# A Longitudinal Study of the Effect of Renal Failure on Readmission Rates of Patients with *Clostridium Difficile*

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# Abstract

Clostridium Difficile Infection (C. *diff*, or simply CDI) is a highly contagious endospore forming bacterium that is transferred through physical contact with an infected surface. Symptoms range from diarrhea to life-threatening colitis and is most commonly acquired in a hospital setting where antimicrobials have been administered. Increased mortality in CDI patients with renal failure comorbidities has appeared in the literature as early as 1998 [1]. In this study, we use the *Nationwide Readmissions Database* to assess the risk of 30, 60, and 90 day readmissions in patients with comorbid CDI and renal failure conditions. We also discuss general CDI trends from 2001-2014, using the *Nationwide Inpatient Sample*.

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# Chapter 1

# Introduction

Clostridium Difficile Infection (often referred to as C. *diff*, or CDI), has been an increasing concern in hospitals and nursing homes, where it is most frequently acquired. [2] [3]

## 1.1 Literature review

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tesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

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litora torquent per conubia nostra, per inceptos hymenaeos. Praesent sapien turpis, fermentum vel, eleifend faucibus, vehicula eu, lacus.

# Chapter 2

# Methods

## 2.1 Data source

The Agency for Healthcare Research and Quality (AHRQ), under the Department of Health and Human Services (DHHS), sponsors the Healthcare Cost and Utilization Project (HCUP), a collection of databases including the Nationwide Inpatient Sample (NIS) and the Nationwide Readmissions Database (NRD). [4]

### 2.1.1 Nationwide Inpatient Sample

The NIS is an annual survey of inpatient discharges dating back to 1988.

### 2.1.2 Nationwide Readmissions Database

## 2.2 Study sample

## 2.3 Statistical analysis

# Chapter 3

# Results

## 3.1 Trends

C. *diff* has been on the rise since the first reported major outbreak of ribotype 027, a hypervirulent strain, in 2004 [5].

```
## [1] 2001

## Parsed with column specification:
## cols(
##  nis_key = col_character(),
##  nis_year = col_integer(),
##  nis_stratum = col_integer(),
##  age = col_integer(),
##  discwt = col_double(),
##  hospid = col_integer(),
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```
##  ckd6 = col_integer(),
##  renal_failure_unspecified = col_integer()
## )


## Parsed with column specification:
## cols(
##  nis_key = col_character(),
##  nis_year = col_integer(),
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##  discwt = col_double(),
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##  ckd4 = col_integer(),
##  ckd5 = col_integer(),
```

```
##  ckd6 = col_integer(),
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##  ckd3 = col_integer(),
##  ckd4 = col_integer(),
##  ckd5 = col_integer(),
##  ckd6 = col_integer(),
##  renal_failure_unspecified = col_integer()
## )
```

```
## $`2001_ckd`
##                          2.5% 97.5%
## I(ckd == 1) 0.00874 0.00825  0.01
##
## $`2001_ckd1`
##                             2.5% 97.5%
## I(ckd1 == 1) 2.90e-12 2.81e-12     0
##
## $`2001_ckd2`
##                             2.5% 97.5%
## I(ckd2 == 1) 2.90e-12 2.81e-12     0
##
## $`2001_ckd3`
##                             2.5% 97.5%
## I(ckd3 == 1) 2.90e-12 2.81e-12     0
##
## $`2001_ckd4`
##                             2.5% 97.5%
## I(ckd4 == 1) 2.90e-12 2.81e-12     0
##
## $`2001_ckd5`
##                             2.5% 97.5%
## I(ckd5 == 1) 2.90e-12 2.81e-12     0
##
## $`2001_ckd6`
##                             2.5% 97.5%
## I(ckd6 == 1) 2.90e-12 2.81e-12     0
##
## $`2001_renal_failure`
##                                                                          2.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.0239 0.0231
##                                                                        97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.02
##
## $`2002_cdi`
##                          2.5% 97.5%
```

```
## I(cdi == 1) 0.00511 0.00477  0.01
##
## $`2002_aki`
##                       2.5% 97.5%
## I(aki == 1) 0.0196 0.0187  0.02
##
## $`2002_ckd`
##                         2.5% 97.5%
## I(ckd == 1) 0.00823 0.00777  0.01
##
## $`2002_ckd1`
##                             2.5% 97.5%
## I(ckd1 == 1) 2.89e-12 2.79e-12     0
##
## $`2002_ckd2`
##                             2.5% 97.5%
## I(ckd2 == 1) 2.89e-12 2.79e-12     0
##
## $`2002_ckd3`
##                             2.5% 97.5%
## I(ckd3 == 1) 2.89e-12 2.79e-12     0
##
## $`2002_ckd4`
##                             2.5% 97.5%
## I(ckd4 == 1) 2.89e-12 2.79e-12     0
##
## $`2002_ckd5`
##                             2.5% 97.5%
## I(ckd5 == 1) 2.89e-12 2.79e-12     0
##
## $`2002_ckd6`
##                             2.5% 97.5%
## I(ckd6 == 1) 2.89e-12 2.79e-12     0
##
## $`2002_renal_failure`
##                                                                  2.5%
```

```
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.0265 0.0254
##                                                                    97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.03
##
## $`2003_cdi`
##                          2.5% 97.5%
## I(cdi == 1) 0.00543 0.00511  0.01
##
## $`2003_aki`
##                        2.5% 97.5%
## I(aki == 1) 0.0231 0.0222  0.02
##
## $`2003_ckd`
##                          2.5% 97.5%
## I(ckd == 1) 0.00796 0.00746  0.01
##
## $`2003_ckd1`
##                             2.5% 97.5%
## I(ckd1 == 1) 2.89e-12 2.79e-12     0
##
## $`2003_ckd2`
##                             2.5% 97.5%
## I(ckd2 == 1) 2.89e-12 2.79e-12     0
##
## $`2003_ckd3`
##                             2.5% 97.5%
## I(ckd3 == 1) 2.89e-12 2.79e-12     0
##
## $`2003_ckd4`
##                             2.5% 97.5%
## I(ckd4 == 1) 1.16e-07 1.63e-08     0
##
## $`2003_ckd5`
##                             2.5% 97.5%
## I(ckd5 == 1) 2.89e-12 2.79e-12     0
##
```

```
## $`2003_ckd6`
##                            2.5% 97.5%
## I(ckd6 == 1) 1.01e-06 1.42e-07     0
##
## $`2003_renal_failure`
##                                                                      2.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.0296 0.0285
##                                                                     97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.03
##
## $`2004_cdi`
##                          2.5% 97.5%
## I(cdi == 1) 0.00631 0.00597  0.01
##
## $`2004_aki`
##                        2.5% 97.5%
## I(aki == 1) 0.0271 0.0260  0.03
##
## $`2004_ckd`
##                          2.5% 97.5%
## I(ckd == 1) 0.00677 0.00643  0.01
##
## $`2004_ckd1`
##                            2.5% 97.5%
## I(ckd1 == 1) 2.89e-12 2.79e-12     0
##
## $`2004_ckd2`
##                            2.5% 97.5%
## I(ckd2 == 1) 2.89e-12 2.79e-12     0
##
## $`2004_ckd3`
##                            2.5% 97.5%
## I(ckd3 == 1) 2.89e-12 2.79e-12     0
##
## $`2004_ckd4`
##                            2.5% 97.5%
```

```
## I(ckd4 == 1) 2.89e-12 2.79e-12     0
##
## $`2004_ckd5`
##                            2.5% 97.5%
## I(ckd5 == 1) 2.89e-12 2.79e-12     0
##
## $`2004_ckd6`
##                            2.5% 97.5%
## I(ckd6 == 1) 2.89e-12 2.79e-12     0
##
## $`2004_renal_failure`
##                                                                          2.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.0324 0.0312
##                                                                        97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.03
##
## $`2005_cdi`
##                         2.5% 97.5%
## I(cdi == 1) 0.00757 0.00716  0.01
##
## $`2005_aki`
##                       2.5% 97.5%
## I(aki == 1) 0.0309 0.0297  0.03
##
## $`2005_ckd`
##                       2.5% 97.5%
## I(ckd == 1) 0.0129 0.0124  0.01
##
## $`2005_ckd1`
##                            2.5% 97.5%
## I(ckd1 == 1) 5.59e-05 3.49e-05     0
##
## $`2005_ckd2`
##                            2.5% 97.5%
## I(ckd2 == 1) 0.000162 0.000139     0
##
```

```
## $`2005_ckd3`
##                            2.5% 97.5%
## I(ckd3 == 1) 0.000429 0.000365     0
##
## $`2005_ckd4`
##                            2.5% 97.5%
## I(ckd4 == 1) 0.000390 0.000352     0
##
## $`2005_ckd5`
##                            2.5% 97.5%
## I(ckd5 == 1) 0.000247 0.000207     0
##
## $`2005_ckd6`
##                          2.5% 97.5%
## I(ckd6 == 1) 0.00421 0.00397     0
##
## $`2005_renal_failure`
##                                                                          2.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.0456 0.0441
##                                                                         97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.05
##
## $`2006_cdi`
##                         2.5% 97.5%
## I(cdi == 1) 0.00787 0.00745  0.01
##
## $`2006_aki`
##                       2.5% 97.5%
## I(aki == 1) 0.0361 0.0347  0.04
##
## $`2006_ckd`
##                       2.5% 97.5%
## I(ckd == 1) 0.0239 0.0229  0.02
##
## $`2006_ckd1`
##                            2.5% 97.5%
```

```
## I(ckd1 == 1) 0.000216 0.000132     0
##
## $`2006_ckd2`
##                            2.5% 97.5%
## I(ckd2 == 1) 0.000876 0.000758     0
##
## $`2006_ckd3`
##                           2.5% 97.5%
## I(ckd3 == 1) 0.00330 0.00281     0
##
## $`2006_ckd4`
##                           2.5% 97.5%
## I(ckd4 == 1) 0.00241 0.00219     0
##
## $`2006_ckd5`
##                           2.5% 97.5%
## I(ckd5 == 1) 0.00133 0.00116     0
##
## $`2006_ckd6`
##                         2.5% 97.5%
## I(ckd6 == 1) 0.0199 0.0188  0.02
##
## $`2006_renal_failure`
##                                                                          2.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.0780 0.0754
##                                                                        97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.08
##
## $`2007_cdi`
##                          2.5% 97.5%
## I(cdi == 1) 0.00810 0.00769  0.01
##
## $`2007_aki`
##                        2.5% 97.5%
## I(aki == 1) 0.0434 0.0415  0.05
##
```

```
## $`2007_ckd`
##                       2.5% 97.5%
## I(ckd == 1) 0.0436 0.0419  0.05
##
## $`2007_ckd1`
##                            2.5% 97.5%
## I(ckd1 == 1) 0.000160 0.000139     0
##
## $`2007_ckd2`
##                           2.5% 97.5%
## I(ckd2 == 1) 0.00122 0.00108     0
##
## $`2007_ckd3`
##                           2.5% 97.5%
## I(ckd3 == 1) 0.00586 0.00527  0.01
##
## $`2007_ckd4`
##                           2.5% 97.5%
## I(ckd4 == 1) 0.00377 0.00352     0
##
## $`2007_ckd5`
##                           2.5% 97.5%
## I(ckd5 == 1) 0.00146 0.00125     0
##
## $`2007_ckd6`
##                         2.5% 97.5%
## I(ckd6 == 1) 0.0217 0.0206  0.02
##
## $`2007_renal_failure`
##                                                                          2.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.1023 0.0988
##                                                                        97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.11
##
## $`2008_cdi`
##                           2.5% 97.5%
```

```
## I(cdi == 1) 0.00853 0.00811  0.01
##
## $`2008_aki`
##                       2.5% 97.5%
## I(aki == 1) 0.0537 0.0518  0.06
##
## $`2008_ckd`
##                       2.5% 97.5%
## I(ckd == 1) 0.0391 0.0376  0.04
##
## $`2008_ckd1`
##                            2.5% 97.5%
## I(ckd1 == 1) 0.000275 0.000237     0
##
## $`2008_ckd2`
##                          2.5% 97.5%
## I(ckd2 == 1) 0.00186 0.00167     0
##
## $`2008_ckd3`
##                          2.5% 97.5%
## I(ckd3 == 1) 0.00998 0.00904  0.01
##
## $`2008_ckd4`
##                          2.5% 97.5%
## I(ckd4 == 1) 0.00591 0.00557  0.01
##
## $`2008_ckd5`
##                          2.5% 97.5%
## I(ckd5 == 1) 0.00159 0.00144     0
##
## $`2008_ckd6`
##                        2.5% 97.5%
## I(ckd6 == 1) 0.0222 0.0211  0.02
##
## $`2008_renal_failure`
##                                                                  2.5%
```

```
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.113 0.110
##                                                                  97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.12
##
## $`2009_cdi`
##                          2.5% 97.5%
## I(cdi == 1) 0.00831 0.00793  0.01
##
## $`2009_aki`
##                        2.5% 97.5%
## I(aki == 1) 0.0625 0.0602  0.06
##
## $`2009_ckd`
##                        2.5% 97.5%
## I(ckd == 1) 0.0412 0.0395  0.04
##
## $`2009_ckd1`
##                             2.5% 97.5%
## I(ckd1 == 1) 0.000352 0.000303     0
##
## $`2009_ckd2`
##                           2.5% 97.5%
## I(ckd2 == 1) 0.00266 0.00242     0
##
## $`2009_ckd3`
##                          2.5% 97.5%
## I(ckd3 == 1) 0.0155 0.0142  0.02
##
## $`2009_ckd4`
##                           2.5% 97.5%
## I(ckd4 == 1) 0.00768 0.00727  0.01
##
## $`2009_ckd5`
##                           2.5% 97.5%
## I(ckd5 == 1) 0.00157 0.00146     0
##
```

```
## $`2009_ckd6`
##                        2.5% 97.5%
## I(ckd6 == 1) 0.0233 0.0222  0.02
##
## $`2009_renal_failure`
##                                                                        2.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.127 0.123
##                                                                       97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.13
##
## $`2010_cdi`
##                         2.5% 97.5%
## I(cdi == 1) 0.00867 0.00831  0.01
##
## $`2010_aki`
##                       2.5% 97.5%
## I(aki == 1) 0.0691 0.0665  0.07
##
## $`2010_ckd`
##                       2.5% 97.5%
## I(ckd == 1) 0.0402 0.0385  0.04
##
## $`2010_ckd1`
##                            2.5% 97.5%
## I(ckd1 == 1) 0.000536 0.000365     0
##
## $`2010_ckd2`
##                          2.5% 97.5%
## I(ckd2 == 1) 0.00316 0.00284     0
##
## $`2010_ckd3`
##                        2.5% 97.5%
## I(ckd3 == 1) 0.0202 0.0187  0.02
##
## $`2010_ckd4`
##                          2.5% 97.5%
```

```
## I(ckd4 == 1) 0.00894 0.00848  0.01
##
## $`2010_ckd5`
##                          2.5% 97.5%
## I(ckd5 == 1) 0.00152 0.00142     0
##
## $`2010_ckd6`
##                        2.5% 97.5%
## I(ckd6 == 1) 0.0244 0.0232  0.03
##
## $`2010_renal_failure`
##                                                                      2.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.137 0.133
##                                                                    97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.14
##
## $`2011_cdi`
##                         2.5% 97.5%
## I(cdi == 1) 0.00974 0.00933  0.01
##
## $`2011_aki`
##                       2.5% 97.5%
## I(aki == 1) 0.0760 0.0735  0.08
##
## $`2011_ckd`
##                       2.5% 97.5%
## I(ckd == 1) 0.0413 0.0395  0.04
##
## $`2011_ckd1`
##                            2.5% 97.5%
## I(ckd1 == 1) 0.000523 0.000463     0
##
## $`2011_ckd2`
##                          2.5% 97.5%
## I(ckd2 == 1) 0.00398 0.00365     0
##
```

```
## $`2011_ckd3`
##                      2.5% 97.5%
## I(ckd3 == 1) 0.028 0.026  0.03
##
## $`2011_ckd4`
##                        2.5% 97.5%
## I(ckd4 == 1) 0.0106 0.0101  0.01
##
## $`2011_ckd5`
##                          2.5% 97.5%
## I(ckd5 == 1) 0.00160 0.00152     0
##
## $`2011_ckd6`
##                        2.5% 97.5%
## I(ckd6 == 1) 0.0265 0.0252  0.03
##
## $`2011_renal_failure`
##                                                                          2.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.153 0.148
##                                                                        97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.16
##
## $`2012_cdi`
##                         2.5% 97.5%
## I(cdi == 1) 0.00947 0.00926  0.01
##
## $`2012_aki`
##                       2.5% 97.5%
## I(aki == 1) 0.0785 0.0771  0.08
##
## $`2012_ckd`
##                       2.5% 97.5%
## I(ckd == 1) 0.0374 0.0365  0.04
##
## $`2012_ckd1`
##                           2.5% 97.5%
```

```
## I(ckd1 == 1) 0.000600 0.000527     0
##
## $`2012_ckd2`
##                          2.5% 97.5%
## I(ckd2 == 1) 0.00447 0.00423     0
##
## $`2012_ckd3`
##                         2.5% 97.5%
## I(ckd3 == 1) 0.0304 0.0292  0.03
##
## $`2012_ckd4`
##                         2.5% 97.5%
## I(ckd4 == 1) 0.0108 0.0104  0.01
##
## $`2012_ckd5`
##                          2.5% 97.5%
## I(ckd5 == 1) 0.00160 0.00154     0
##
## $`2012_ckd6`
##                         2.5% 97.5%
## I(ckd6 == 1) 0.0257 0.0250  0.03
##
## $`2012_renal_failure`
##                                                                          2.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.153 0.150
##                                                                       97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.16
##
## $`2013_cdi`
##                          2.5% 97.5%
## I(cdi == 1) 0.00961 0.00941  0.01
##
## $`2013_aki`
##                         2.5% 97.5%
## I(aki == 1) 0.0878 0.0864  0.09
##
```

```
## $`2013_ckd`
##                       2.5% 97.5%
## I(ckd == 1) 0.0362 0.0353  0.04
##
## $`2013_ckd1`
##                            2.5% 97.5%
## I(ckd1 == 1) 0.000686 0.000605     0
##
## $`2013_ckd2`
##                          2.5% 97.5%
## I(ckd2 == 1) 0.00487 0.00462  0.01
##
## $`2013_ckd3`
##                       2.5% 97.5%
## I(ckd3 == 1) 0.0347 0.0335  0.04
##
## $`2013_ckd4`
##                       2.5% 97.5%
## I(ckd4 == 1) 0.0116 0.0112  0.01
##
## $`2013_ckd5`
##                          2.5% 97.5%
## I(ckd5 == 1) 0.00168 0.00161     0
##
## $`2013_ckd6`
##                       2.5% 97.5%
## I(ckd6 == 1) 0.0263 0.0256  0.03
##
## $`2013_renal_failure`
##                                                                          2.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.163 0.161
##                                                                        97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.17
##
## $`2014_cdi`
##                       2.5% 97.5%
```

```
## I(cdi == 1) 0.0102 0.0100  0.01
##
## $`2014_aki`
##                       2.5% 97.5%
## I(aki == 1) 0.0970 0.0956   0.1
##
## $`2014_ckd`
##                       2.5% 97.5%
## I(ckd == 1) 0.0360 0.0352  0.04
##
## $`2014_ckd1`
##                            2.5% 97.5%
## I(ckd1 == 1) 0.000627 0.000584     0
##
## $`2014_ckd2`
##                          2.5% 97.5%
## I(ckd2 == 1) 0.00514 0.00495  0.01
##
## $`2014_ckd3`
##                        2.5% 97.5%
## I(ckd3 == 1) 0.0398 0.0388  0.04
##
## $`2014_ckd4`
##                        2.5% 97.5%
## I(ckd4 == 1) 0.0127 0.0124  0.01
##
## $`2014_ckd5`
##                          2.5% 97.5%
## I(ckd5 == 1) 0.00177 0.00171     0
##
## $`2014_ckd6`
##                        2.5% 97.5%
## I(ckd6 == 1) 0.0264 0.0258  0.03
##
## $`2014_renal_failure`
##                                                                  2.5%
```

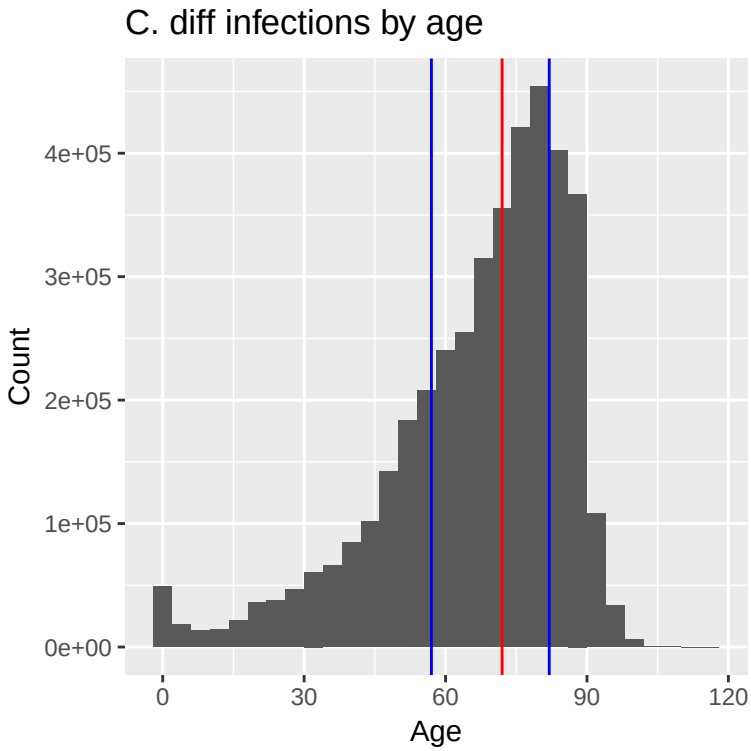


Figure 3.1: The blue lines on either side represent the interquartile range, while the red line in the middle

```
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0) 0.174 0.172
##                                                              97.5%
## I(aki + ckd + ckd1 + ckd2 + ckd3 + ckd4 + ckd5 + ckd6 > 0)  0.18
```

has the elderly, and that continues to be the case today. Caroll and Bartlett [6] Figure **??** shows the distribution of C. *diff* patients by age for all data from 2001-2014. [7]

In Figure **??**, we plot the

Increased age as a risk factor may be confounded by increased risk of other acquired comorbidities such as renal failure. [8] [7]

```
## Don't know how to automatically pick scale for object of type ts.  Defaulting
to continuous.
```

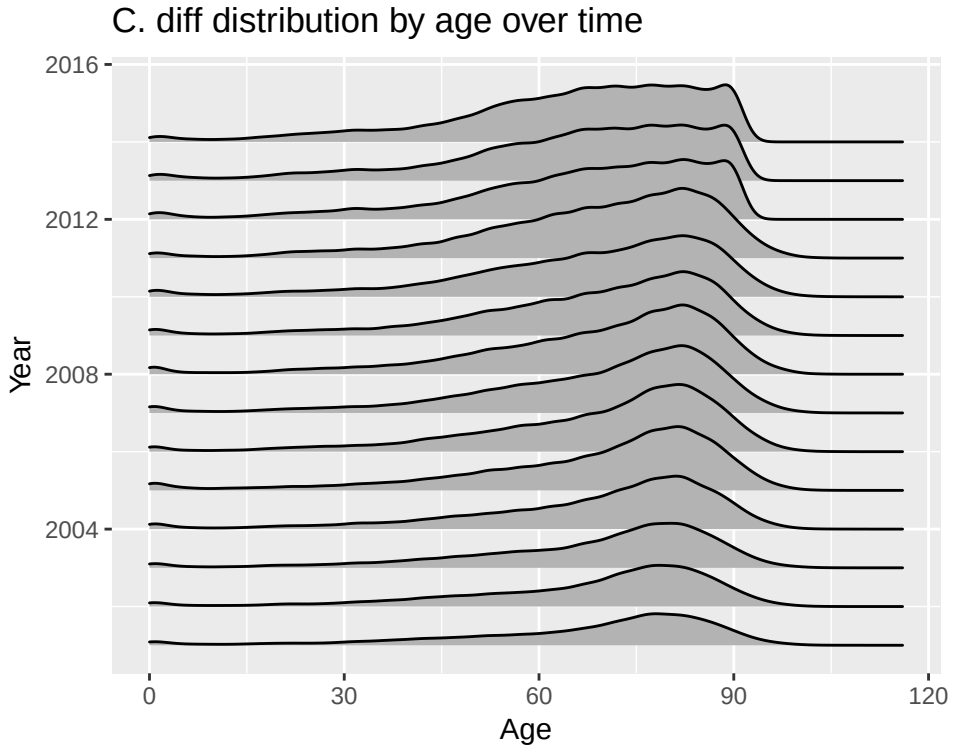


Figure 3.2: Age distribution by year from 2001 to 2014. The distribution is becoming less left-skewed and more platykurtic.

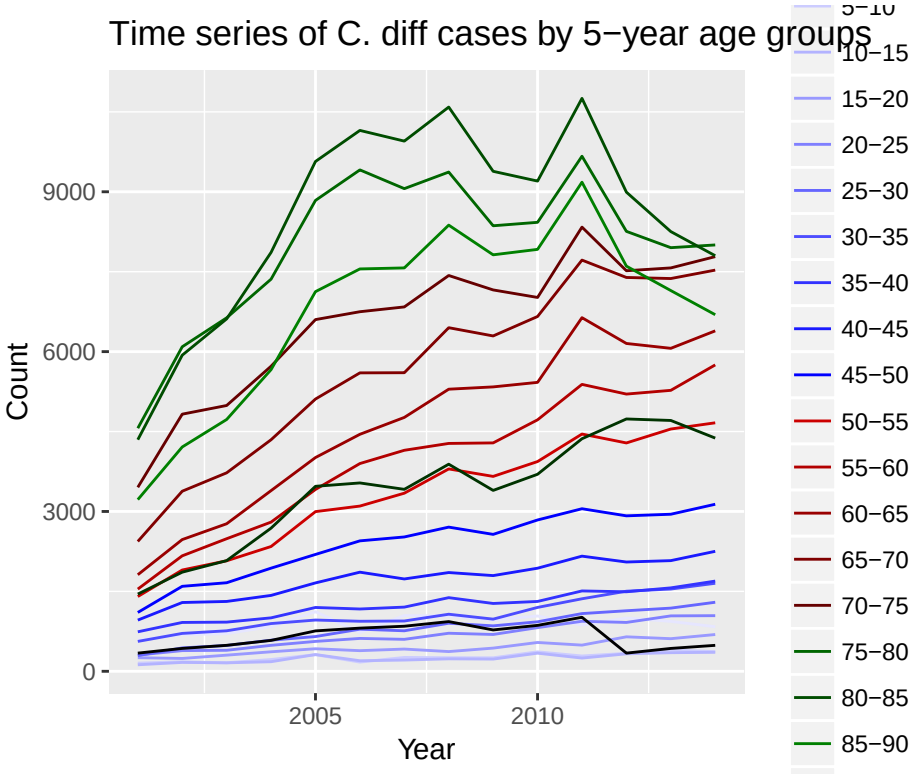


Figure 3.3: Age distribution by year from 2001 to 2014.

# Chapter 4

# Discussion

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Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus.

Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

Quisque ullamcorper placerat ipsum. Cras nibh. Morbi vel justo vitae lacus tincidunt ultrices. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. In hac habitasse platea dictumst. Integer tempus convallis augue. Etiam facilisis. Nunc elementum fermentum wisi. Aenean placerat. Ut imperdiet, enim sed gravida sollicitudin, felis odio placerat quam, ac pulvinar elit purus eget enim. Nunc vitae tortor. Proin tempus nibh sit amet nisl. Vivamus quis tortor vitae risus porta vehicula.

Fusce mauris. Vestibulum luctus nibh at lectus. Sed bibendum, nulla a faucibus semper, leo velit ultricies tellus, ac venenatis arcu wisi vel nisl. Vestibulum diam. Aliquam pellentesque, augue quis sagittis posuere, turpis lacus congue quam, in hendrerit risus eros eget felis. Maecenas eget erat in sapien mattis porttitor. Vestibulum porttitor. Nulla facilisi. Sed a turpis eu lacus commodo facilisis. Morbi fringilla, wisi in dignissim interdum, justo lectus sagittis dui, et vehicula libero dui cursus dui. Mauris tempor ligula sed lacus. Duis cursus enim ut augue. Cras ac magna. Cras nulla. Nulla egestas. Curabitur a leo. Quisque egestas wisi eget nunc. Nam feugiat lacus vel est. Curabitur consectetuer.

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Sed commodo posuere pede. Mauris ut est. Ut quis purus. Sed ac odio. Sed vehicula hendrerit sem. Duis non odio. Morbi ut dui. Sed accumsan risus eget odio. In hac habitasse platea dictumst. Pellentesque non elit. Fusce sed justo eu urna porta tincidunt. Mauris felis odio, sollicitudin sed, volutpat a, ornare ac, erat. Morbi quis dolor. Donec pellentesque, erat ac sagittis semper, nunc dui lobortis purus, quis congue purus metus ultricies tellus. Proin et quam. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos hymenaeos. Praesent sapien turpis, fermentum vel, eleifend faucibus, vehicula eu, lacus.

# Chapter 5

# Conclusion and future work

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# Chapter 6

# Conclusion

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