." Below this is a section titled "API Token:" with a long, randomly generated token string: "CZQH2XQD0L7R2PZKXKXKXKJ0". At the bottom, there are two buttons: "Delete token" and "Regenerate token".

- Open your R environment file with `usethis::edit_r_environ()` and give your token a meaningful name. Use an = and quote the string.

The screenshot shows an RStudio code editor with a file named ".Renviron\*" open. The code contains the following assignment statement:

```
IDEA_R_Medicine_2023 = "CZQH2XQD0L7R2PZKXKXKXKJ0"
```

The code editor interface includes tabs for Run and Run Script, and a status bar at the bottom indicating "Shell".

# Add Code to Load

- Typically you would just do:

```
tidyREDCap::import_instruments(
 "https://redcap.miami.edu/api/",
 Sys.getenv("nacho_anxiety_key")
)
```

- Because this project uses a custom subject ID name and numbering, do:

```
tidyREDCap::import_instruments(
 url = "https://redcapdemo.vanderbilt.edu/api/",
 token = Sys.getenv("IDEA_R_Medicine_2023_Clone"),
 record_id= "id_code", first_record_id = "07"
)
```

# What could possibly go wrong?

If you see:

```
Error in REDCapR::redcap_metadata_read(redcap_uri = url, token = token) :
 Assertion on 'token' failed: Must comply to pattern '^.{1,}$.':
```

`tidyREDCap` can't find the name of the API key in your `.Renviron` file. Check for inconsistency (a typo) between the two places where the name is typed.

```
Error in sanitize_token(token) :
 The token is not a valid 32-character hexadecimnal value.
```

The API key is invalid. Try to copy and paste it again. ***Restart R***.

```
Error in `pull()` :
 ! `!!enquo(var)` must select exactly one column.
Run `rlang::last_error()` to see where the error occurred.
```

The API key is not associated with a REDCap project. Try to copy and paste it again. ***Restart R***.

# Loaded Data

The screenshot shows the RStudio interface with the following details:

- Environment** tab is active.
- Import Dataset** button is visible.
- Memory** dropdown shows "R".
- Global Environment** dropdown is open.
- Data** section lists two datasets:
  - daily**: 26 obs. of 190 variables
  - enrollment**: 23 obs. of 127 variables

- The data is imported and the variables have labels:

	id_code	date Date	is_mobile Enrollment Location:	is_mobile_where If this is a mobile visit, where did it occur?	initials Name Initials
1	07	2016-07-05	Fixed	NA	AB
2	15	2016-09-09	Fixed	NA	EF
3	23	2016-11-16	Fixed	NA	IJ

	id_code	redcap_repeat_instance	da_date Date (Daily)	da_is_mobile Daily Location	da_is_mobile_where If this is a mobile daily visit, where did it occur?
13	45		1	2016-02-23	Fixed
14	45		2	2016-07-22	Fixed
15	45		3	2017-03-02	Overtown
16	52		1	2016-12-25	Miami Beach
17	52		2	2017-08-21	Miami Beach
18	65		1	2016-10-10	Fixed
19	65		2	2017-01-14	County Line
20	65		3	2017-09-04	County Line

# The Origin of tidyREDCap

- Novices could not process the export of choose-all-that-apply questions.
    - For example, the export has a column for Carfentanil, Cocaine, Crack, etc.
  - How do we get the count of all the chosen things?
  - How can we look at co-occurring patterns?

injection_drugs__1	injection_drugs__2	injection_drugs__3
In the past 30 days, which injection drugs have you used?: ...	In the past 30 days, which injection drugs have you used?: ...	In the past 30 days, which injec
Unchecked	In the past 30 days, which injection drugs have you used?: Carfentanil	Unchecked
Unchecked	Unchecked	Unchecked
Unchecked	Unchecked	Unchecked
Unchecked	Unchecked	Unchecked
Unchecked	Checked	Unchecked
Unchecked	Unchecked	Unchecked
Unchecked	Checked	Unchecked
Unchecked	Unchecked	Unchecked
Unchecked	Unchecked	Unchecked
Unchecked	Unchecked	Unchecked
Unchecked	Checked	Unchecked
Unchecked	Unchecked	Unchecked
Unchecked	Unchecked	Unchecked
Unchecked	Checked	Unchecked

# **make\_choose\_one\_table()**

```
library(tidyREDCap)
enrollment |>
 make_choose_one_table(injection_drugs____1) |>
 knitr::kable()
```

## In the past 30 days, which injection drugs have you used?: Carfentanil

Response	n	percent
Checked	1	3%
Unchecked	33	97%

# make\_choose\_all\_table()

- Merge all the choices into a single column and do a count:

```
library(tidyREDCap)
enrollment |>
 make_choose_all_table("injection_drugs__") |>
 knitr::kable()
```

What	Count
Carfentanil	1
Cocaine	5
Crack	2
Fentanyl	9
Heroin	12
Hormones	0
Methamphetamine	6
Pain Killers	0
Prescription Opioids	1
	0

# `make_binary_word()`

1

- Use `_` or a letter to show co-occurring patterns:

Var	Abbreviation	Drug
1	R	Carfentanil
2	C	Cocaine
3	K	Crack
4	F	Fentanyl
5	H	Heroin
7	M	Methamphetamine
8	P	Pain Killers
9	O	Prescription Opioids
10	S	Speedball

pattern	n	percent
R_____	1	2.94%
_C_F____S	1	2.94%
_C_F_____	1	2.94%
_C__HM__S	1	2.94%
_C__H__OS	1	2.94%
_C__M____	1	2.94%
_K_____	2	5.88%
__F_M__S	1	2.94%
__F_____	6	17.65%
__H__S	4	11.76%
__H_____	6	17.65%
__M____	3	8.82%
_____S	1	2.94%
_____	5	14.71%

# make\_binary\_word() 2

```
suppressPackageStartupMessages(library(tidyverse))

labels <-
 c("R", "C", "K", "F", "H", "M", "P", "O", "S")

pattern <-
 enrollment |>
 select(
 injection_drugs__1:injection_drugs__5,
 injection_drugs__7:injection_drugs__10
) |>
 make_binary_word(the_labels = labels)

janitor::tabyl(pattern) |>
 janitor::adorn_pct_formatting(digits =2) |>
 knitr::kable()
```

pattern	n	percent
R_____	1	2.94%
_C_F____S	1	2.94%
_C_F_____	1	2.94%
_C_HM__S	1	2.94%
_C_H_OS	1	2.94%
_C_M____	1	2.94%
_K_____	2	5.88%
_F_M__S	1	2.94%
_F_____	6	17.65%
_H__S	4	11.76%
_H_____	6	17.65%
_M____	3	8.82%
_____S	1	2.94%
_____	5	14.71%

# But wait there is more!

- `tidyREDCap` also has tools for converting checked/unchecked/unknown into yes/no responses.

```
library(tidyREDCap)
make_yes_no(enrollment$injection_drugs___1) |>
 tidyREDCap::make_choose_one_table()
```

```
Response n percent
No or Unknown 33 97%
Yes 1 3%
```

```
make_yes_no_unknown(enrollment$injection_drugs___1) |>
 tidyREDCap::make_choose_one_table()
```

```
Response n percent
No 33 97%
Yes 1 3%
Unknown 0 0%
```

# Thank you!

- IDEA
  - Hansel Tookes, MD MPH, University of Miami
  - Tyler Bartholomew, PhD, University of Miami
  - Belen del Sol Hervera, MPH, University of Miami
- [rUM](#)
  - Gabriel Odom, PhD, Florida International University
  - Kyle Grealis, MS, University of Miami
  - Francisco Cardoza, (almost PhD) University of Miami
  - Frank Gutierrez, MS, University of Miami
- [tidyREDCap](#)
  - Gabriel Odom, PhD, Florida International University
  - Anna Calderon, MS, University of Miami
  - Layla Bouzoubaa, MSPH, Drexel University
  - Wayne DeFreitas, MS, University of Miami
  - Lauren Nahodyl, MS, University of Miami
  - Lionel Henry, Posit
  - Davis Vaughan, Posit
- All of this work
  - Daniel Feaster, PhD, University of Miami
  - The R and R/Medicine community

# Funding That Made This Work Possible

- Healing Communities Study: Developing and Testing an Integrated Approach to Address the Opioid Crisis-New York State. National Institute on Drug Abuse, 1 UM1 DA049415
- CTN-0094 Individual Level Predictive Modeling of Opioid Use Disorder Treatment Outcome. Florida Node Alliance of The Drug Abuse Clinical Trials Network (NIDA) UG1 DA013720
- University of Miami Center for HIV and Researching Mental Health (CHARM) NIH 1P30MH116867-01A1
- University of Miami, Sylvester Comprehensive Cancer Center
- Florida International University, Stempel College of Public Health

# But wait there is even more!

The developers of [REDCapTidieR](#) gives your REDCap projects super(tibble) powers and [REDCapDM](#) gives you tailored data management/checking tools.

# **... and there is still more!**

The ultimate power, including loading your data into REDCap, is at your fingertips with the [REDCapR](#) package.