

Annex A: Analysis of Queue Time & Service Times

SGH PAC Data (2020–2021)

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Contents

1	Introduction	2
2	Assumptions	2
3	Methodology	2
4	Data Cleaning	3
4.1	Raw Data	3
4.2	Cleaned Data	5
5	Finding Distributions	18
5.1	Planned and Walk-In Appointments	18
5.2	Planned Appointments	38
5.3	Walk-In Appointments	58
6	Summary and Conclusion	78
6.1	Planned and Walk-In Appointments	78
6.2	Planned Appointments	79
6.3	Walk-In Appointments	80

1 Introduction

In forming our queuing model for SGH PAC, the role and aim in this section is to extract distributions for these two variables:

1. *Queueing time.* This is the variable that indicates the amount of time taken between the arrival of a patient and the consult with the anaesthesiologist.
2. *Service time.* This is the variable that indicates the amount of time taken in a consult with the anaesthesiologist.

The data given to us is from 2019 to 2021 for both planned appointments and walk-in appointments. However, we will only focus on data from 2020 onwards due to SGH's claim that the 2019 data may not be as reliable.

2 Assumptions

Acknowledging that the real world data may not be ideal, we would like to lay down some assumptions regarding the data that will help with the model-fitting.

1. There is no exact data for queueing time. Therefore, it will be assumed that the queueing time is the total duration that the patient is in PAC subtracted by the actual consult duration. Implicitly, the other PAC stations (e.g. Radiology) where patients are assessed are considered as a “queue” in this case. For our purposes, this decision is justified as the project focuses on the anaesthesiologists and the consults thereof.
2. That any service time below 15 minutes is considered a data error. We must also acknowledge the assumption that any data above that is fully accurate to a reasonable degree, except when in the case that it is unrealistically high.

3 Methodology

This is a mostly quantitative analysis. The data will be cleaned, meaning that any data error will be removed, and appropriate data types shall be applied to each variable. Data from 2020 and 2021 will then be aggregated into two tibbles (in essence, a better version of a data frame for R), one for planned appointments and walk-in appointments. There will be eight tibbles formed through this split, knowing that ASA Scores range from 1 to 4. However, there may not be enough data to form a distribution for the ASA Score of 4 due to its rarity.

The eight tibbles will be analysed using descriptive statistics in the beginning, and then we will try to fit likely distributions to it. Ideally, the distributions will all be exponential. The main test that will be done to corroborate the distribution and its parameters will be the chi-squared test at $\alpha = 0.05$.

4 Data Cleaning

4.1 Raw Data

4.1.1 2020 Planned Appointments

```
## # A tibble: 6 x 21
##   `PAC Date` `Visit Time` Identifier Age `Visit dept. OU` `Procedure Code` 
##   <chr>       <chr>      <chr>     <chr> <chr>      <chr>
## 1 1/7/20     8:00       44013879ZGG 63   H&N - ENT    SJ802T
## 2 1/7/20     8:00       44013201IGJ 71   Orthop Surg   SB741S
## 3 1/7/20     8:00       44013138HIG 36   Orthop Surg   SB700H
## 4 1/7/20     8:00       44013339ZGG 47   Gynaecology  SI710V
## 5 1/7/20     8:30       44013492ZAZ 3    Otolary      SM701E
## 6 1/7/20     8:30       44013516ZGH 69   Orthop Surg   SB810K
## # ... with 15 more variables: No Show / Attended <chr>, Listing Date <chr>,
## #   No. of days between PAC date and listing date <chr>, Surgery Date <chr>,
## #   Lead time to Surgery <chr>, Admit Specialty <chr>, ASA Score <chr>,
## #   PAC Registration Time <chr>, PAC End Time <chr>,
## #   PAC Consult Duration <chr>, TOSP Table Code <chr>,
## #   Complexity of Surgery <chr>, TPS Patient (Yes/No) <chr>,
## #   TPS Patient (Recruited before PAC / Onsite) <chr>, X21 <lgl>
```

4.1.2 2020 Walk-In Appointments

```
## # A tibble: 6 x 20
##   `PAC Date` `Visit Time` Identifier Age `Visit dept. OU` `Procedure Code` 
##   <chr>       <chr>      <chr>     <chr> <chr>      <chr>
## 1 1/7/20     8:00       44013585ENB 22   Orthop Surg   SB703K
## 2 1/7/20    10:00       44013980AKI 35   Orthop Surg   SB840H
## 3 1/7/20    11:00       44013923ABC 66   VASCULAR SUR  SD817A
## 4 1/7/20    9:30        44013272ANF 67   Colorec Surg   SF802C
## 5 1/7/20    10:00       44013680FGG 85   Colorec Surg   SF802C
## 6 1/7/20   14:30       44013335III 47   Gynaecology  SI725U
## # ... with 14 more variables: No Show / Attended <chr>, Listing Date <chr>,
## #   No. of days between PAC date and listing date <chr>, Surgery Date <chr>,
## #   Lead time to Surgery <chr>, Admit Specialty <chr>, ASA Score <chr>,
## #   PAC Registration Time <chr>, PAC End Time <chr>,
## #   PAC Consult Duration <chr>, TOSP Table Code <chr>,
## #   Complexity of Surgery <chr>, TPS Patient (Yes/No) <chr>,
## #   TPS Patient (Recruited before PAC / Onsite) <chr>
```

4.1.3 2021 Planned Appointments

```
## # A tibble: 6 x 20
##   `PAC Date` `Visit Time` Identifier Age `Visit dept. OU` `Procedure Code` 
##   <chr>       <time>      <chr>     <chr> <chr>      <chr>
## 1 4/1/21     08:00       44200586JIG 23   Urology      SJ802T
## 2 4/1/21     08:00       44200015FDG 57   GI/BARIATRIC SB715K
```

```

## 3 4/1/21      08:00      44200377JGH 88      Orthop Surg      SB816S
## 4 4/1/21      08:00      44200448ZNC 75      GI/BARIATRIC    SB727S
## 5 4/1/21      08:00      44200247HCK #N/A    EYE          #N/A
## 6 4/1/21      08:00      44200829FEF 74      HRM          SB810K
## # ... with 14 more variables: No Show / Attended <chr>, Listing Date <chr>,
## #   No. of days between PAC date and listing date <chr>, Surgery Date <chr>,
## #   Lead time to Surgery <chr>, Admit Specialty <chr>, ASA Score <chr>,
## #   PAC Registration Time <chr>, PAC End Time <chr>,
## #   PAC Consult Duration <chr>, TOSP Table Code <chr>,
## #   Complexity of Surgery <chr>, TPS Patient (Yes/No) <chr>,
## #   TPS Patient (Recruited before PAC / Onsite) <chr>

```

4.1.4 2021 Walk-In Appointments

```

## # A tibble: 6 x 21
##   `PAC Date` `Visit Time` Identifier Age  `Visit dept. OU` `Procedure Code` 
##   <chr>       <chr>        <chr>     <chr> <chr>        <chr>      
## 1 4/1/21      13:30       44200185FGB 62  Colorec Surg  SF836A    
## 2 4/1/21      15:00       44200222HGZ 37  Gynaecology SI843U    
## 3 4/1/21      8:00        44200230EID 27  Gynaecology SF836A    
## 4 5/1/21      14:30       44201892EEG 41  GI/BARIATRIC SF703S    
## 5 5/1/21      11:30       44201820DOH 85  VASCULAR SUR  SD712A    
## 6 5/1/21      13:30       44201147ANI 76  VASCULAR SUR  SD821A    
## # ... with 15 more variables: No Show / Attended <chr>, Listing Date <chr>,
## #   No. of days between PAC date and listing date <chr>, Surgery Date <chr>,
## #   Lead time to Surgery <chr>, Admit Specialty <chr>, ASA Score <chr>,
## #   PAC Registration Time <chr>, PAC End Time <chr>,
## #   PAC Consult Duration <chr>, TOSP Table Code <chr>,
## #   Complexity of Surgery <chr>, TPS Patient (Yes/No) <chr>,
## #   TPS Patient (Recruited before PAC / Onsite) <chr>, X21 <lgl>

```

4.2 Cleaned Data

4.2.1 Planned Appointments Aggregate

```
## # A tibble: 6 x 4
##   asa   queue_time consult_duration month
##   <chr>     <int>           <int>    <dbl>
## 1 1          52              33      7
## 2 2          69              46      7
## 3 1          72              28      7
## 4 1          28              20      7
## 5 2          90              30      7
## 6 2         413             17      7
```

Table 1: Descriptive statistics for planned appointments

ASA Score	Queue Time	Consult Duration	Month
Min. :1.000	Min. : 13.0	Min. : 15.00	Min. : 1.000
1st Qu.:2.000	1st Qu.: 94.0	1st Qu.: 21.00	1st Qu.: 7.000
Median :2.000	Median :131.0	Median : 29.00	Median : 9.000
Mean :1.822	Mean :144.6	Mean : 35.18	Mean : 7.654
3rd Qu.:2.000	3rd Qu.:180.0	3rd Qu.: 42.00	3rd Qu.:10.750
Max. :4.000	Max. :556.0	Max. :319.00	Max. :12.000

Seeing the histogram for consult duration, it might be a bit more useful to think of it as the amount of time beyond 15 minutes the consult will take. Hence, we will translate the consult duration by 15 minutes to the left.

Histogram for Queue Times for Appointments in PAC
From 1 July 2020 to 5 March 2021

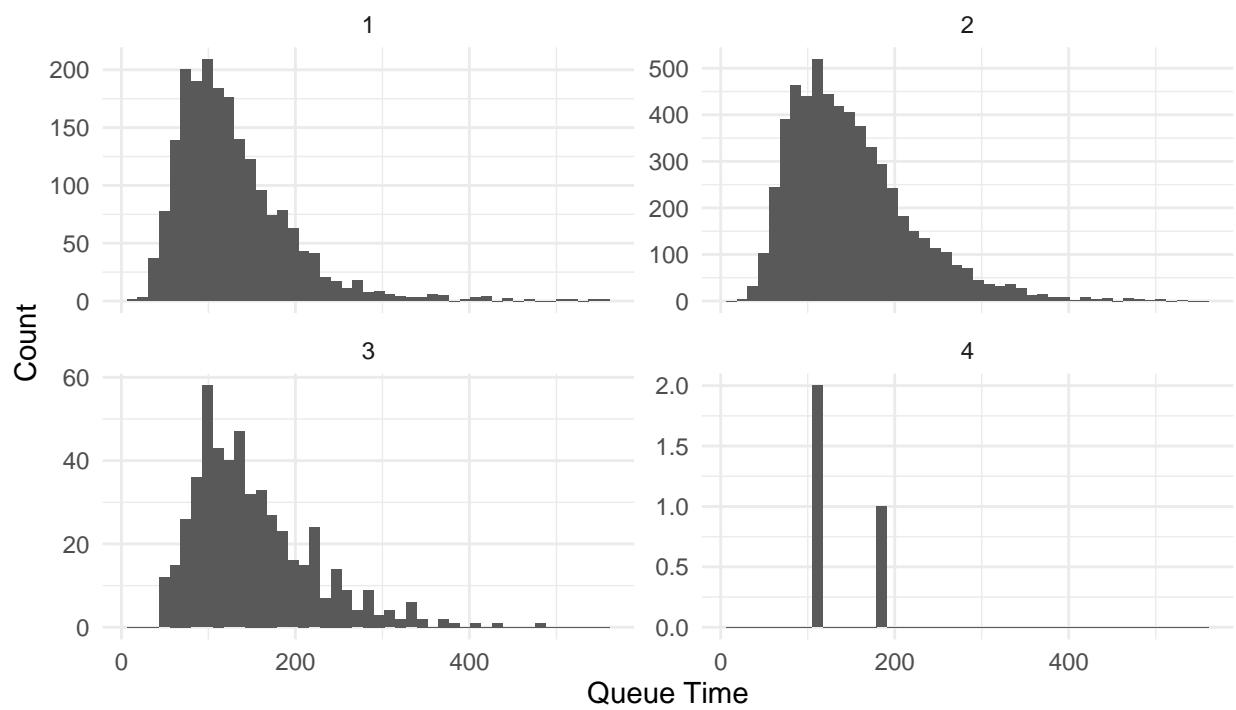


Figure 1: Histogram for queuing time for appointments in PAC

Histogram for Consult Duration for Appointments in PAC
From 1 July 2020 to 5 March 2021

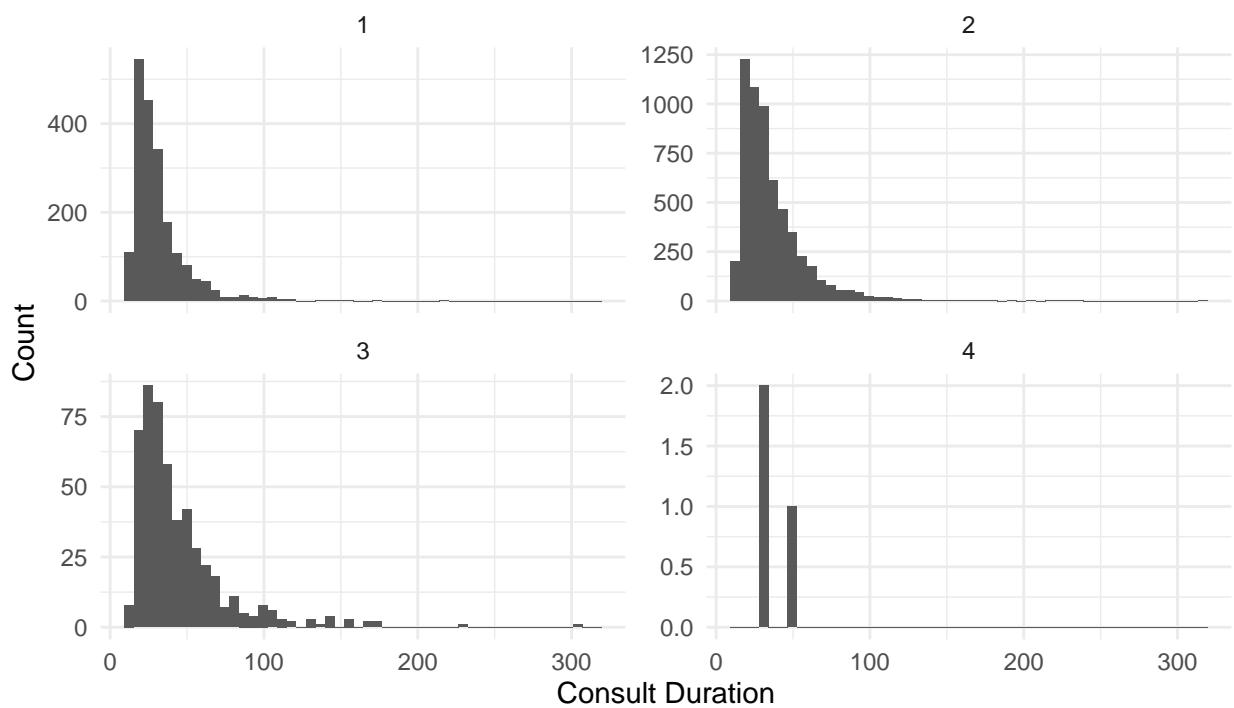


Figure 2: Histogram for consult duration for appointments in PAC

Histogram for Adjusted Consult Duration for Appointments in PAC
From 1 July 2020 to 5 March 2021

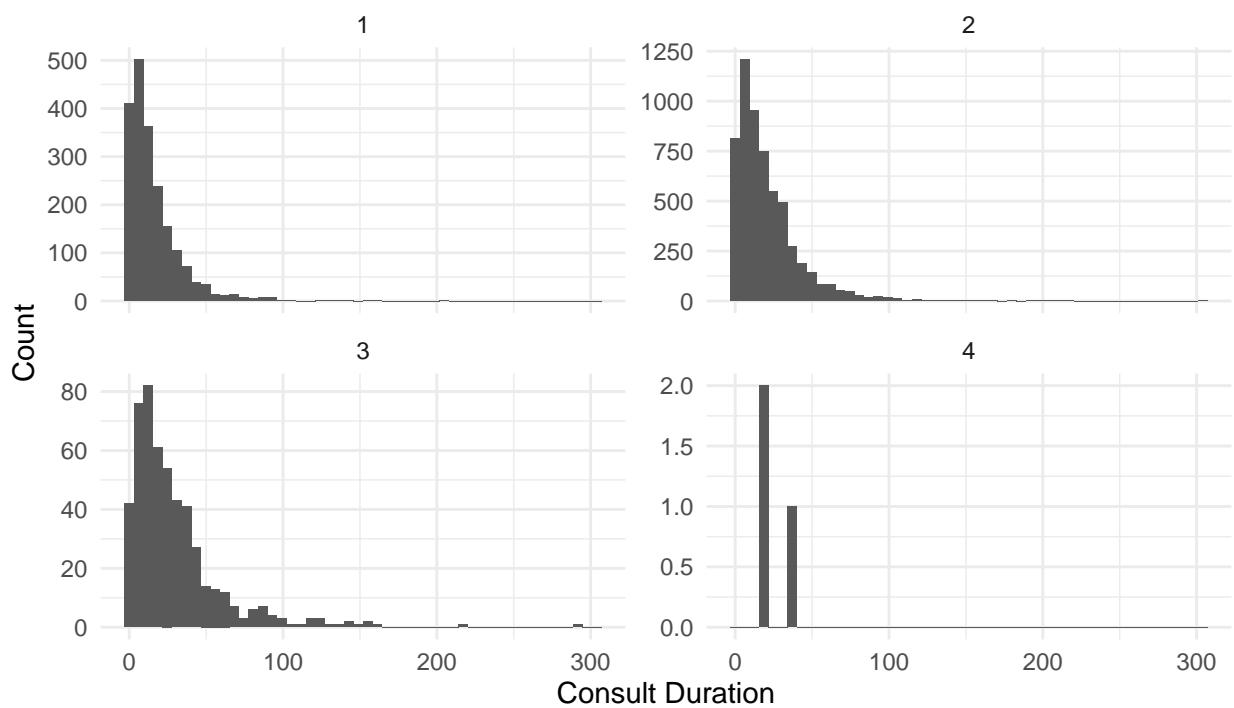


Figure 3: Histogram for adjusted consult duration for appointments in PAC

4.2.2 Walk-In Appointments Aggregate

```
## # A tibble: 6 x 4
##   asa    queue_time consult_duration month
##   <chr>     <dbl>            <int>      <dbl>
## 1 1          80              17       7
## 2 3          189             41       7
## 3 3          136             74       7
## 4 2          334             23       7
## 5 2          291             68       7
## 6 1          59              18       7
```

Table 2: Descriptive statistics for walk-in appointments

ASA Score	Queue Time	Consult Duration	Month
Min. :1.000	Min. : 16.0	Min. : 15.00	Min. : 1.000
1st Qu.:1.000	1st Qu.: 95.0	1st Qu.: 20.00	1st Qu.: 7.000
Median :2.000	Median :139.0	Median : 28.00	Median : 8.000
Mean :1.794	Mean :160.9	Mean : 34.61	Mean : 7.663
3rd Qu.:2.000	3rd Qu.:206.0	3rd Qu.: 40.00	3rd Qu.:10.000
Max. :3.000	Max. :585.0	Max. :185.00	Max. :12.000

Similarly to the planned appointments, the three figures below describe the queue time and consult duration in histograms.

Histogram for Queue Times for Walk–Ins in PAC
From 1 July 2020 to 5 March 2021

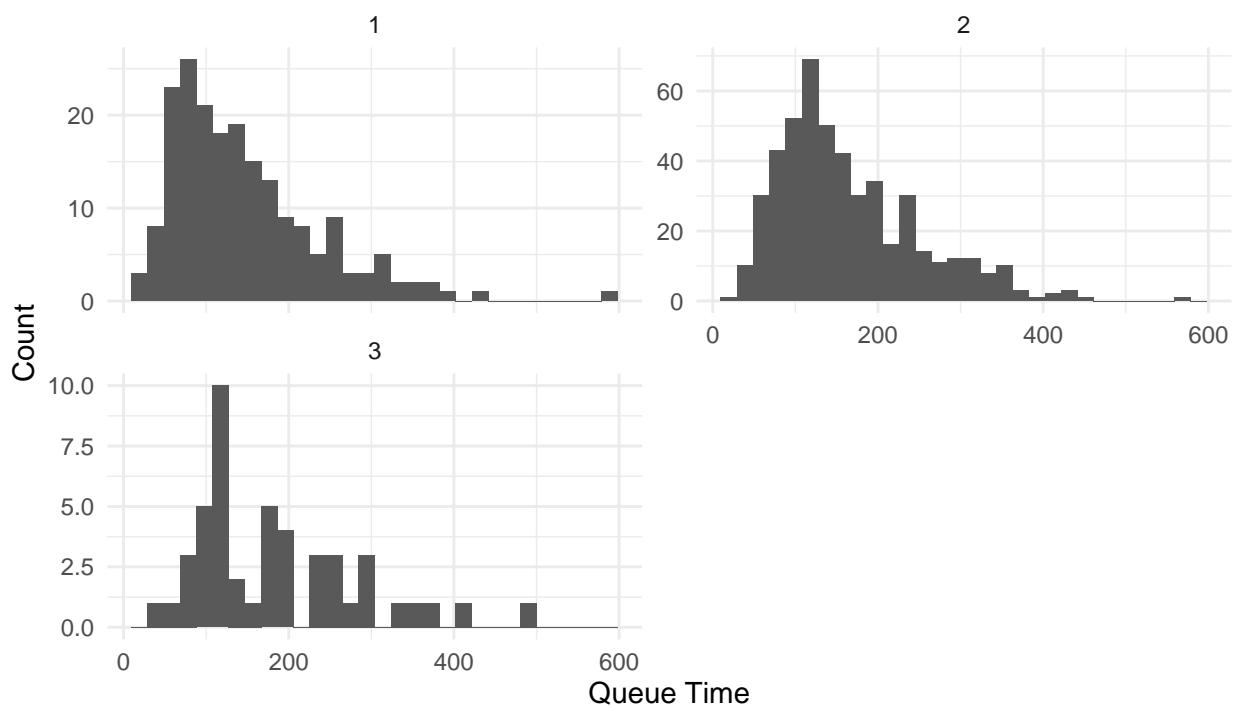


Figure 4: Histogram for queuing time for walk-ins in PAC

Histogram for Consult Duration for Walk-Ins in PAC
From 1 July 2020 to 5 March 2021

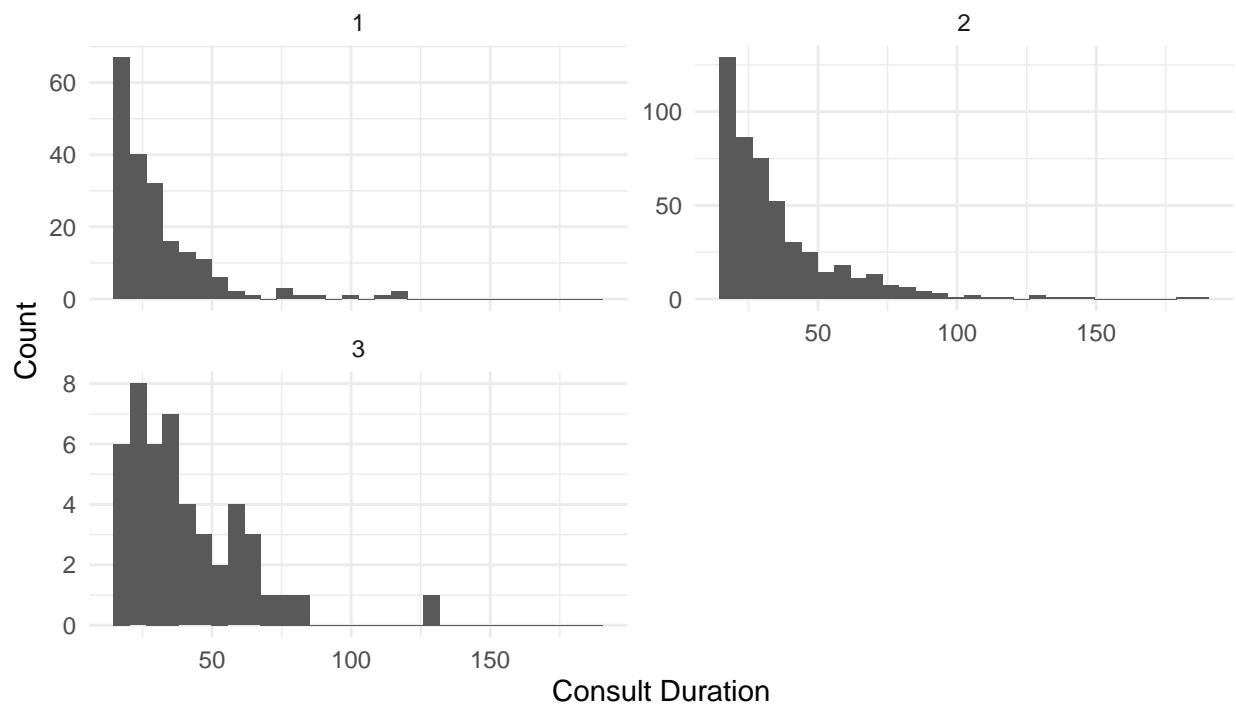


Figure 5: Histogram for consult duration for walk-ins in PAC

Histogram for Adjusted Consult Duration for Walk-Ins in PAC
From 1 July 2020 to 5 March 2021

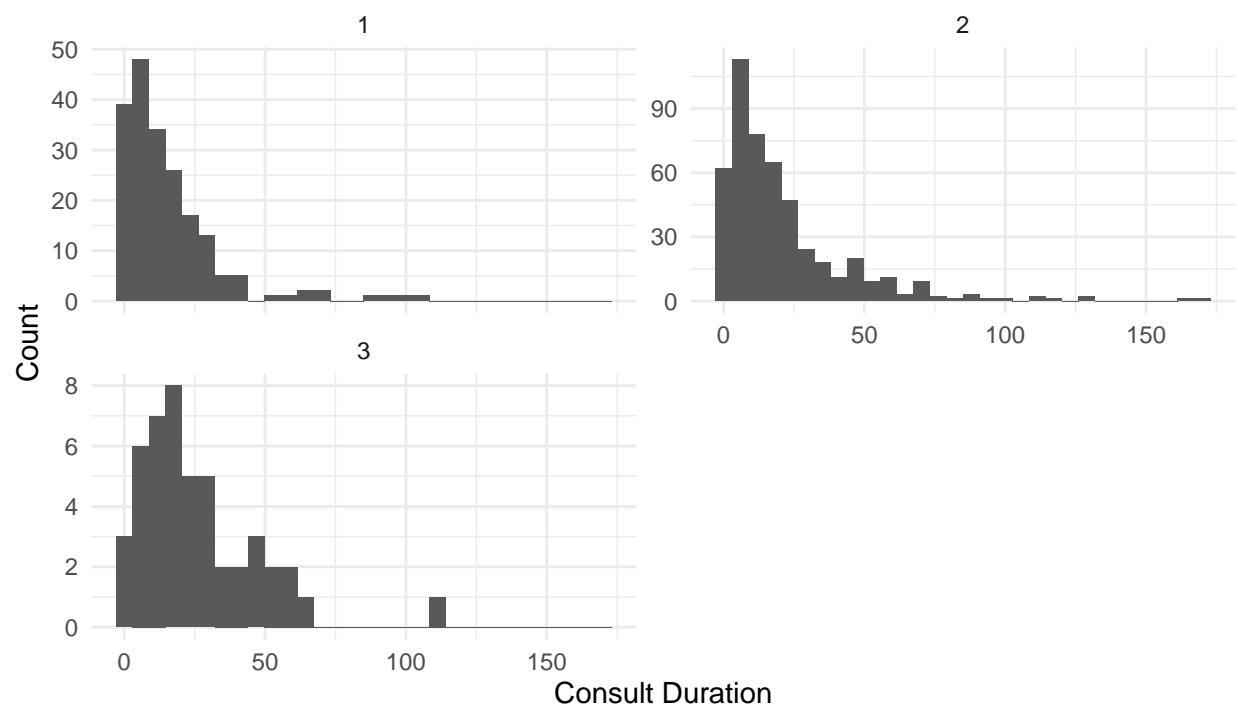


Figure 6: Histogram for adjusted consult duration for walk-ins in PAC

4.2.3 Appointments Aggregate

```
## # A tibble: 6 x 4
##   asa    queue_time consult_duration month
##   <chr>     <dbl>            <int> <dbl>
## 1 1          52              33     7
## 2 2          69              46     7
## 3 1          72              28     7
## 4 1          28              20     7
## 5 2          90              30     7
## 6 2         413             17     7
```

Histogram for Consult Duration in PAC
From 1 July 2020 to 5 March 2021

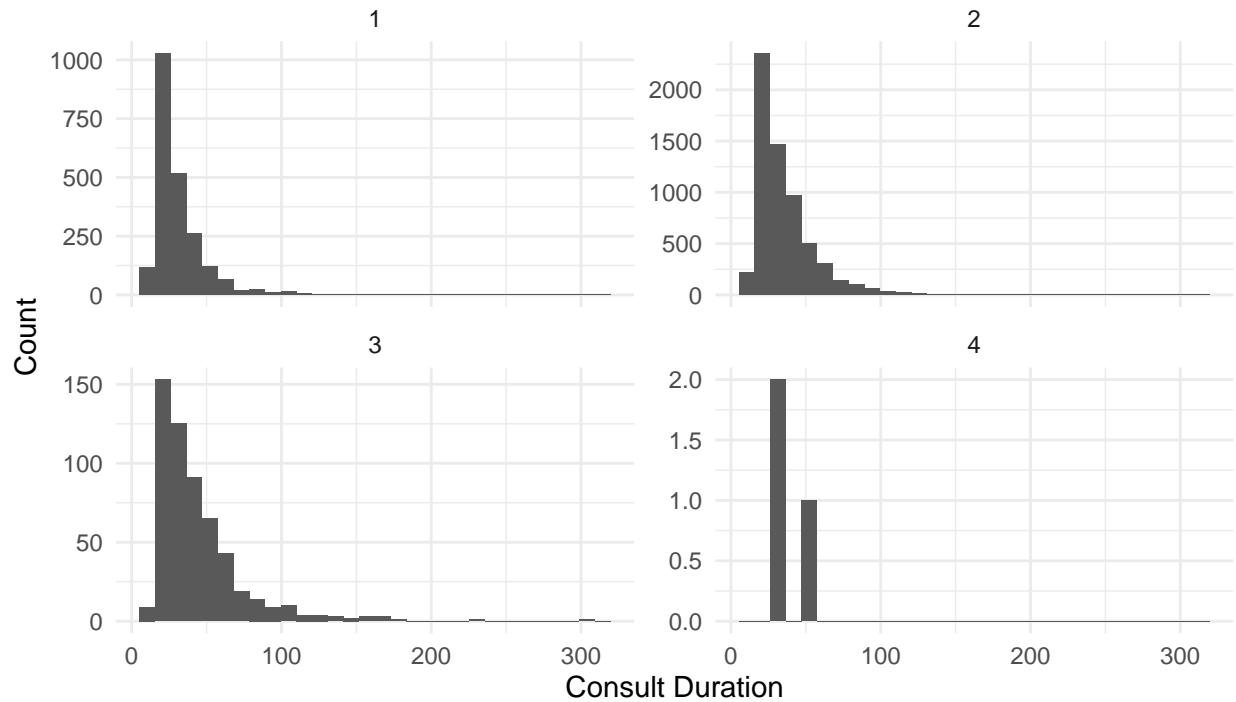


Figure 7: Histogram for consult duration in PAC

Histogram for Adjusted Consult Duration in PAC
From 1 July 2020 to 5 March 2021

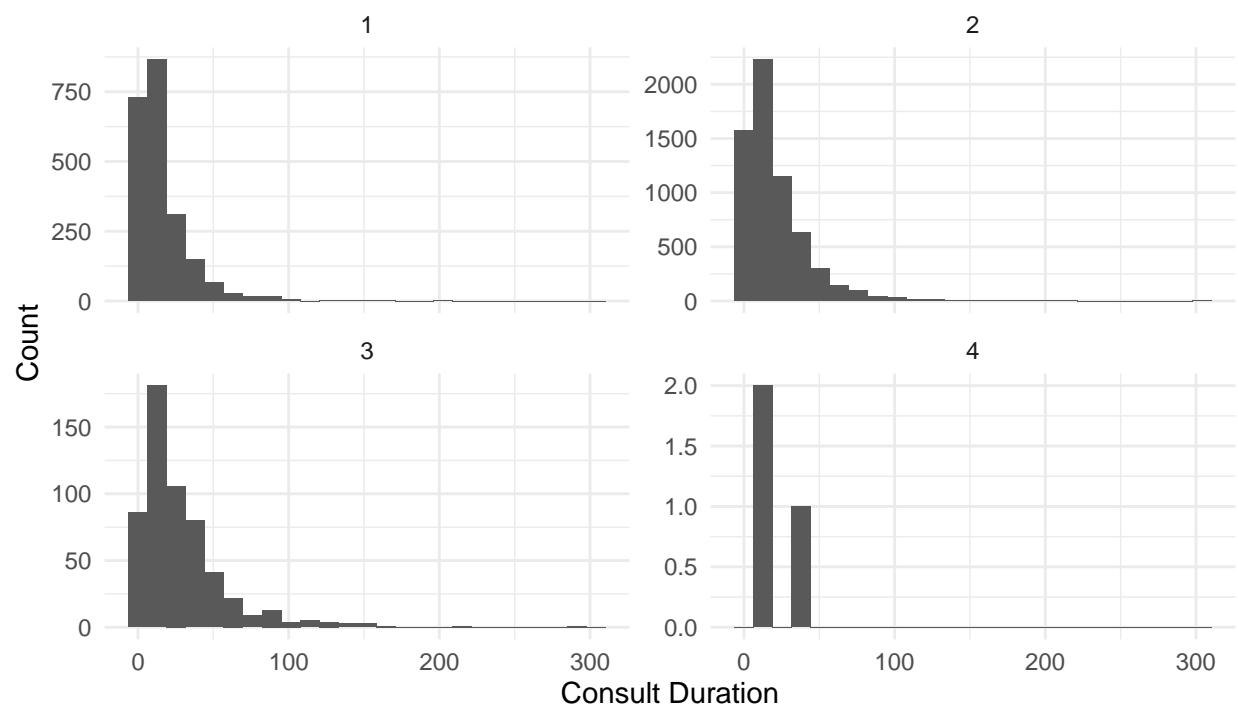


Figure 8: Histogram for adjusted consult duration in PAC

4.2.4 Counts Per Month

4.2.4.1 2020

Bar Chart for the Number of Patients in 2020

From 1 July 2020 to 1 December 2020

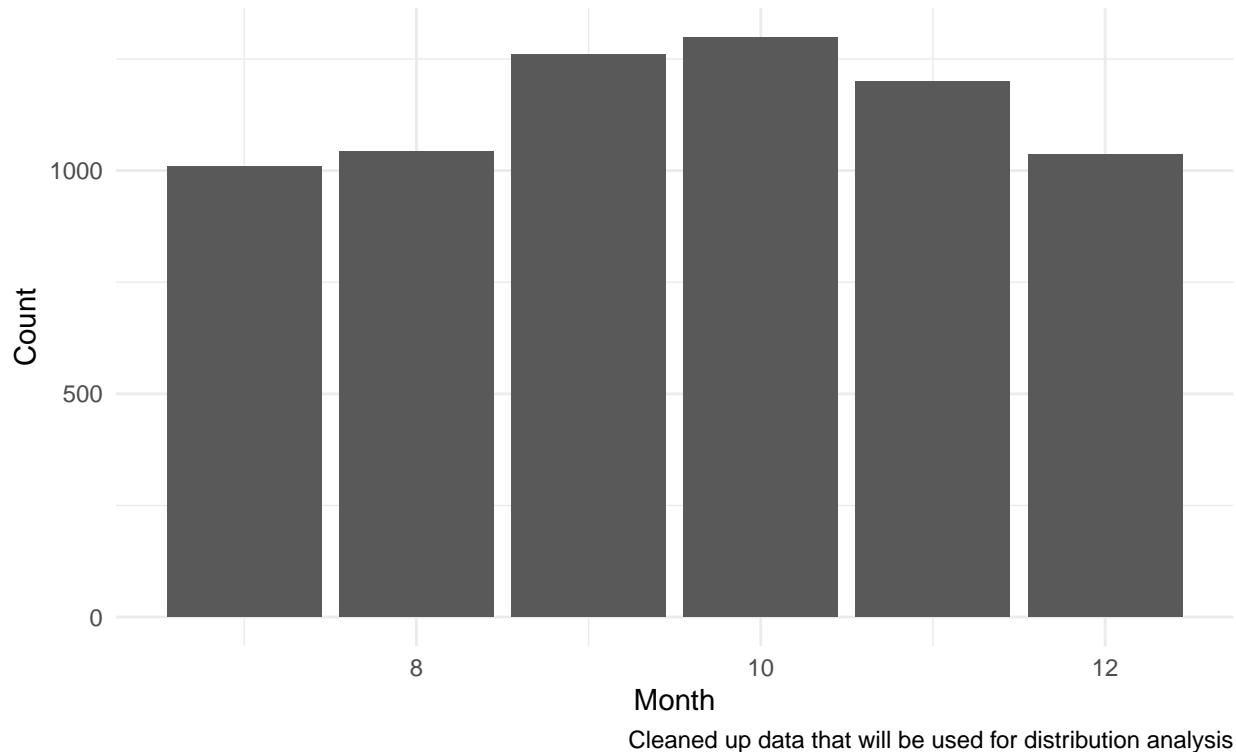


Figure 9: Histogram for patient counts in 2020

4.2.4.2 2021

4.2.4.3 Compared by ASA

Table 3: Ratio of Patients by ASA

ASA 1	ASA 2	ASA 3-4
0.2433692	0.6941516	0.0624792

Bar Chart for the Number of Patients in 2021

From 1 January 2021 to 5 March 2021

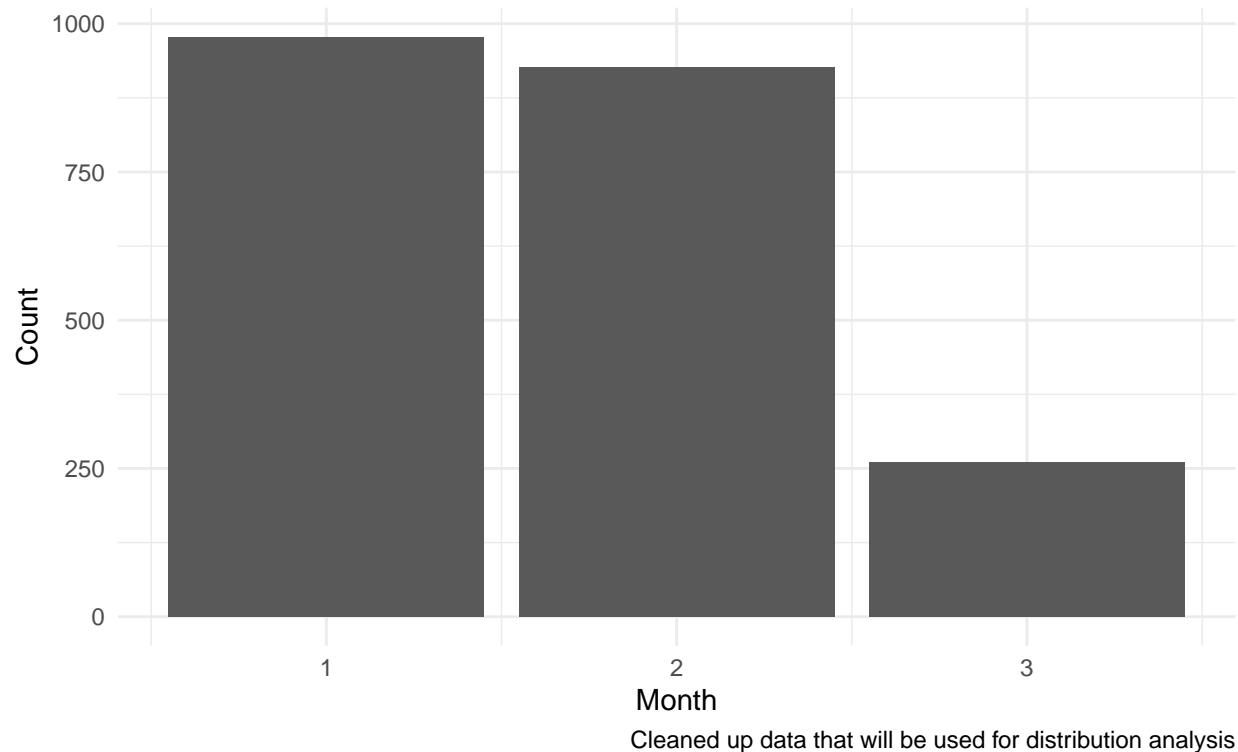


Figure 10: Histogram for patient counts in 2021

Patient Counts by ASA

From 1 July 2020 to 5 March 2021

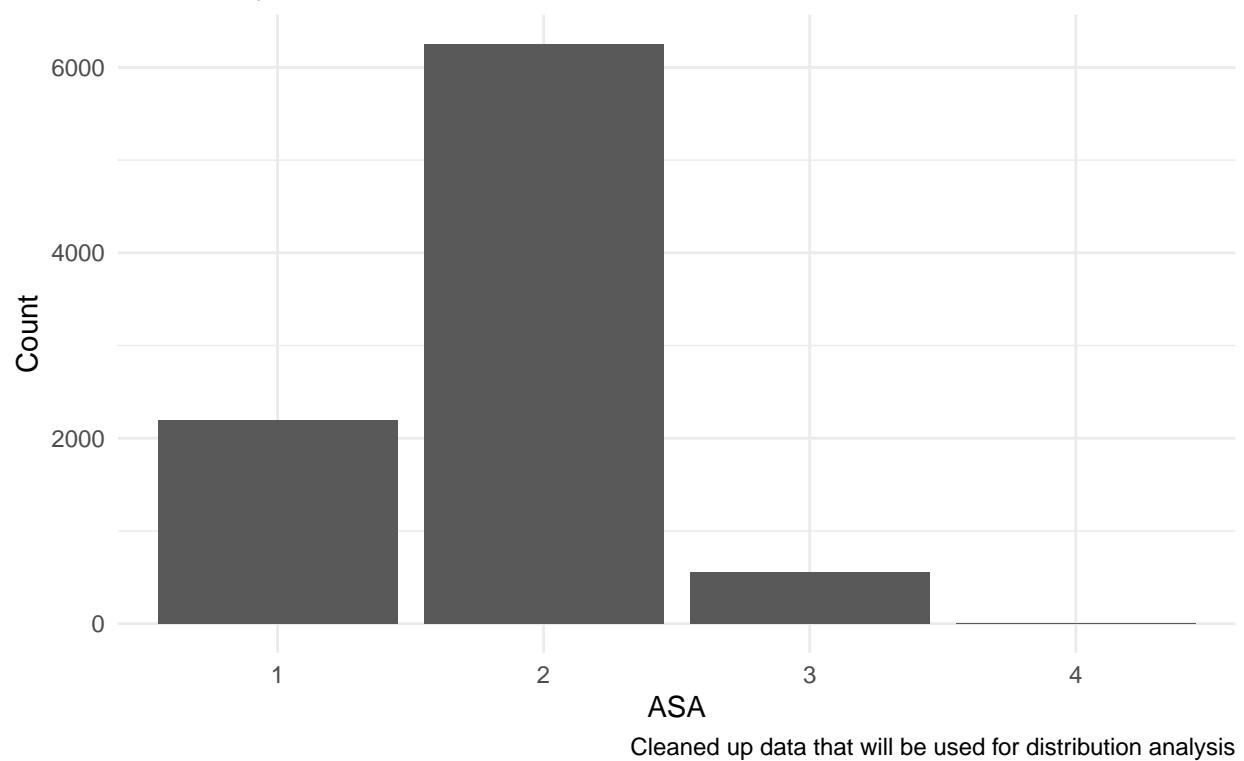


Figure 11: Counts by ASA

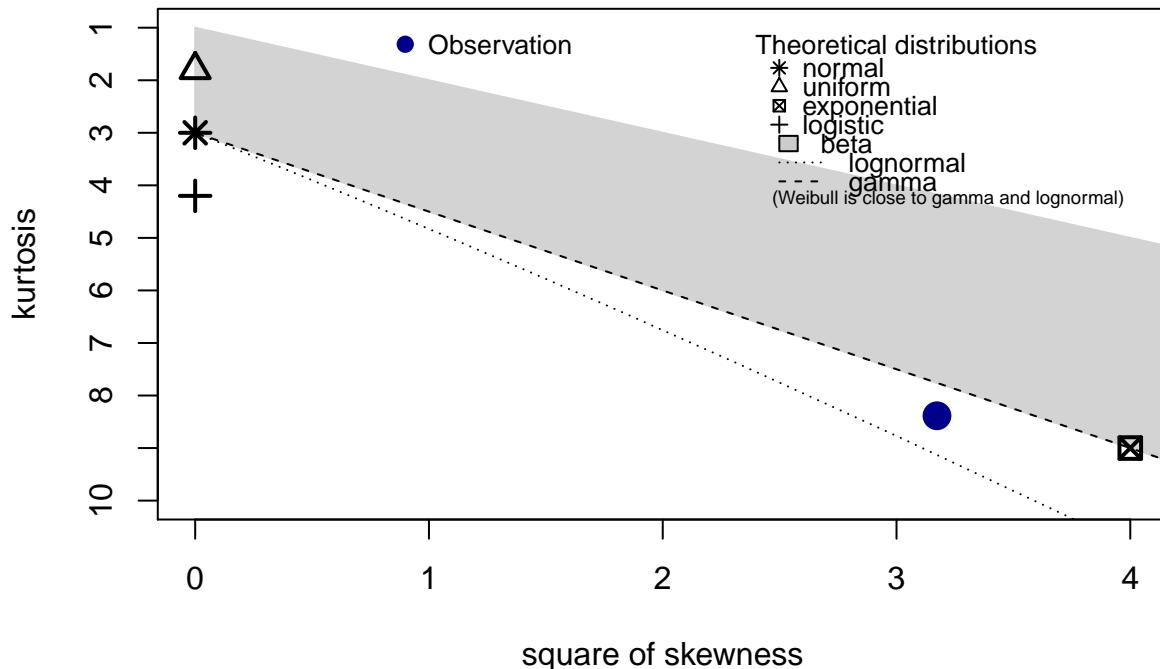
5 Finding Distributions

5.1 Planned and Walk-In Appointments

5.1.1 Queue Time

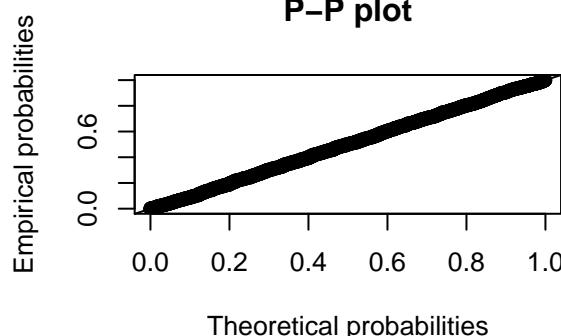
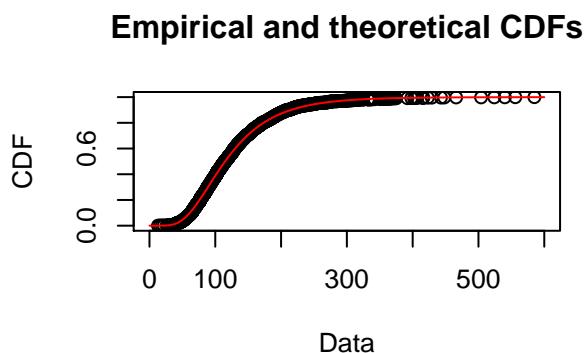
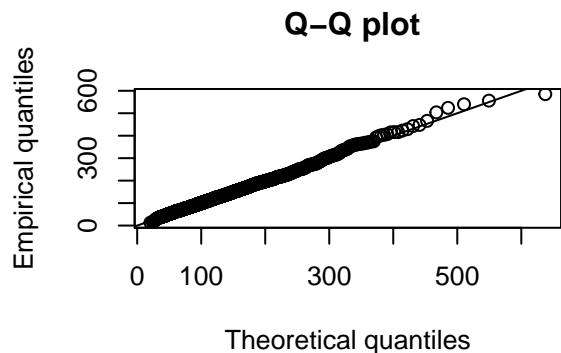
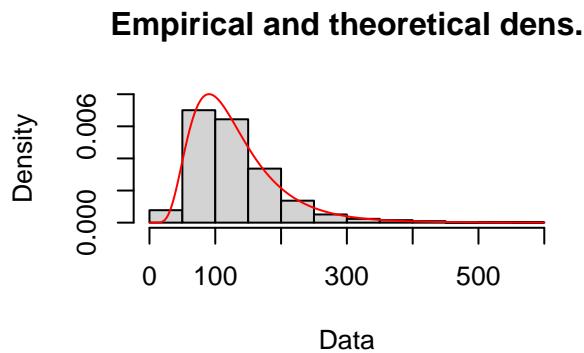
5.1.1.1 ASA 1

Cullen and Frey graph



```
## summary statistics
## -----
## min: 13   max: 585
## median: 115
## mean: 129.4893
## estimated sd: 67.28252
## estimated skewness: 1.78132
## estimated kurtosis: 8.385513
```

5.1.1.1.1 Testing for Lognormal Distribution



```

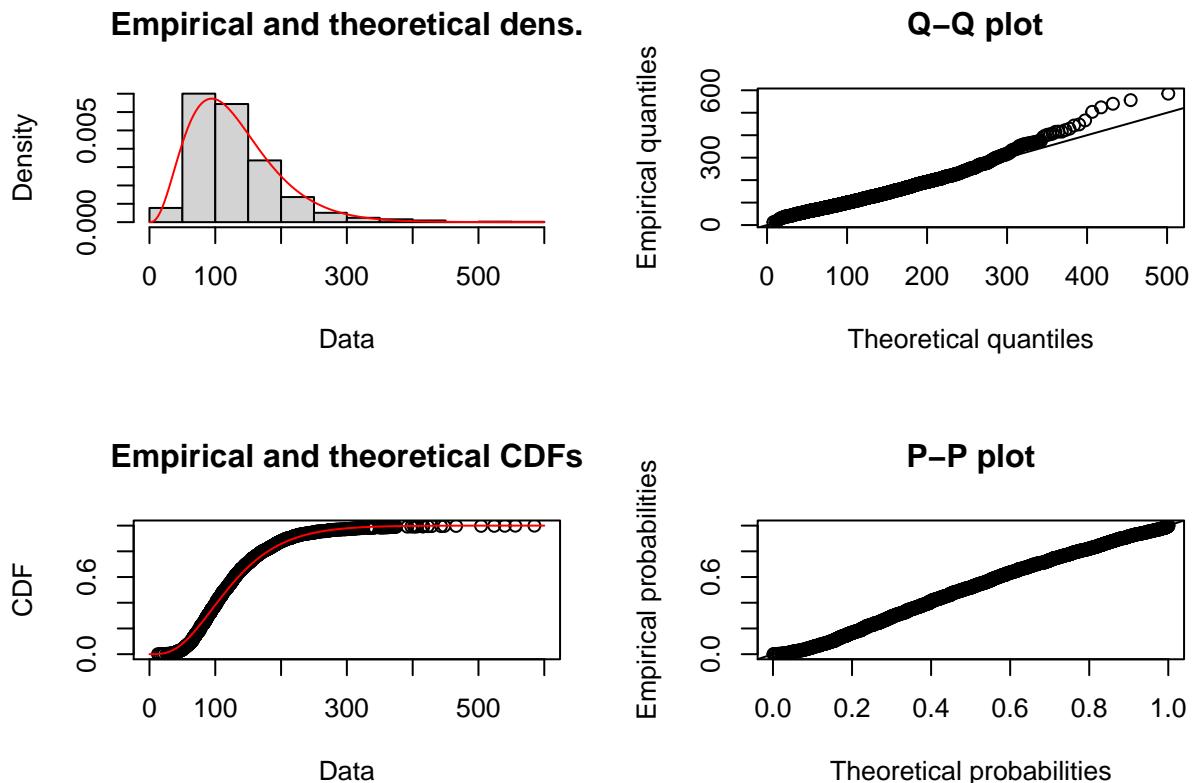
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic   0.0179067
## Cramer-von Mises statistic    0.0603894
## Anderson-Darling statistic    0.6085893
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion 23851.54
## Bayesian Information Criterion 23862.92
##
## [[2]]
## Fitting of the distribution ' lnorm ' by matching moments
## Parameters :
##       estimate
## meanlog 4.7441447
## sdlog   0.4887809
## Loglikelihood: -11923.77   AIC: 23851.54   BIC: 23862.92

```

Table 4: Chi-Squared Test for Lognormal Distribution
with MeanLog 4.7441447 and SdLog 0.4887809

Pass	Error	Critical Value
Not rejected	3.790103	9.487729

5.1.1.1.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.05277488
## Cramer-von Mises statistic   1.55534146
## Anderson-Darling statistic  12.68223134
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion    23981.55
## Bayesian Information Criterion    23992.94
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##      estimate

```

```

## shape 3.70562271
## rate 0.02861722
## Loglikelihood: -11988.78 AIC: 23981.55 BIC: 23992.94

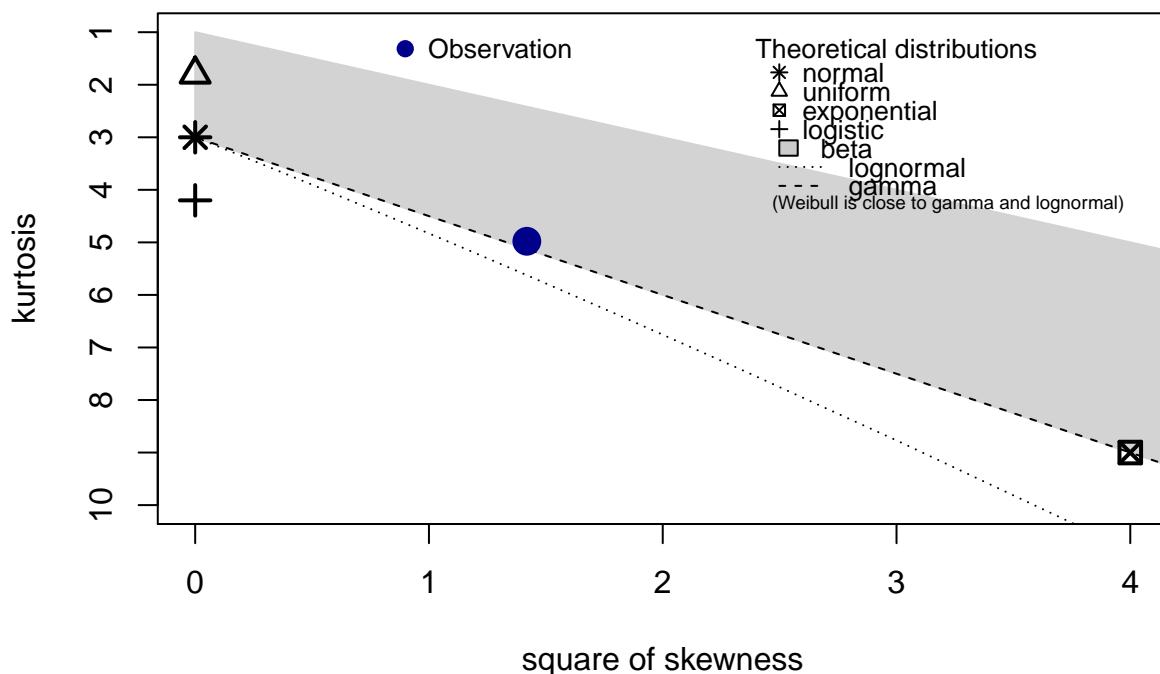
```

Table 5: Chi-Squared Test for Gamma Distribution with Shape 3.70562271 and Rate 0.02861722

Pass	Error	Critical Value
Rejected	39.74268	9.487729

5.1.1.2 ASA 2

Cullen and Frey graph

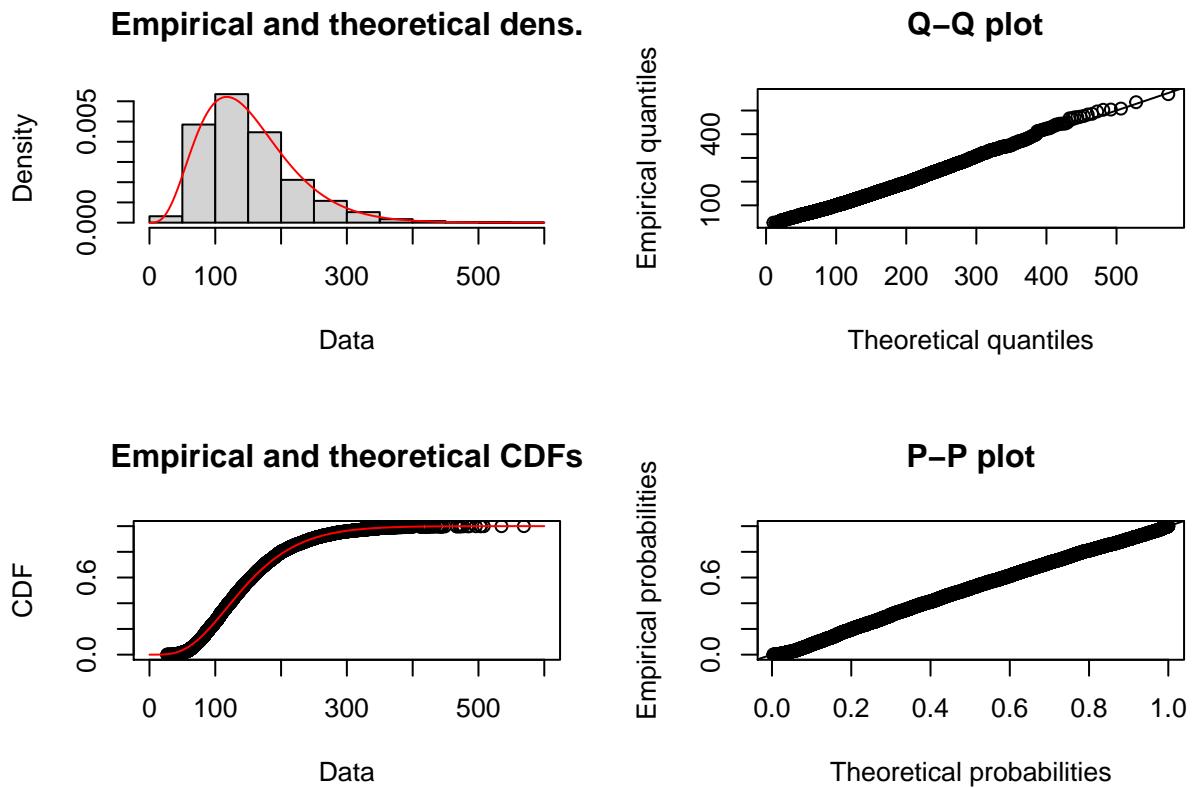


```

## summary statistics
## -----
## min: 27 max: 569
## median: 137
## mean: 150.9156
## estimated sd: 71.03786
## estimated skewness: 1.191075
## estimated kurtosis: 4.97947

```

5.1.1.2.1 Testing for Gamma Distribution



```

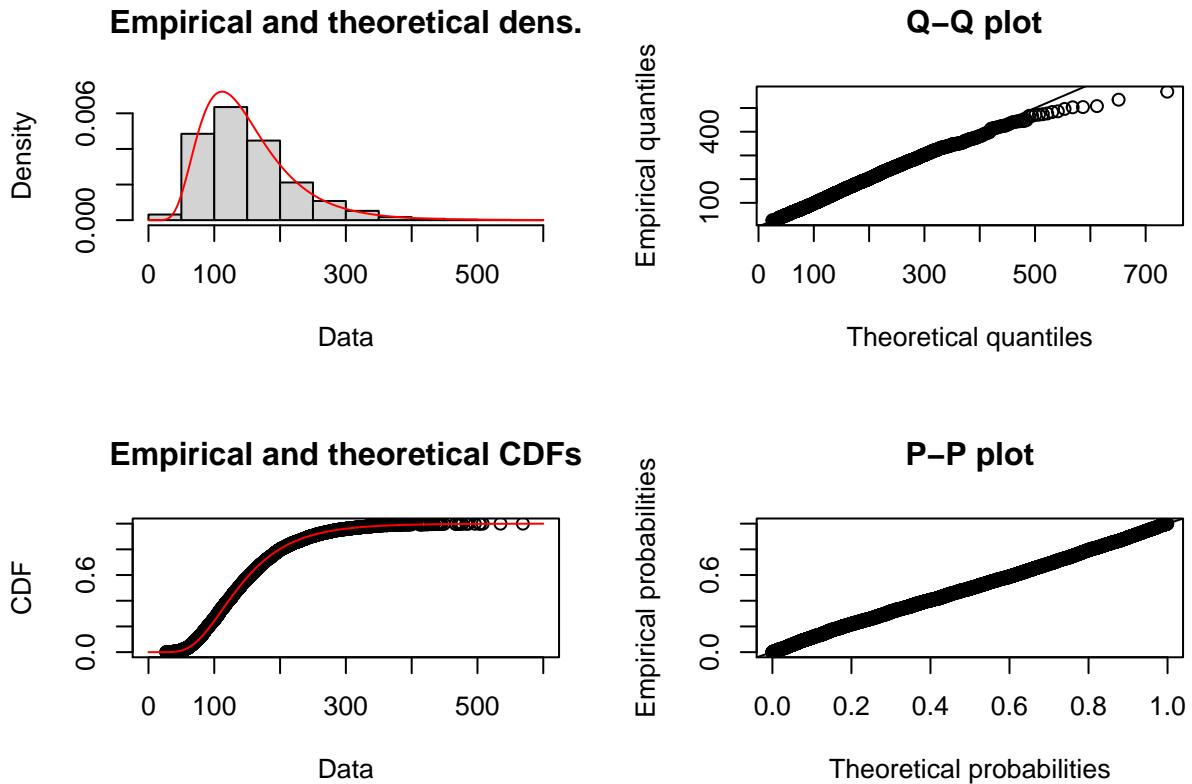
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.02898534
## Cramer-von Mises statistic   1.13535433
## Anderson-Darling statistic   10.55945776
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      69662.87
## Bayesian Information Criterion     69676.35
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate
## shape 4.51396193
## rate  0.02991051
## Loglikelihood: -34829.43    AIC:  69662.87    BIC:  69676.35

```

Table 6: Chi-Squared Test for Gamma Distribution with Shape 4.51396193 and Rate 0.02991051

Pass	Error	Critical Value
Not rejected	17.96091	18.30704

5.1.1.2.2 Testing for Lognormal Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic 0.02405473
## Cramer-von Mises statistic  0.69879880
## Anderson-Darling statistic  4.89547405
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion   69527.77
## Bayesian Information Criterion   69541.25
##
## [[2]]
## Fitting of the distribution 'lnorm' by matching moments
## Parameters :
##      estimate

```

```

## meanlog 4.9166666
## sdlog 0.4473345
## Loglikelihood: -34761.88 AIC: 69527.77 BIC: 69541.25

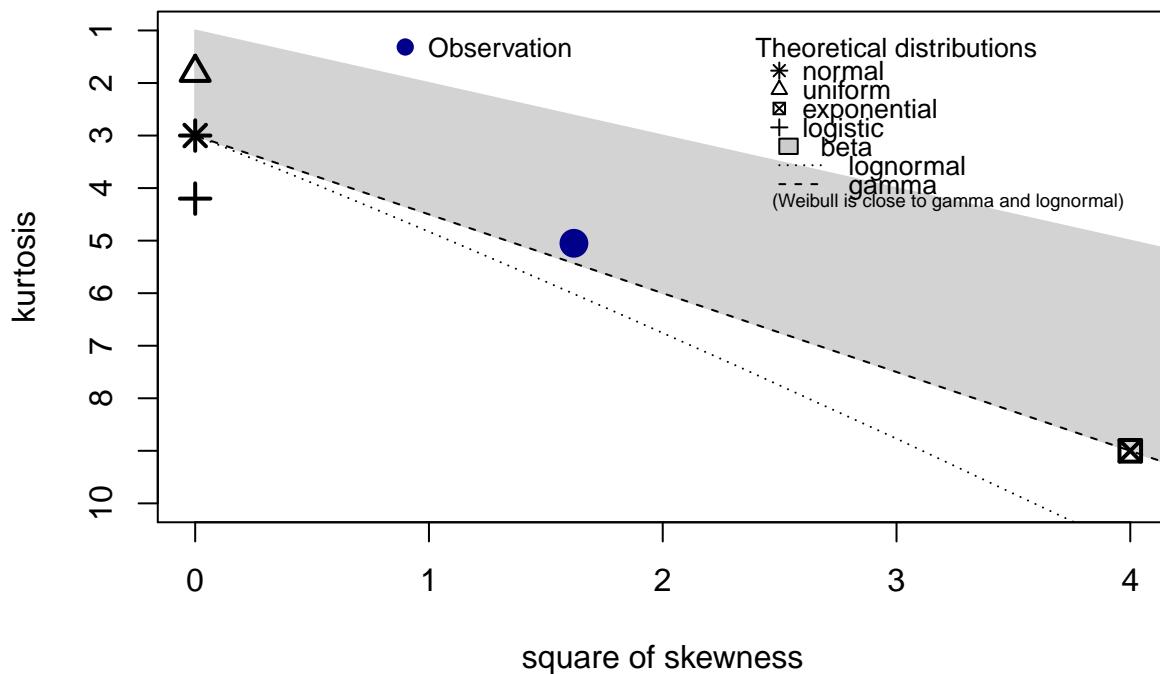
```

Table 7: Chi-Squared Test for Lognormal Distribution
with MeanLog 4.9116591 and SdLog 0.4419957

Pass	Error	Critical Value
Rejected	29.33012	19.67514

5.1.1.3 ASA 3

Cullen and Frey graph

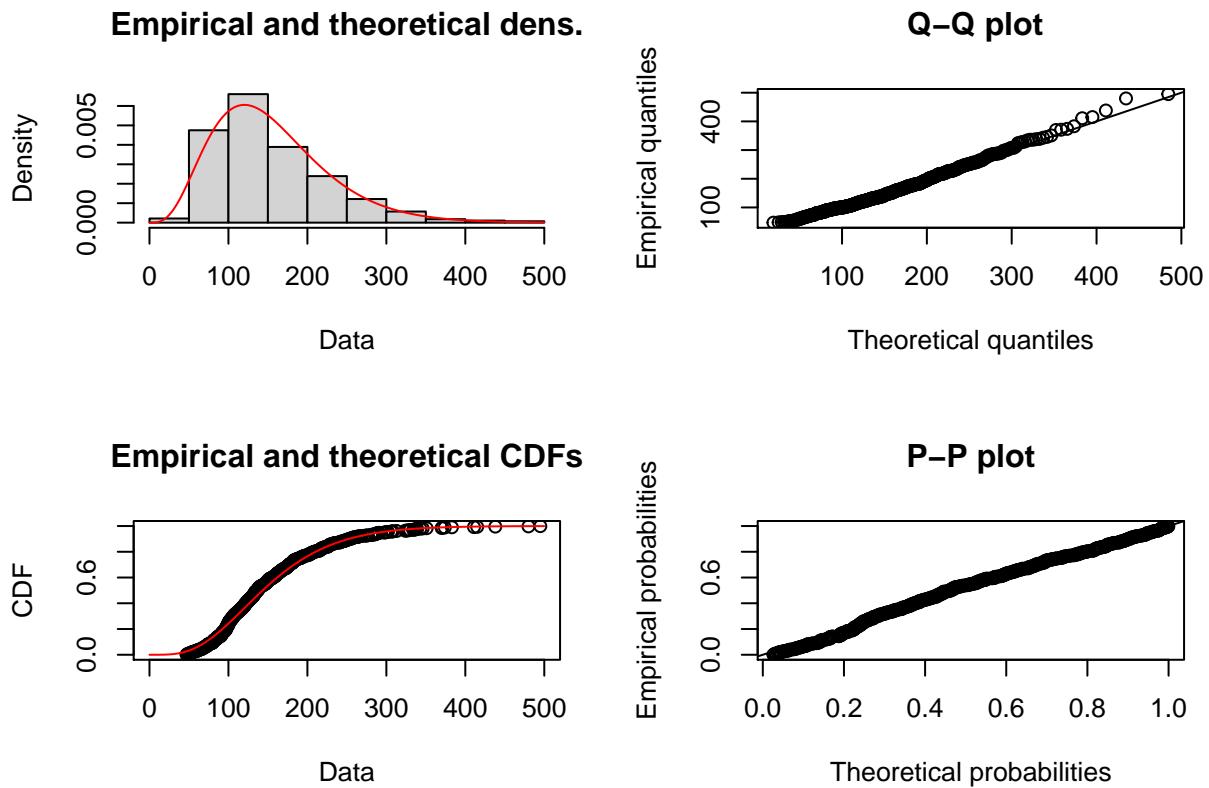


```

## summary statistics
## -----
## min: 47 max: 495
## median: 137
## mean: 154.6518
## estimated sd: 73.04713
## estimated skewness: 1.272831
## estimated kurtosis: 5.050589

```

5.1.1.3.1 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.05181065
## Cramer-von Mises statistic   0.35534652
## Anderson-Darling statistic   2.48916670
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      6256.461
## Bayesian Information Criterion     6265.117
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##   estimate
## shape 4.4903452
## rate 0.0290352
## Loglikelihood: -3126.23    AIC: 6256.461    BIC: 6265.117

```

Table 8: Chi-Squared Test for Gamma Distribution with Shape 4.4903452 and Rate 0.0290352

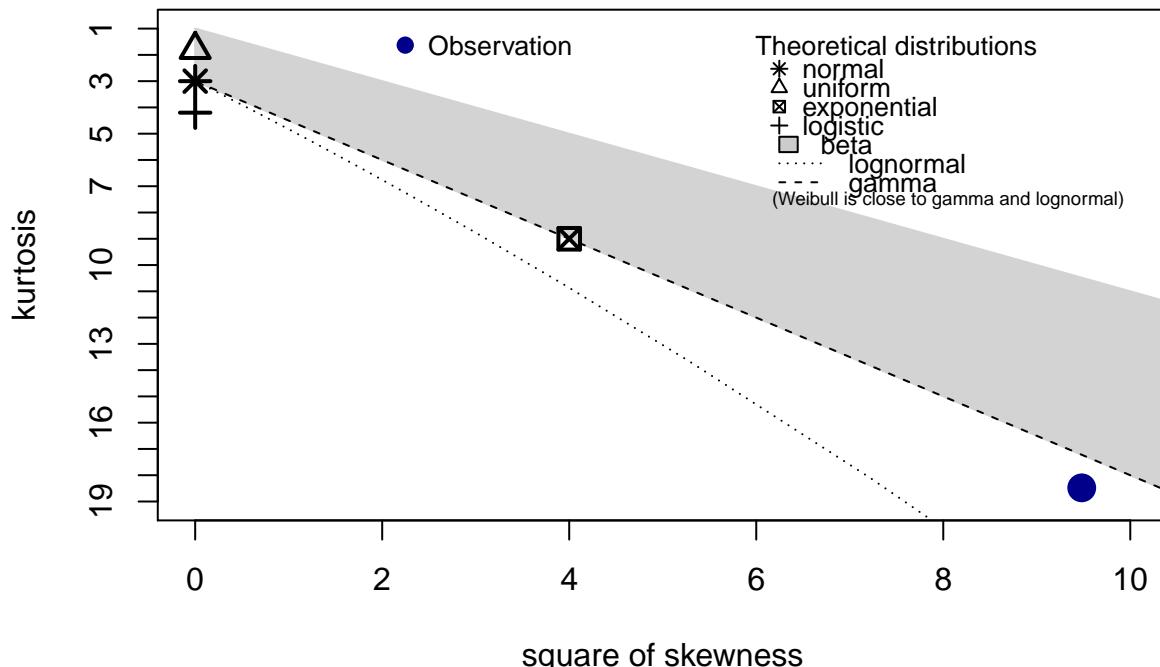
Pass	Error	Critical Value
Not rejected	13.37659	18.30704

5.1.2 Consult Duration

Adjusted version, meaning that the consult duration was shifted by 15 minutes, unless otherwise stated.

5.1.2.1 ASA 1

Cullen and Frey graph

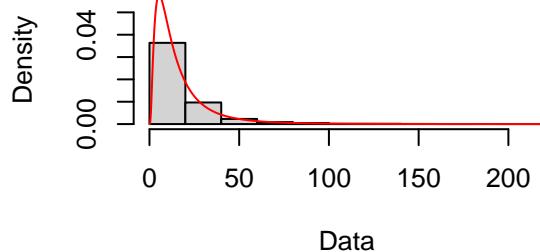


```
## summary statistics
## -----
## min: 0   max: 204
## median: 11
## mean: 16.0456
## estimated sd: 18.30492
## estimated skewness: 3.079084
## estimated kurtosis: 18.48056
```

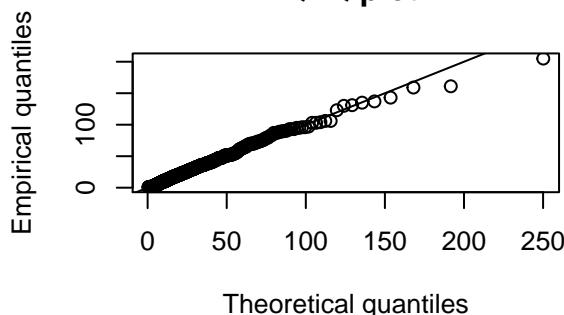
5.1.2.1.1 Testing for Lognormal Distribution

The lognormal distribution requires numbers above 0. Hence, the shifting in this case is by 14, such that the minimum is 1.

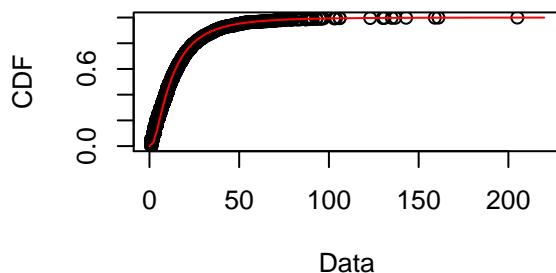
Empirical and theoretical dens.



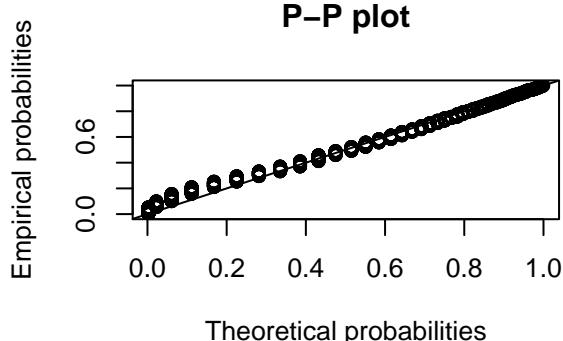
Q–Q plot



Empirical and theoretical CDFs



P–P plot



```

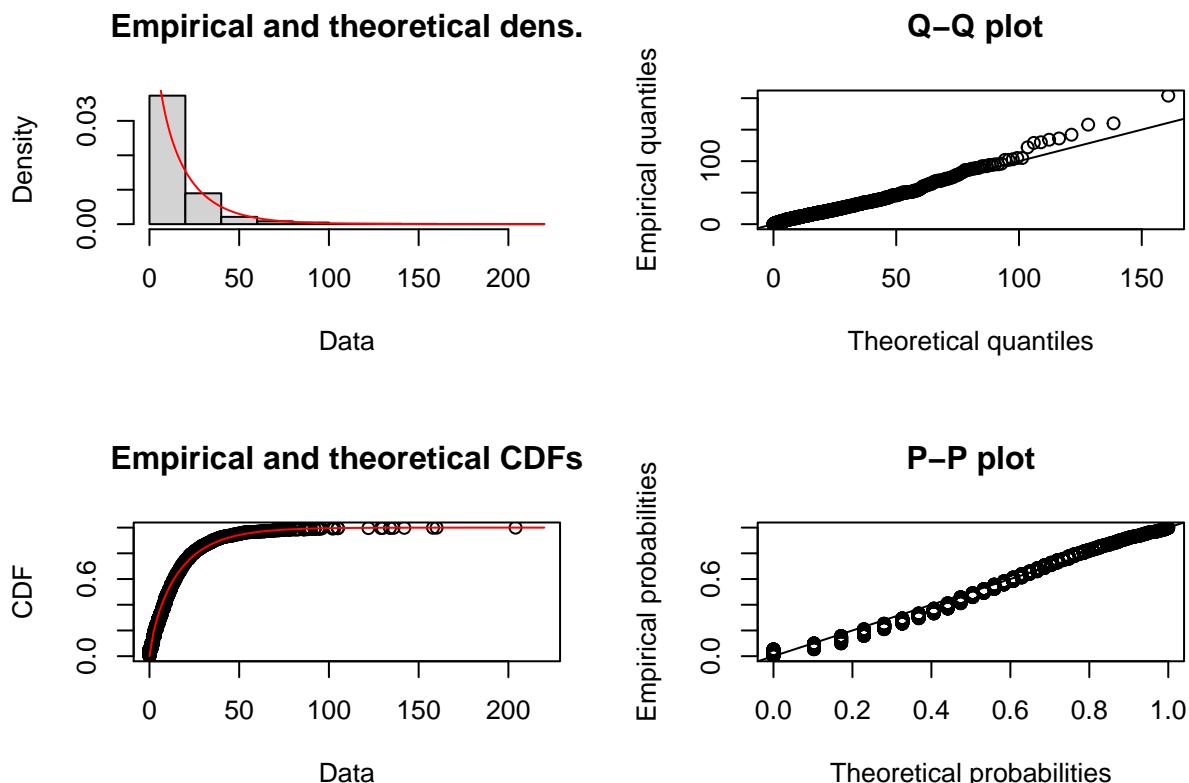
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic 0.09808718
## Cramer-von Mises statistic   2.65276066
## Anderson-Darling statistic  38.40126539
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion    16941.03
## Bayesian Information Criterion    16952.41
##
## [[2]]
## Fitting of the distribution ' lnorm ' by matching moments
## Parameters :
##       estimate
## meanlog 2.4525327
## sdlog   0.8756247
## Loglikelihood: -8468.513   AIC: 16941.03   BIC: 16952.41

```

Table 9: Chi-Squared Test for Lognormal Distribution
with MeanLog 2.4525327 and SdLog 0.8756247

Pass	Error	Critical Value
Not rejected	9.605517	15.50731

5.1.2.1.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.07372338
## Cramer-von Mises statistic   2.59119338
## Anderson-Darling statistic      Inf
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      -Inf
## Bayesian Information Criterion      -Inf
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate

```

```

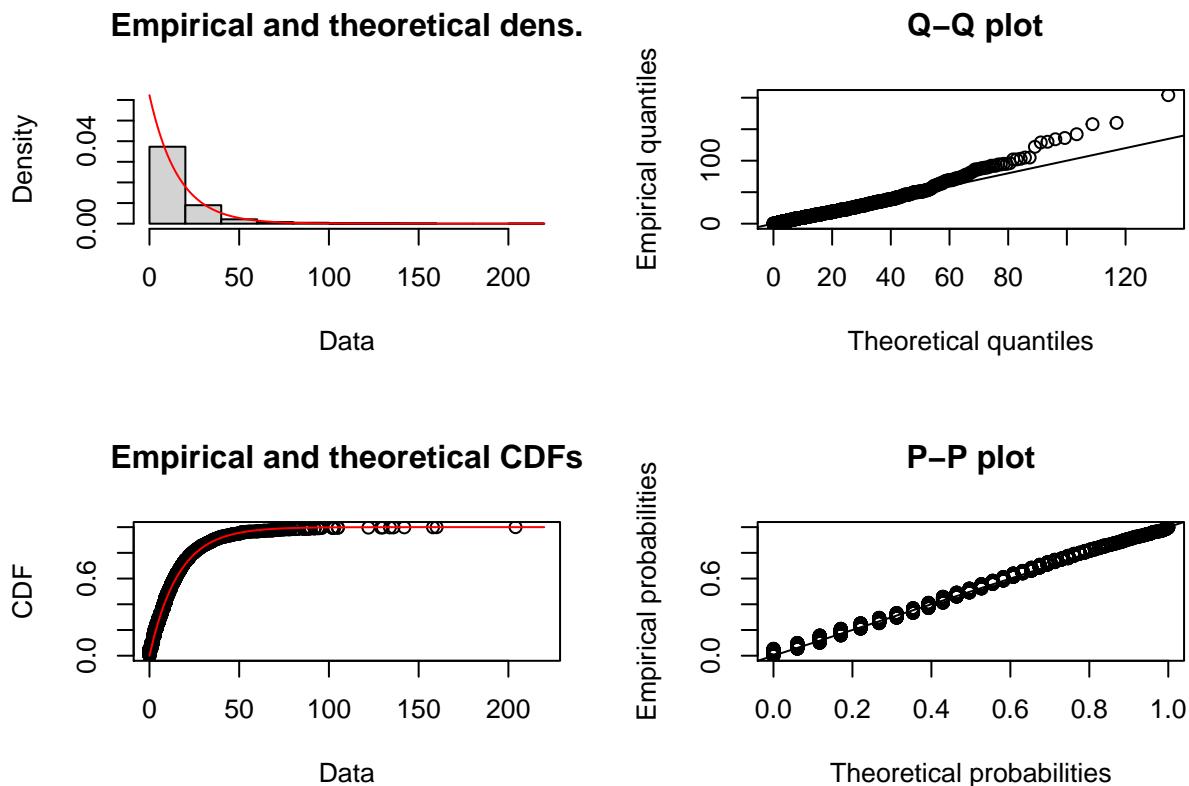
## shape 0.76873108
## rate 0.04790915
## Loglikelihood: Inf AIC: -Inf BIC: -Inf

```

Table 10: Chi-Squared Test for Gamma Distribution with Shape 0.76873108 and Rate 0.04790915

Pass	Error	Critical Value
Rejected	55.54124	14.06714

5.1.2.1.3 Testing for Exponential Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-exp
## Kolmogorov-Smirnov statistic 0.05380757
## Cramer-von Mises statistic   0.70027975
## Anderson-Darling statistic      Inf
## 
## Goodness-of-fit criteria
##                               1-mme-exp
## Akaike's Information Criterion 16561.06
## Bayesian Information Criterion 16566.75
## 

```

```

## [[2]]
## Fitting of the distribution 'exp' by matching moments
## Parameters :
##     estimate
## rate 0.06232238
## Loglikelihood: -8279.528   AIC: 16561.06   BIC: 16566.75

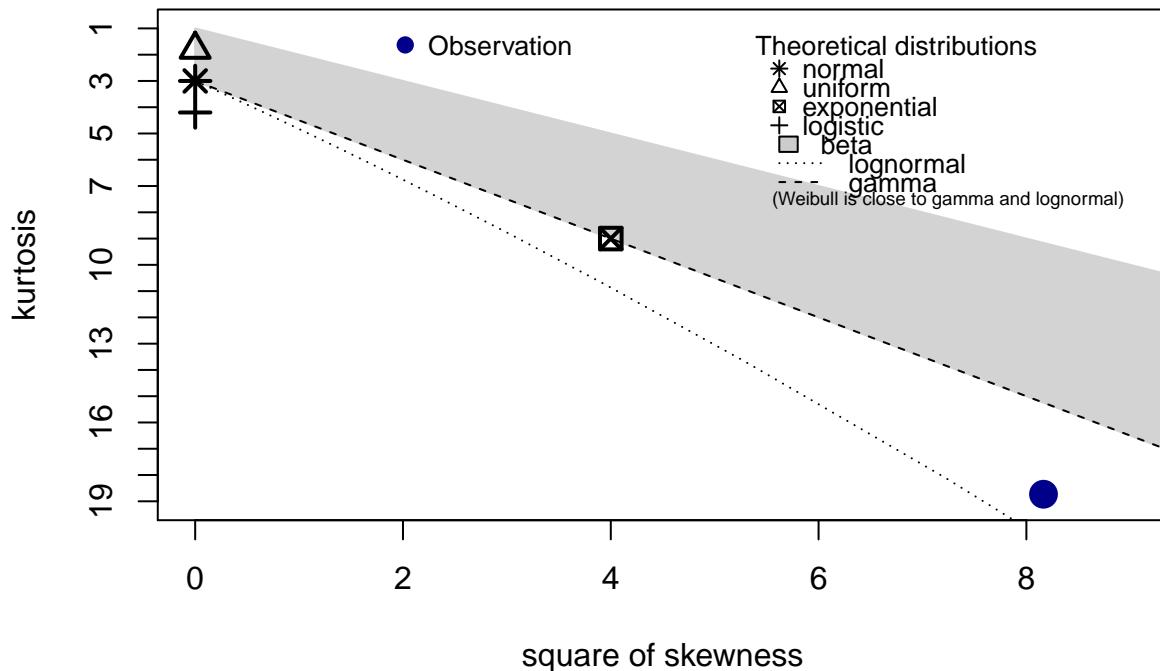
```

Table 11: Chi-Squared Test for Exponential Distribution
with Rate 0.06232238

Pass	Error	Critical Value
Rejected	42.66968	15.50731

5.1.2.2 ASA 2

Cullen and Frey graph



```

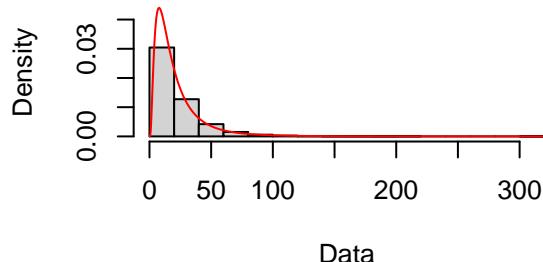
## summary statistics
## -----
## min: 1   max: 305
## median: 16
## mean: 21.73269
## estimated sd: 21.55089
## estimated skewness: 2.857424
## estimated kurtosis: 18.73142

```

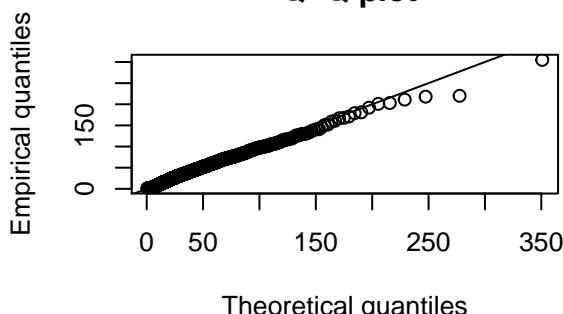
5.1.2.2.1 Testing for Lognormal Distribution

The lognormal distribution requires numbers above 0. Hence, the shifting in this case is by 14, such that the minimum is 1.

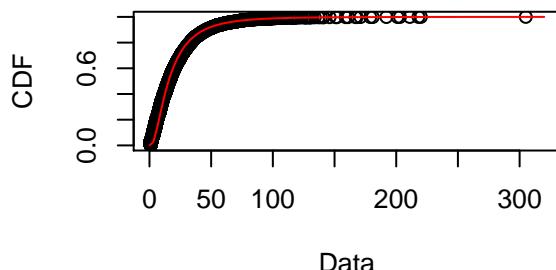
Empirical and theoretical dens.



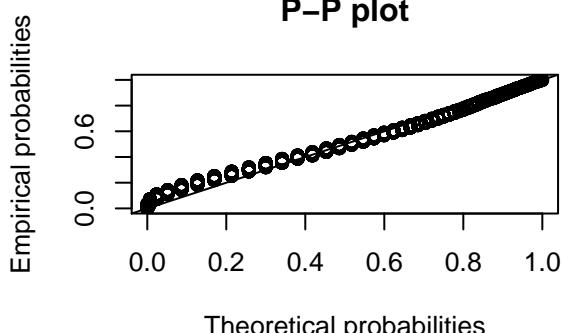
Q-Q plot



Empirical and theoretical CDFs



P-P plot

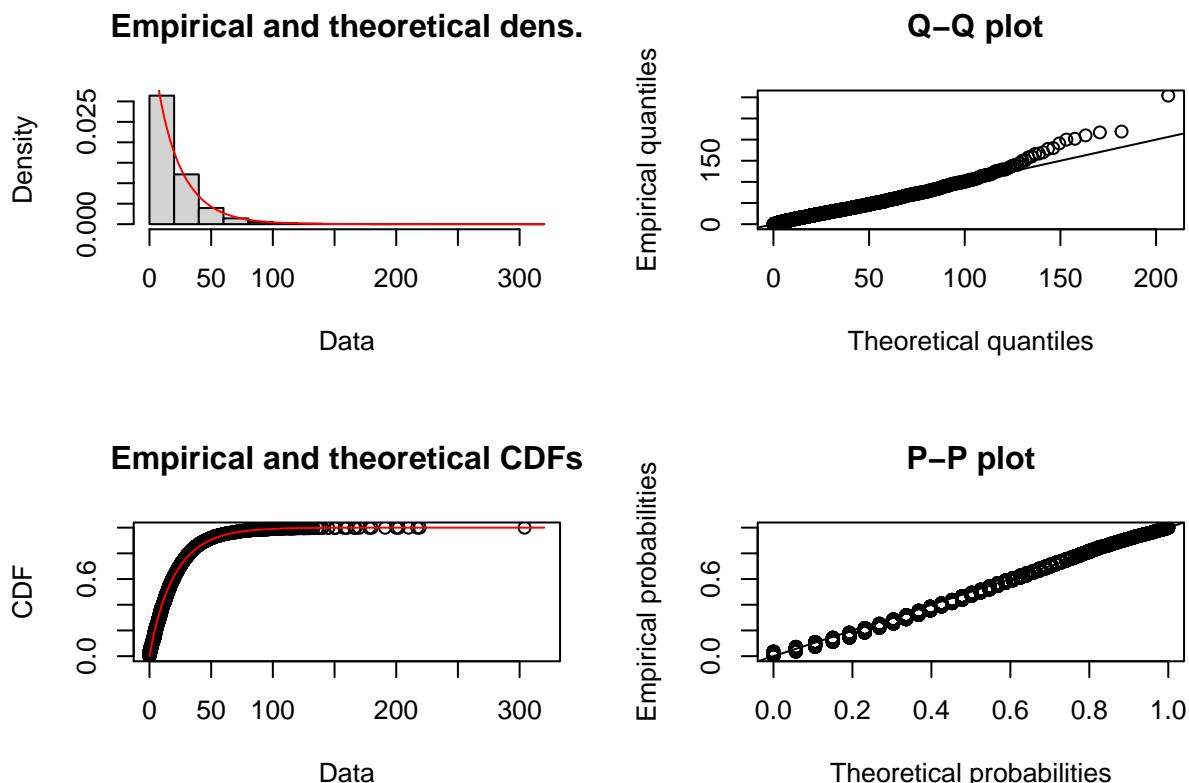


```
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic   0.09597839
## Cramer-von Mises statistic    9.78075237
## Anderson-Darling statistic   146.12106517
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion 51935.91
## Bayesian Information Criterion 51949.39
##
## [[2]]
## Fitting of the distribution 'lnorm' by matching moments
## Parameters :
##       estimate
## meanlog 2.7364665
## sdlog   0.8274675
## Loglikelihood: -25965.95   AIC: 51935.91   BIC: 51949.39
```

Table 12: Chi-Squared Test for Lognormal Distribution
with MeanLog 2.7364665 and SdLog 0.8274675

Pass	Error	Critical Value
Rejected	45.55516	5.991465

5.1.2.2.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.05101785
## Cramer-von Mises statistic   2.85874812
## Anderson-Darling statistic      Inf
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      -Inf
## Bayesian Information Criterion      -Inf
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate

```

```

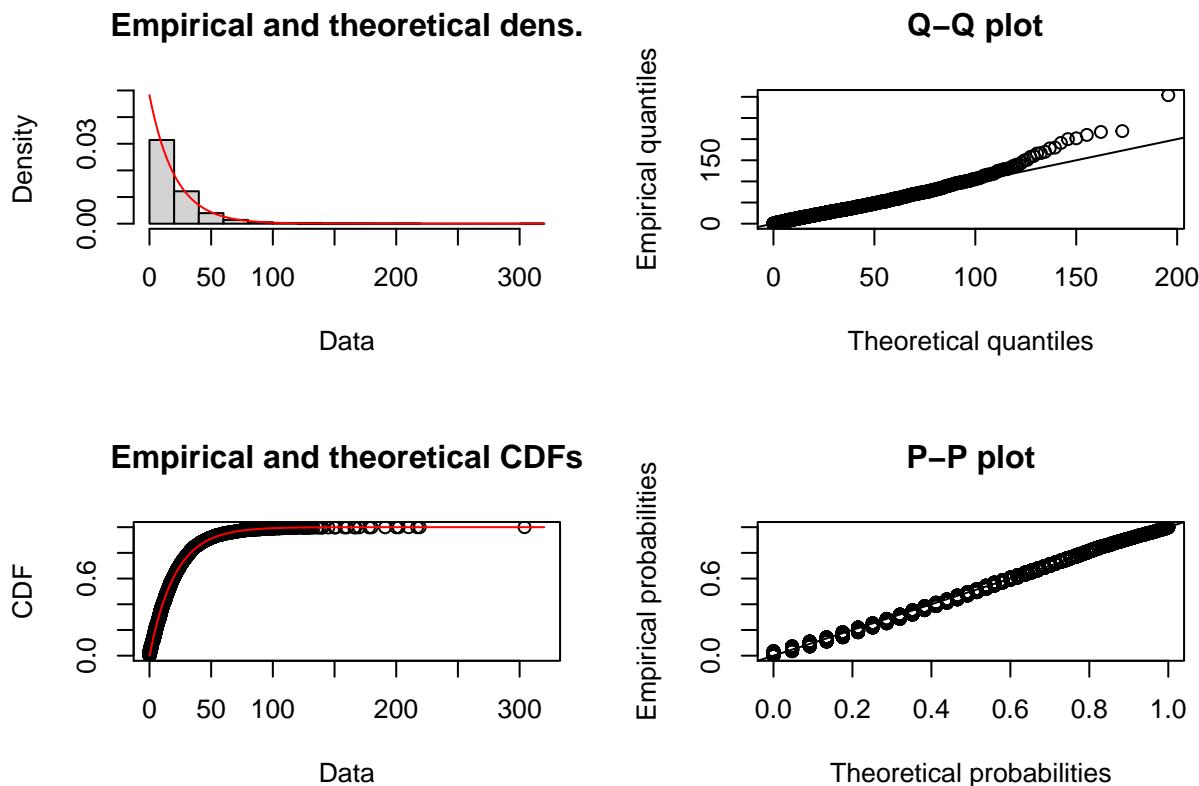
## shape 0.92565787
## rate 0.04464725
## Loglikelihood: Inf AIC: -Inf BIC: -Inf

```

Table 13: Chi-Squared Test for Gamma Distribution with Shape 0.92565787 and Rate 0.04464725

Pass	Error	Critical Value
Rejected	15.25287	3.841459

5.1.2.2.3 Testing for Exponential Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-exp
## Kolmogorov-Smirnov statistic 0.03533173
## Cramer-von Mises statistic   1.08195066
## Anderson-Darling statistic      Inf
## 
## Goodness-of-fit criteria
##                               1-mme-exp
## Akaike's Information Criterion 50438.72
## Bayesian Information Criterion 50445.46
## 

```

```

## [[2]]
## Fitting of the distribution 'exp' by matching moments
## Parameters :
##     estimate
## rate 0.048233
## Loglikelihood: -25218.36    AIC: 50438.72    BIC: 50445.46

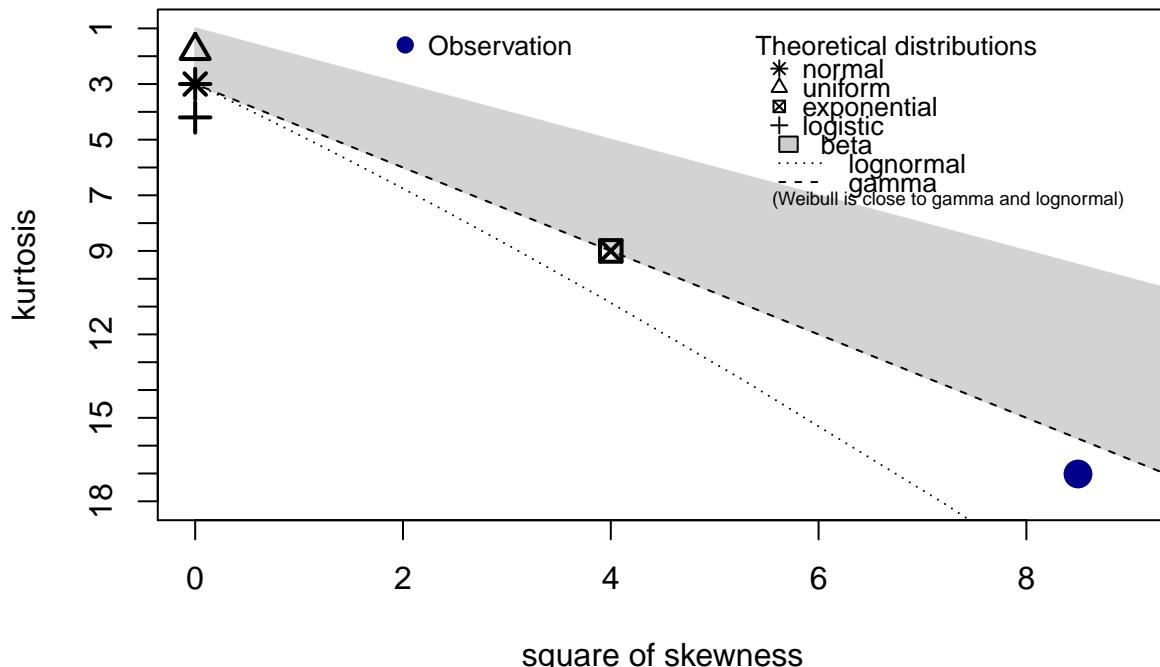
```

Table 14: Chi-Squared Test for Exponential Distribution with Rate 0.048233

Pass	Error	Critical Value
Not rejected	5.7713	5.991465

5.1.2.3 ASA 3

Cullen and Frey graph



```

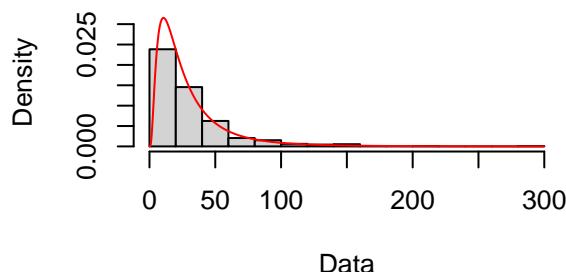
## summary statistics
## -----
## min: 1   max: 292
## median: 22
## mean: 30.45536
## estimated sd: 30.72181
## estimated skewness: 2.914877
## estimated kurtosis: 17.01842

```

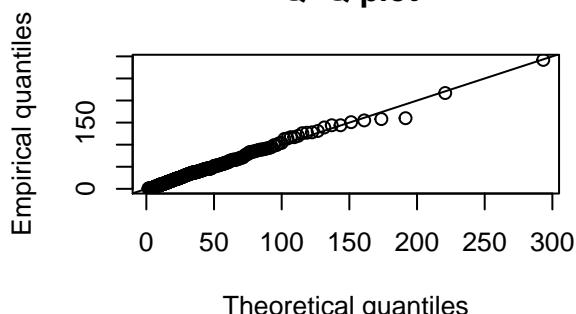
5.1.2.3.1 Testing for Lognormal Distribution

The lognormal distribution requires numbers above 0. Hence, the shifting in this case is by 14, such that the minimum is 1.

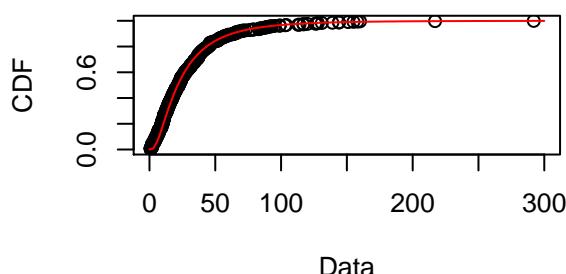
Empirical and theoretical dens.



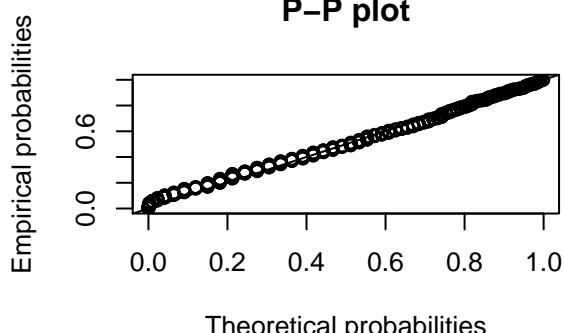
Q-Q plot



Empirical and theoretical CDFs



P-P plot

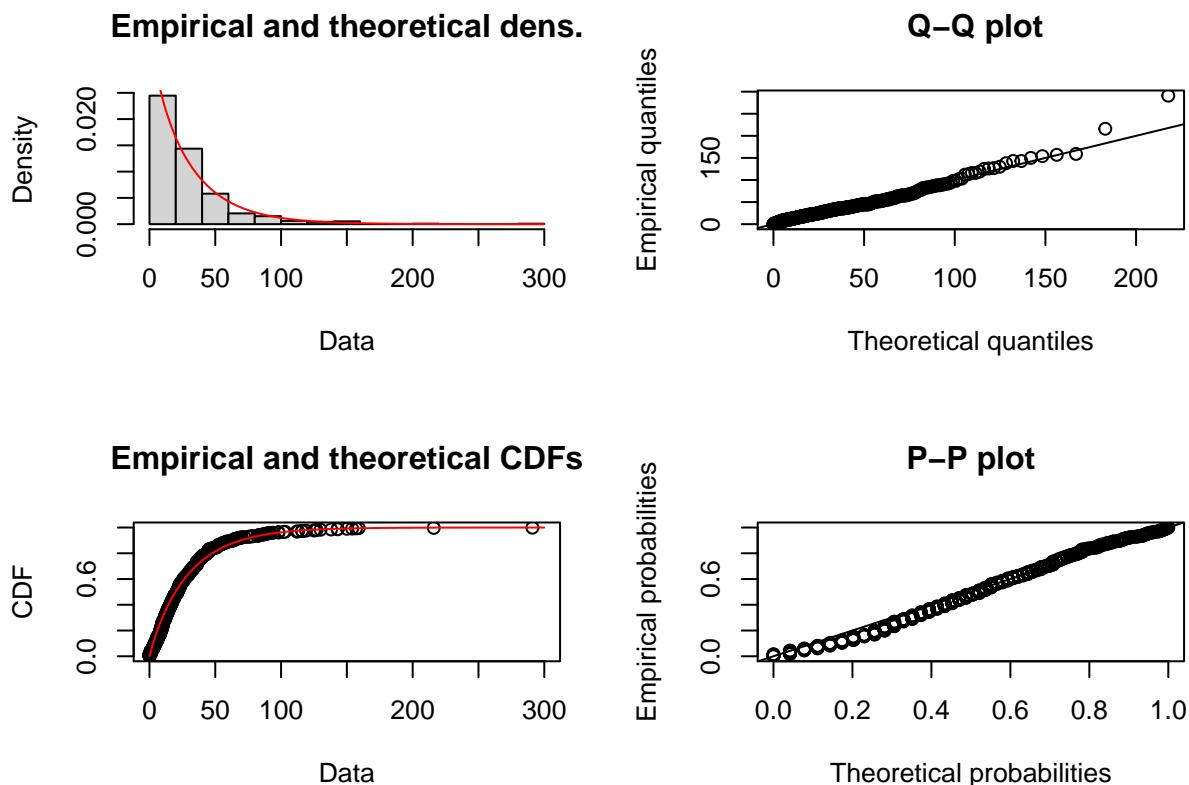


```
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic 0.06304681
## Cramer-von Mises statistic  0.35976253
## Anderson-Darling statistic  6.46302707
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion 4986.764
## Bayesian Information Criterion 4995.420
##
## [[2]]
## Fitting of the distribution 'lnorm' by matching moments
## Parameters :
##       estimate
## meanlog 3.0657644
## sdlog   0.8372545
## Loglikelihood: -2491.382    AIC: 4986.764    BIC: 4995.42
```

Table 15: Chi-Squared Test for Lognormal Distribution
with MeanLog 3.0657644 and SdLog 0.8372545

Pass	Error	Critical Value
Not rejected	5.50356	12.59159

5.1.2.3.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.08827393
## Cramer-von Mises statistic   0.73718487
## Anderson-Darling statistic      Inf
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      -Inf
## Bayesian Information Criterion     -Inf
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate

```

```

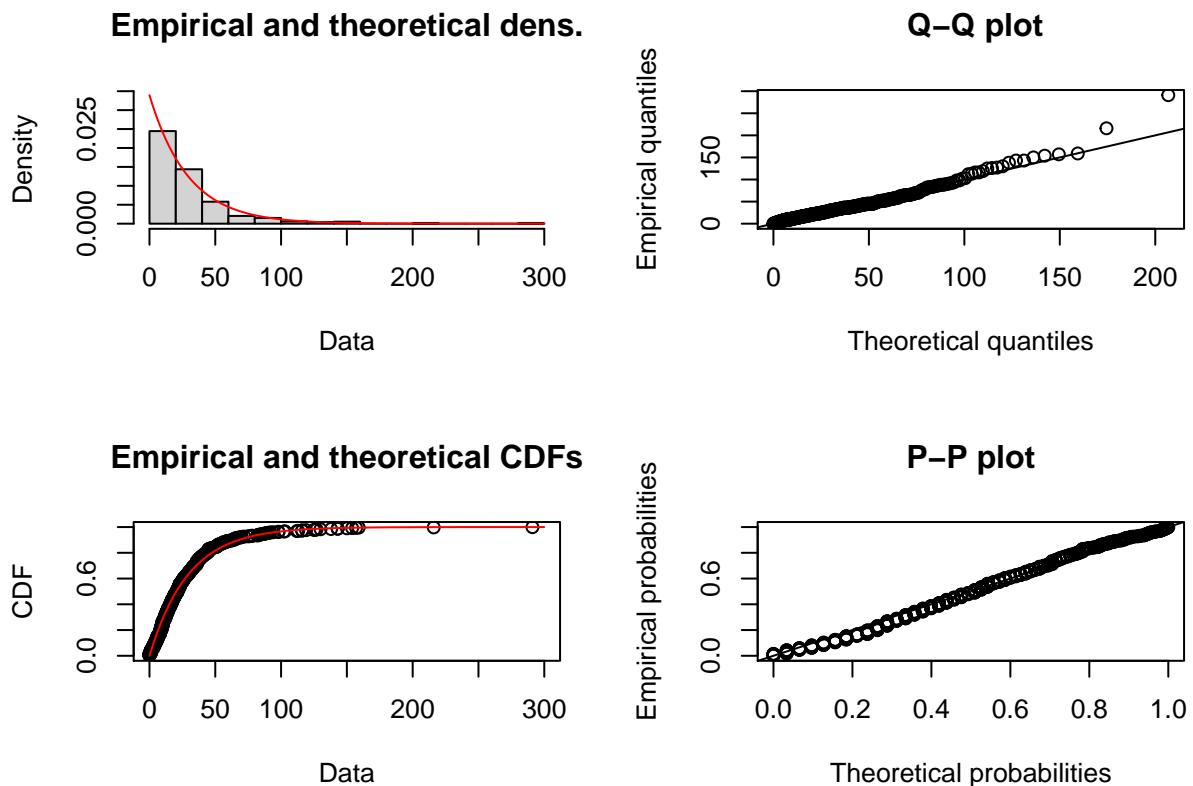
## shape 0.92089709
## rate 0.03126416
## Loglikelihood: Inf AIC: -Inf BIC: -Inf

```

Table 16: Chi-Squared Test for Gamma Distribution with Shape 0.92089709 and Rate 0.03126416

Pass	Error	Critical Value
Not rejected	5.842161	5.991465

5.1.2.3.3 Testing for Exponential Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-exp
## Kolmogorov-Smirnov statistic 0.06998185
## Cramer-von Mises statistic   0.40160340
## Anderson-Darling statistic      Inf
## 
## Goodness-of-fit criteria
##                               1-mme-exp
## Akaike's Information Criterion 4910.821
## Bayesian Information Criterion 4915.149
## 

```

```

## [[2]]
## Fitting of the distribution 'exp' by matching moments
## Parameters :
##     estimate
## rate 0.03394968
## Loglikelihood: -2454.41 AIC: 4910.821 BIC: 4915.149

```

Table 17: Chi-Squared Test for Exponential Distribution with Rate 0.03394968

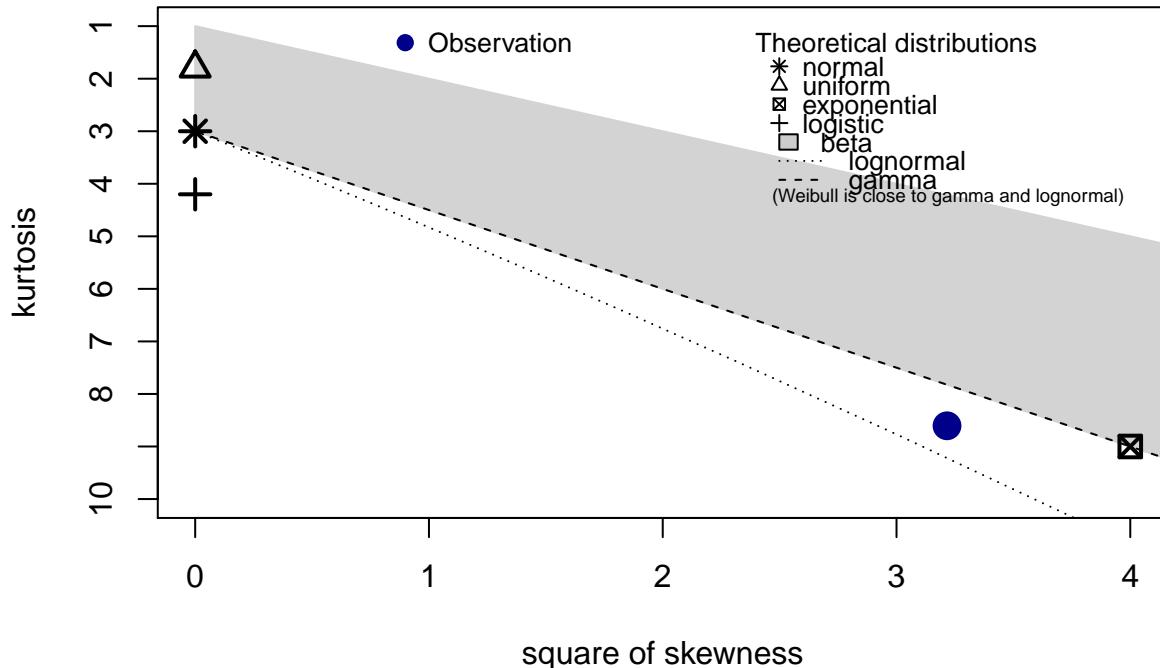
Pass	Error	Critical Value
Not rejected	4.483978	7.814728

5.2 Planned Appointments

5.2.1 Queue Time

5.2.1.1 ASA 1

Cullen and Frey graph



```

## summary statistics
## -----
## min: 13 max: 556
## median: 114
## mean: 127.7265
## estimated sd: 64.52942

```

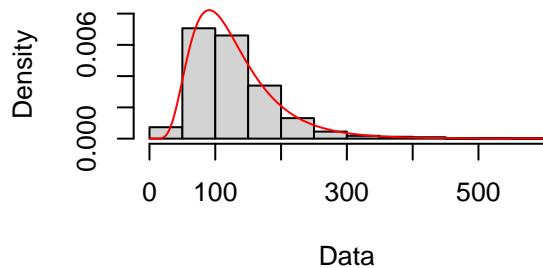
```

## estimated skewness: 1.79333
## estimated kurtosis: 8.60614

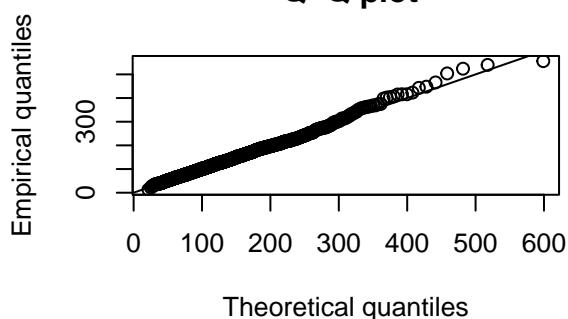
```

5.2.1.1.1 Testing for Lognormal Distribution

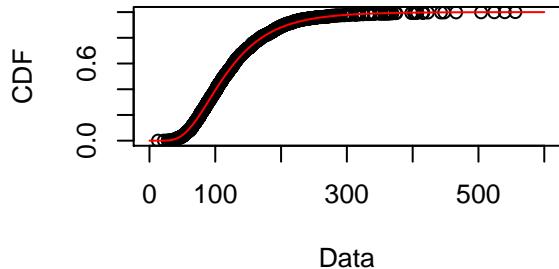
Empirical and theoretical dens.



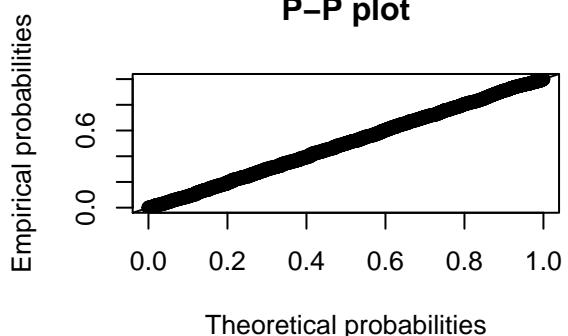
Q-Q plot



Empirical and theoretical CDFs



P-P plot



```

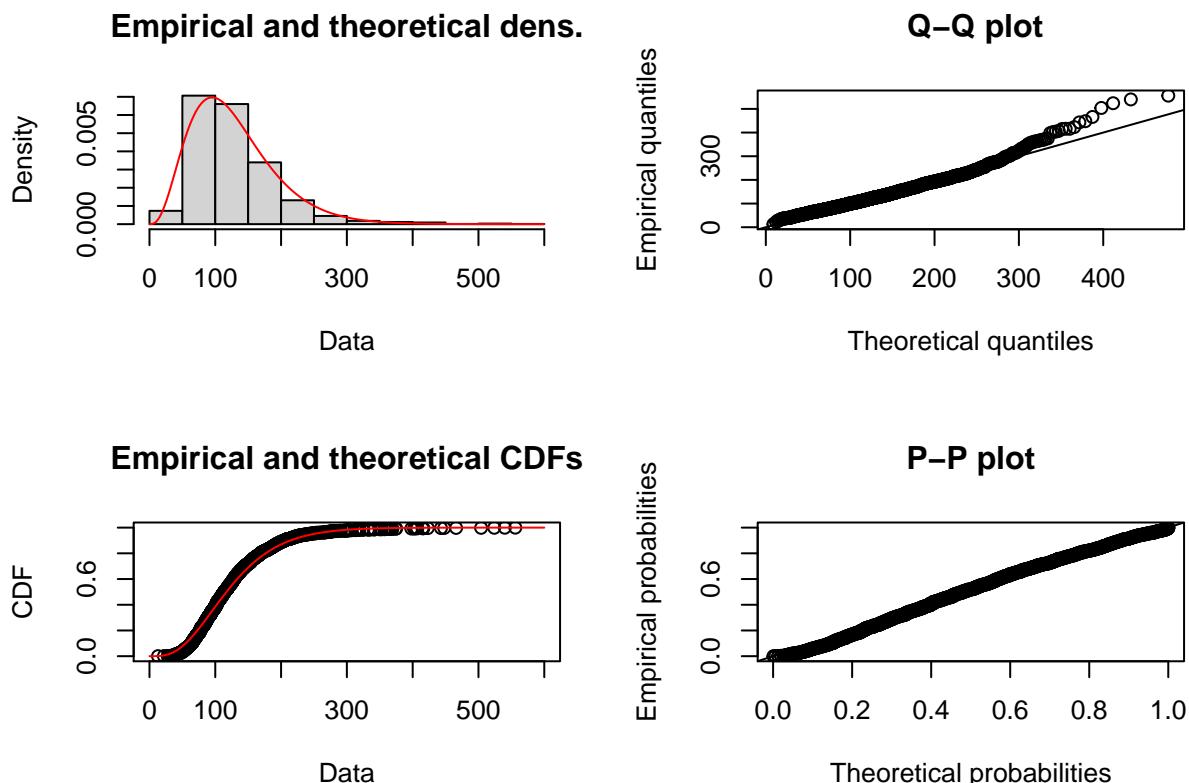
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic 0.01654383
## Cramer-von Mises statistic   0.06195682
## Anderson-Darling statistic   0.63112144
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion    21557.21
## Bayesian Information Criterion    21568.41
##
## [[2]]
## Fitting of the distribution ' lnorm ' by matching moments
## Parameters :
##       estimate
## meanlog 4.7362772
## sdlog   0.4766837
## Loglikelihood: -10776.6   AIC: 21557.21   BIC: 21568.41

```

Table 18: Chi-Squared Test for Lognormal Distribution
with MeanLog 4.7362772 and SdLog 0.4766837

Pass	Error	Critical Value
Not rejected	5.192523	9.487729

5.2.1.1.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.05008021
## Cramer-von Mises statistic   1.31740467
## Anderson-Darling statistic  10.95928126
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion    21678.92
## Bayesian Information Criterion    21690.12
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##      estimate

```

```

## shape 3.91979880
## rate 0.03068901
## Loglikelihood: -10837.46 AIC: 21678.92 BIC: 21690.12

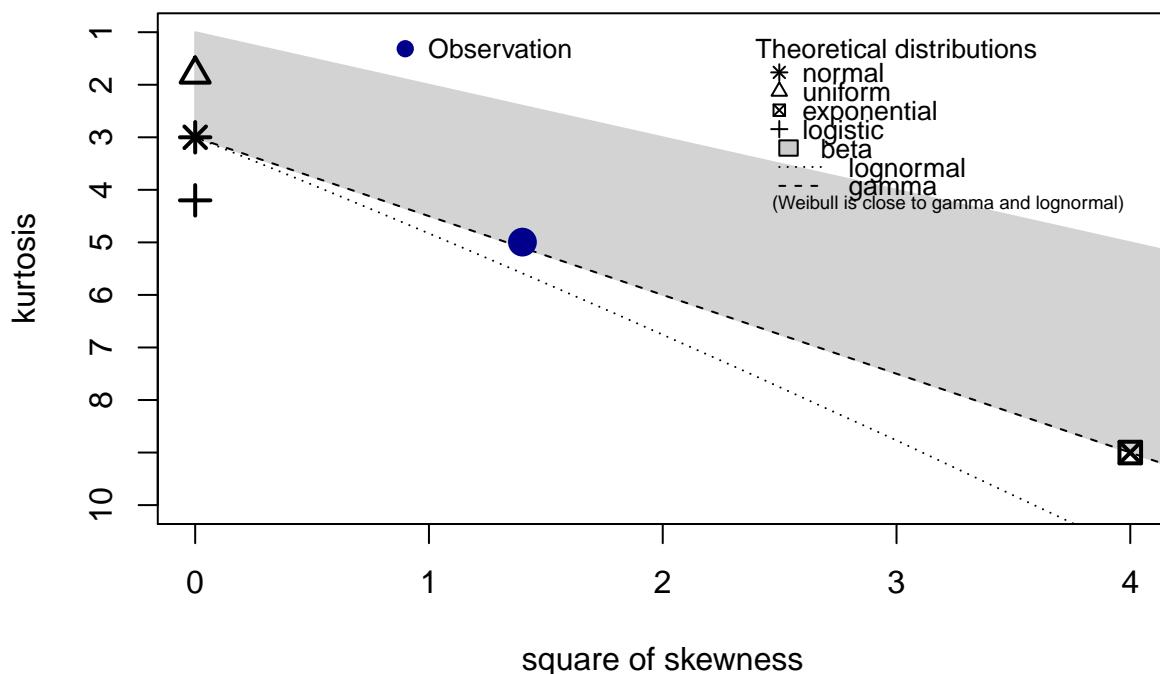
```

Table 19: Chi-Squared Test for Gamma Distribution
with Shape 3.9197988 and Rate 0.03068901

	Pass	Error	Critical Value
Rejected	22.16605	7.814728	

5.2.1.2 ASA 2

Cullen and Frey graph

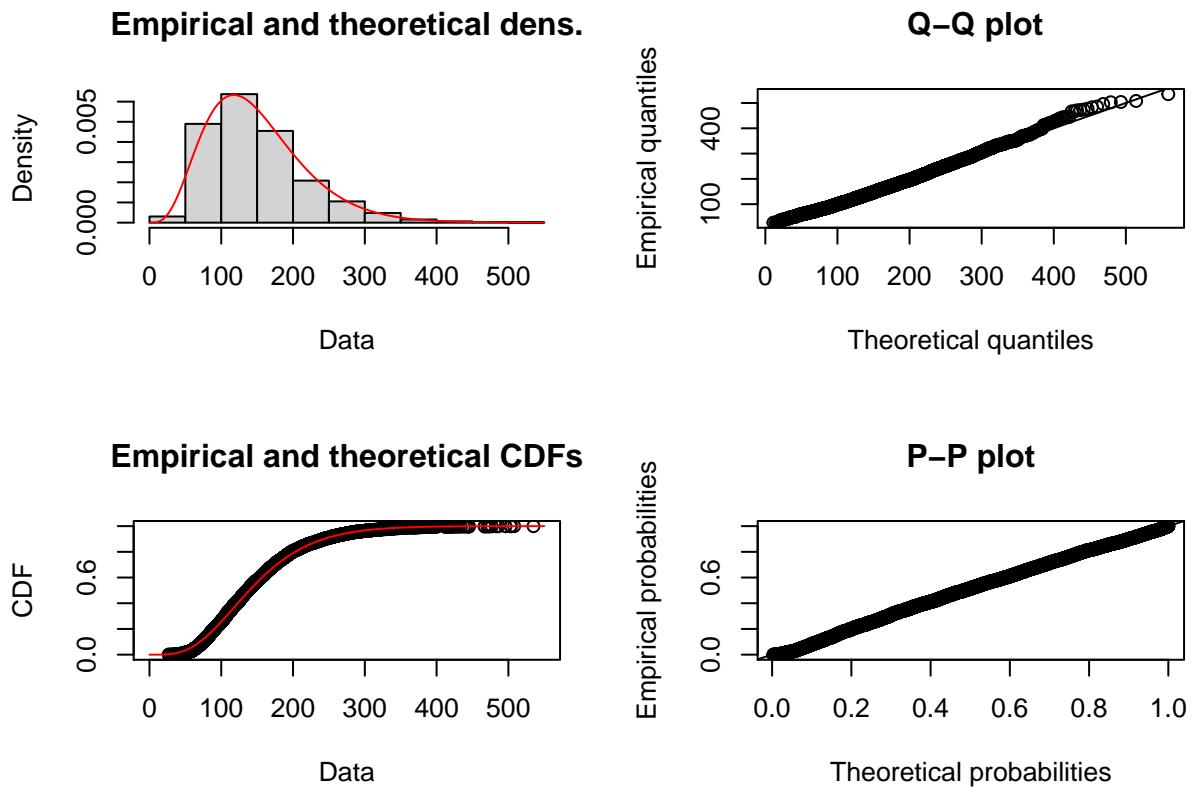


```

## summary statistics
## -----
## min: 27 max: 535
## median: 137
## mean: 149.8057
## estimated sd: 69.58894
## estimated skewness: 1.183166
## estimated kurtosis: 4.995085

```

5.2.1.2.1 Testing for Gamma Distribution



```

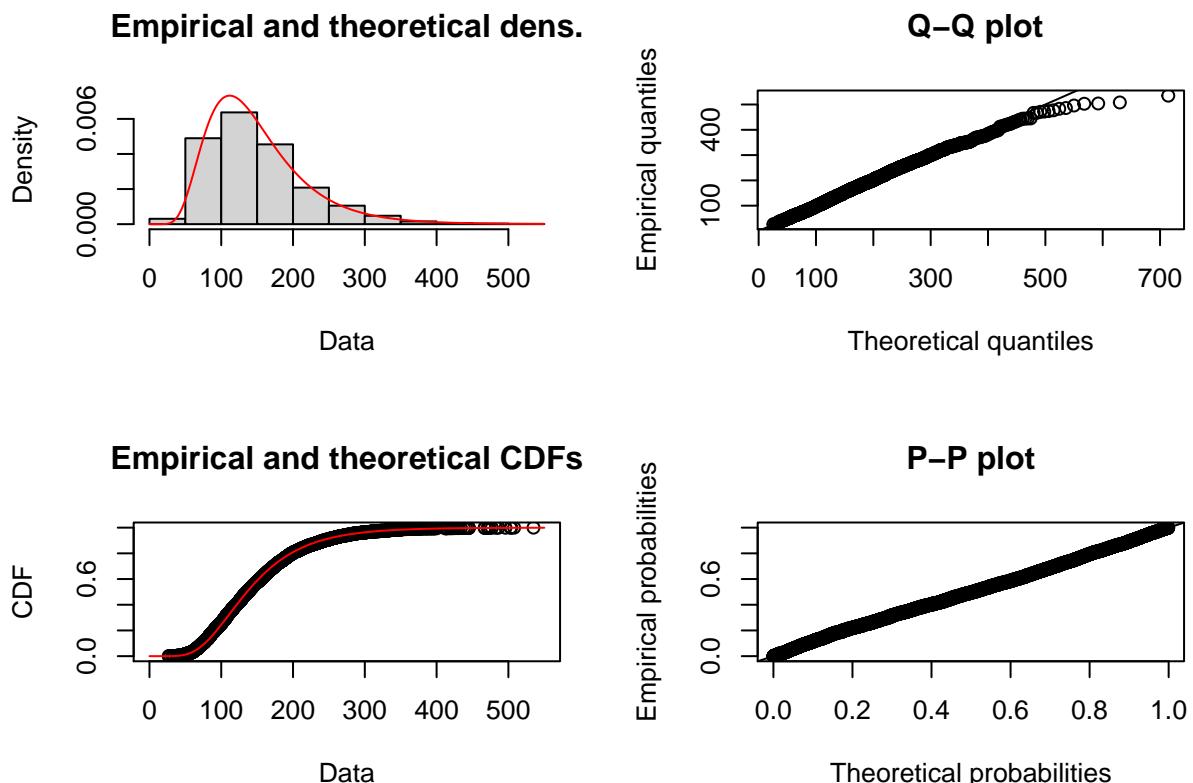
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.02925145
## Cramer-von Mises statistic   0.92462179
## Anderson-Darling statistic   9.11450436
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      64053.78
## Bayesian Information Criterion     64067.10
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##   estimate
## shape 4.6350196
## rate 0.0309402
## Loglikelihood: -32024.89    AIC: 64053.78    BIC: 64067.1

```

Table 20: Chi-Squared Test for Gamma Distribution with Shape 4.6350196 and Rate 0.0309402

Pass	Error	Critical Value
Not rejected	20.84311	21.02607

5.2.1.2.2 Testing for Lognormal Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic 0.02588754
## Cramer-von Mises statistic   0.74568786
## Anderson-Darling statistic   5.00402712
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion    63930.79
## Bayesian Information Criterion    63944.11
##
## [[2]]
## Fitting of the distribution 'lnorm' by matching moments
## Parameters :
##      estimate

```

```

## meanlog 4.9116591
## sdlog 0.4419957
## Loglikelihood: -31963.4 AIC: 63930.79 BIC: 63944.11

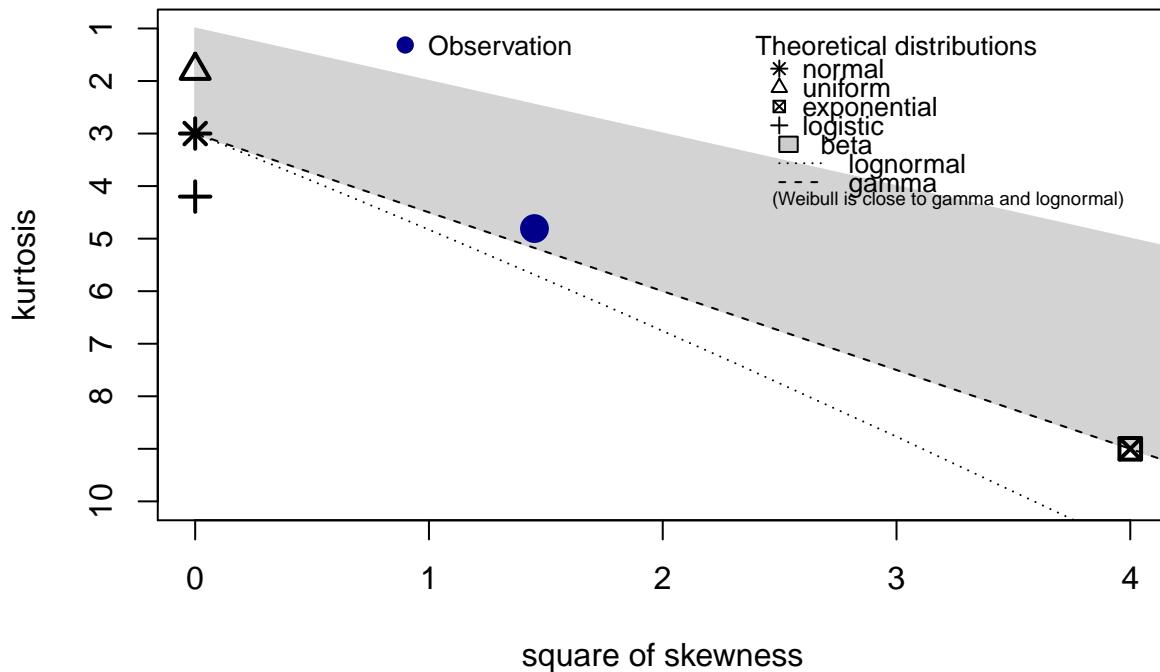
```

Table 21: Chi-Squared Test for Lognormal Distribution
with MeanLog 4.9116591 and SdLog 0.4419957

Pass	Error	Critical Value
Rejected	38.91663	22.36203

5.2.1.3 ASA 3

Cullen and Frey graph

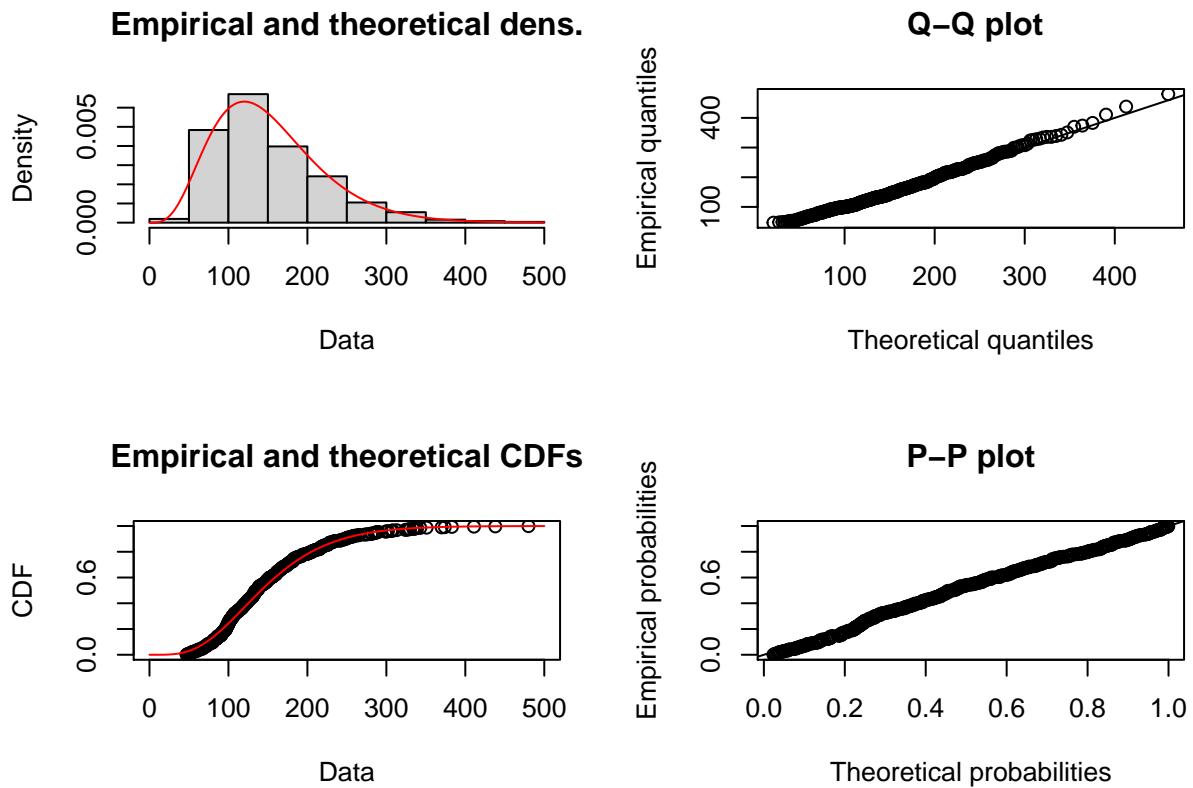


```

## summary statistics
## -----
## min: 47 max: 480
## median: 136
## mean: 151.883
## estimated sd: 69.55987
## estimated skewness: 1.204725
## estimated kurtosis: 4.808147

```

5.2.1.3.1 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic   0.0467720
## Cramer-von Mises statistic    0.2687312
## Anderson-Darling statistic    1.8789186
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion 5691.367
## Bayesian Information Criterion 5699.847
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate
## shape 4.77692467
## rate  0.03145134
## Loglikelihood: -2843.683   AIC: 5691.367   BIC: 5699.847

```

Table 22: Chi-Squared Test for Gamma Distribution with Shape 4.77692467 and Rate 0.03145134

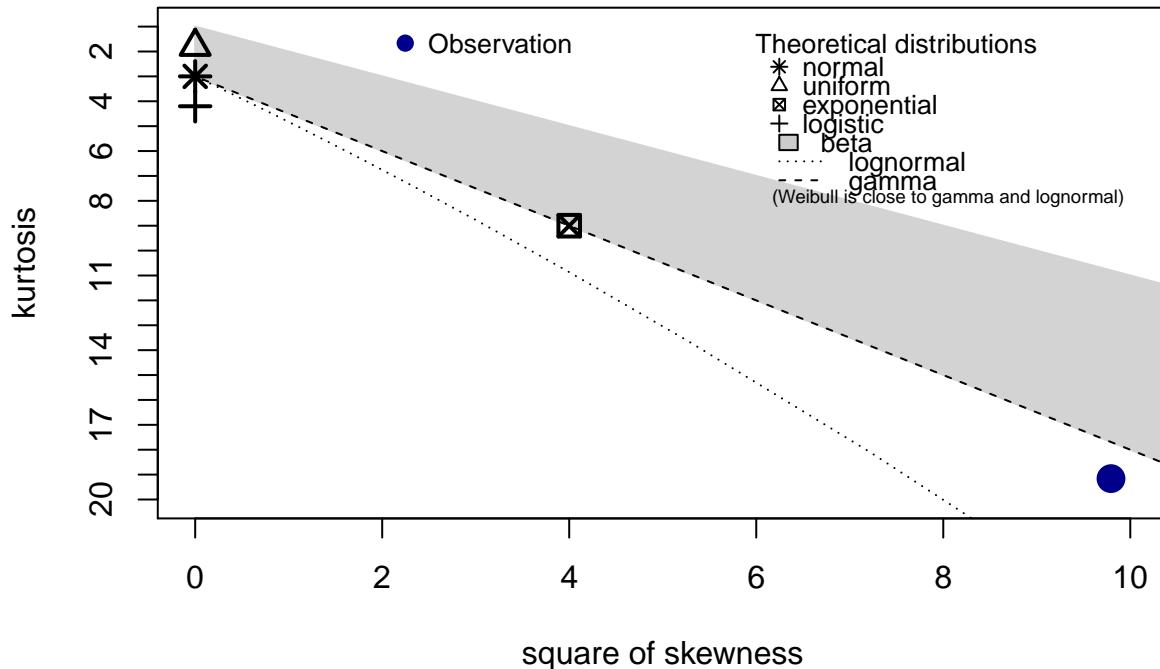
Pass	Error	Critical Value
Not rejected	13.61228	14.06714

5.2.2 Consult Duration

Adjusted version, meaning that the consult duration was shifted by 15 minutes, unless otherwise stated.

5.2.2.1 ASA 1

Cullen and Frey graph

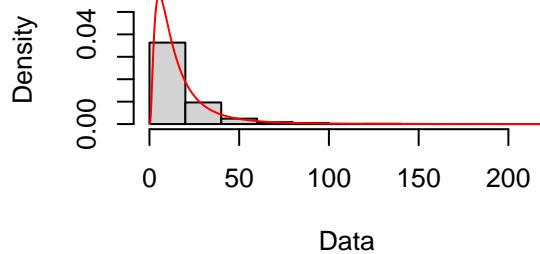


```
## summary statistics
## -----
## min: 0   max: 204
## median: 11
## mean: 16.10571
## estimated sd: 18.33906
## estimated skewness: 3.129485
## estimated kurtosis: 19.16101
```

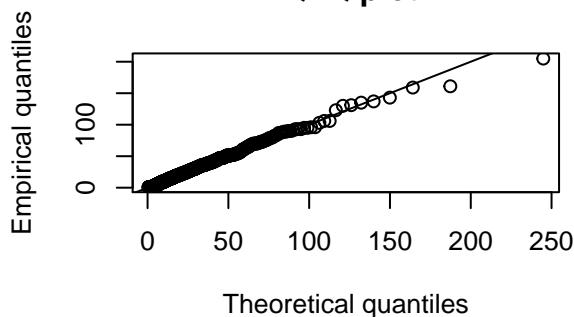
5.2.2.1.1 Testing for Lognormal Distribution

The lognormal distribution requires numbers above 0. Hence, the shifting in this case is by 14, such that the minimum is 1.

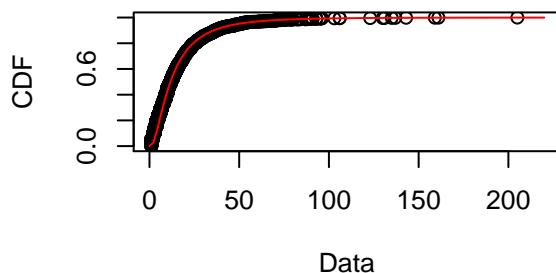
Empirical and theoretical dens.



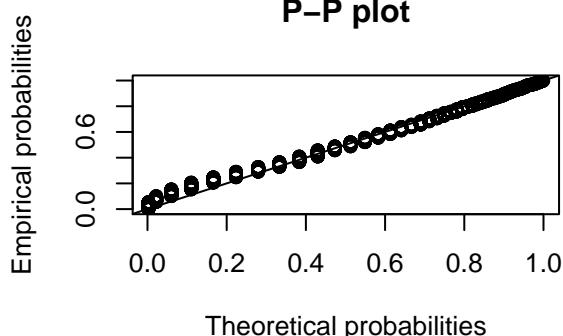
Q–Q plot



Empirical and theoretical CDFs



P–P plot



```

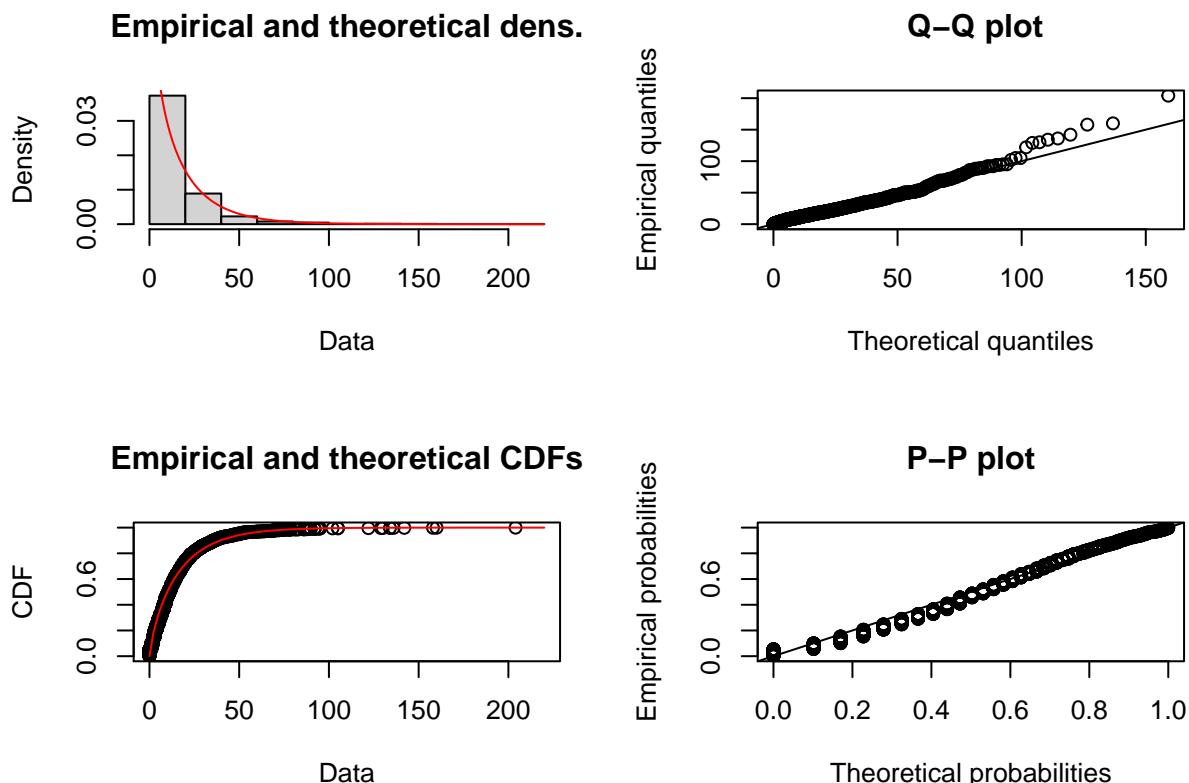
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic   0.0954679
## Cramer-von Mises statistic    2.2509975
## Anderson-Darling statistic   34.5996657
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion 15441.94
## Bayesian Information Criterion 15453.14
##
## [[2]]
## Fitting of the distribution ' lnorm ' by matching moments
## Parameters :
##     estimate
## meanlog 2.456952
## sdlog   0.874598
## Loglikelihood: -7718.972 AIC: 15441.94 BIC: 15453.14

```

Table 23: Chi-Squared Test for Lognormal Distribution
with MeanLog 2.456952 and SdLog 0.874598

Pass	Error	Critical Value
Not rejected	16.66601	16.91898

5.2.2.1.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.07696044
## Cramer-von Mises statistic   2.50299959
## Anderson-Darling statistic      Inf
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      -Inf
## Bayesian Information Criterion      -Inf
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate

```

```

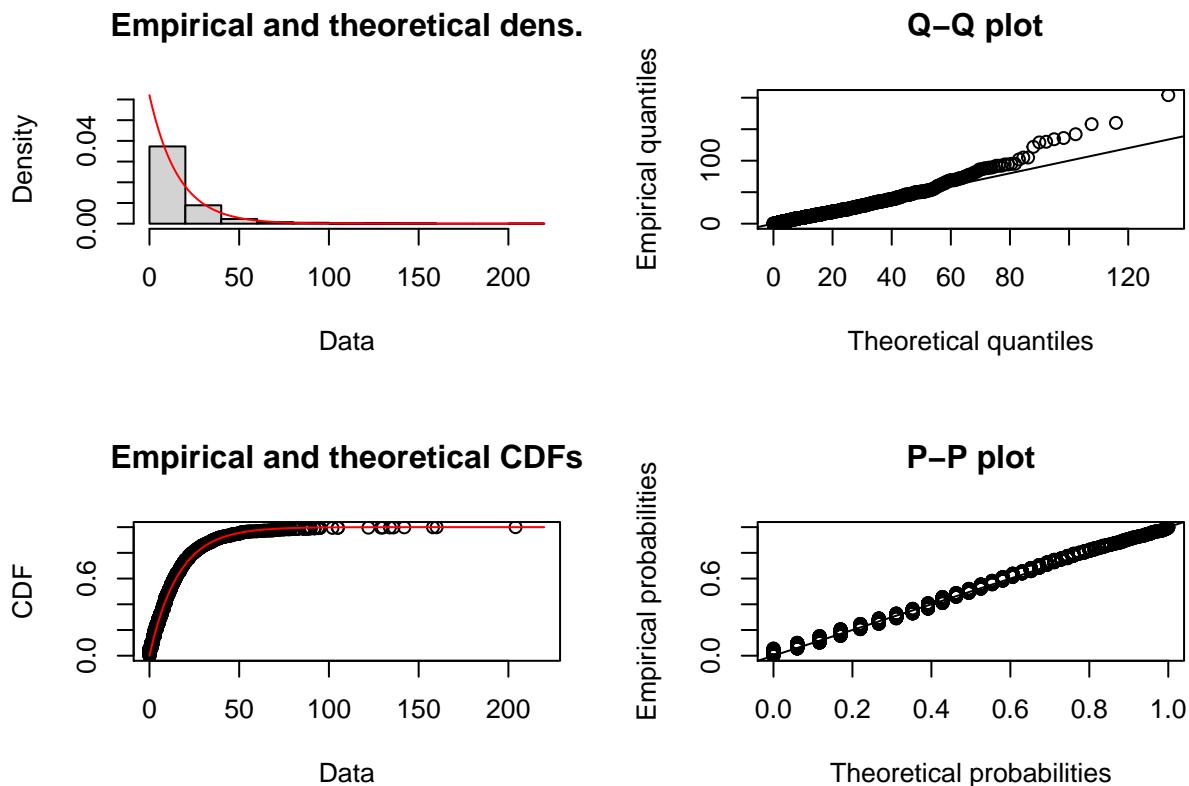
## shape 0.7716552
## rate 0.0479119
## Loglikelihood: Inf AIC: -Inf BIC: -Inf

```

Table 24: Chi-Squared Test for Gamma Distribution with Shape 0.7716552 and Rate 0.0479119

Pass	Error	Critical Value
Not rejected	13.26114	14.06714

5.2.2.1.3 Testing for Exponential Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-exp
## Kolmogorov-Smirnov statistic 0.05511022
## Cramer-von Mises statistic   0.63235091
## Anderson-Darling statistic      Inf
## 
## Goodness-of-fit criteria
##                               1-mme-exp
## Akaike's Information Criterion 15088.46
## Bayesian Information Criterion 15094.06
## 

```

```

## [[2]]
## Fitting of the distribution 'exp' by matching moments
## Parameters :
##     estimate
## rate 0.06208978
## Loglikelihood: -7543.231   AIC: 15088.46   BIC: 15094.06

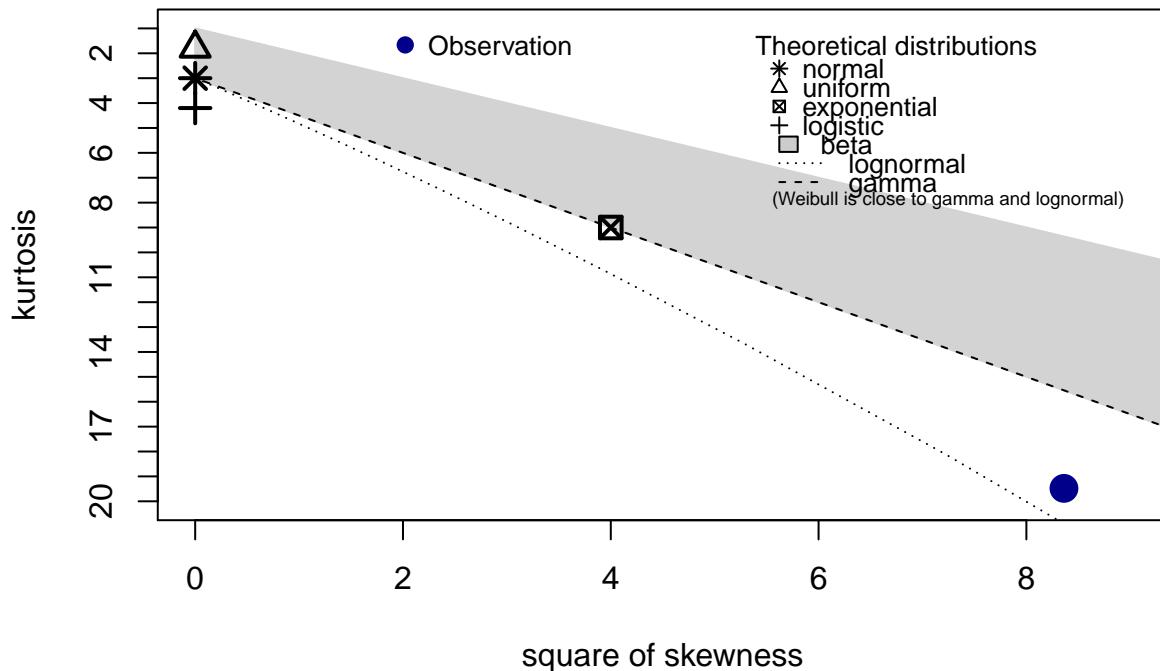
```

Table 25: Chi-Squared Test for Exponential Distribution
with Rate 0.06208978

Pass	Error	Critical Value
Rejected	34.53983	16.91898

5.2.2.2 ASA 2

Cullen and Frey graph



```

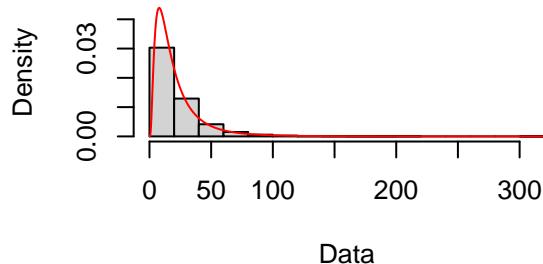
## summary statistics
## -----
## min: 1   max: 305
## median: 16
## mean: 21.73328
## estimated sd: 21.38637
## estimated skewness: 2.89165
## estimated kurtosis: 19.4802

```

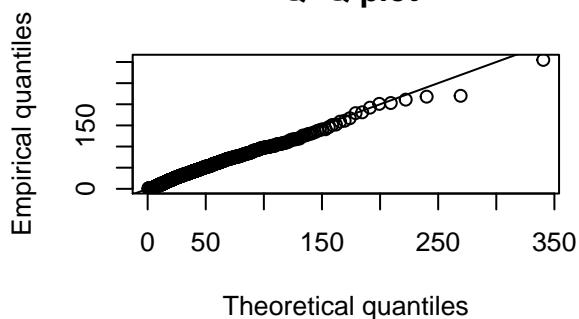
5.2.2.2.1 Testing for Lognormal Distribution

The lognormal distribution requires numbers above 0. Hence, the shifting in this case is by 14, such that the minimum is 1.

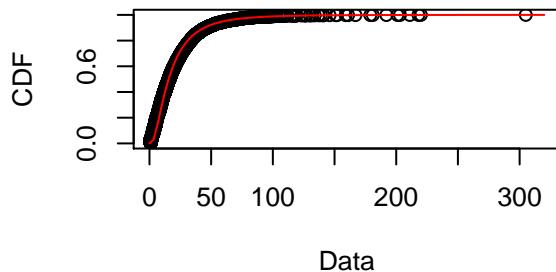
Empirical and theoretical dens.



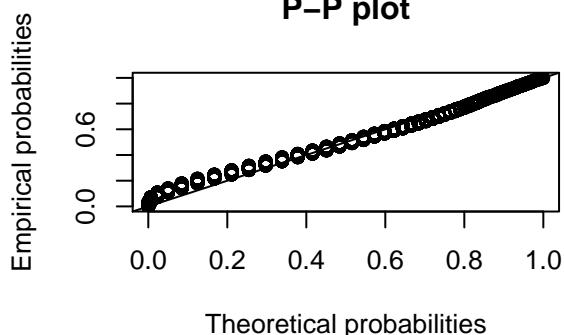
Q-Q plot



Empirical and theoretical CDFs



P-P plot

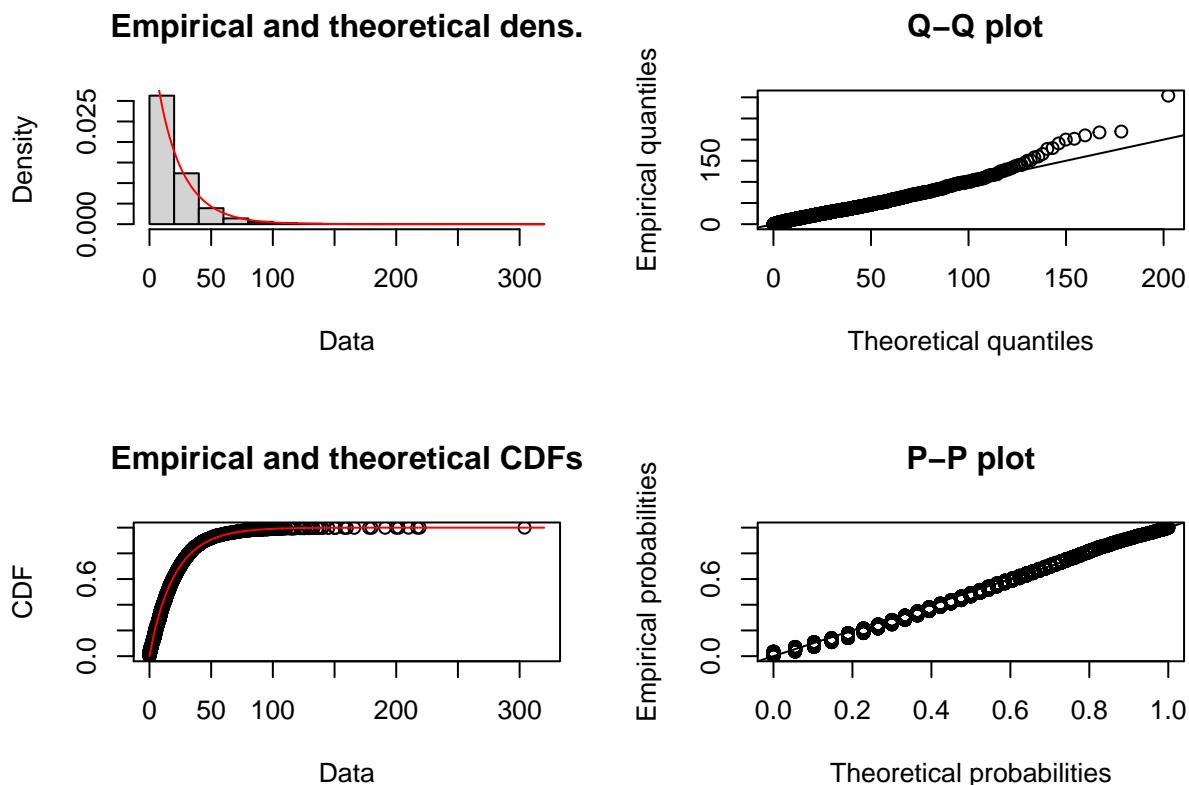


```
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic   0.09452814
## Cramer-von Mises statistic    8.75709084
## Anderson-Darling statistic   133.97976693
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion 47926.62
## Bayesian Information Criterion 47939.94
##
## [[2]]
## Fitting of the distribution 'lnorm' by matching moments
## Parameters :
##       estimate
## meanlog 2.7402942
## sdlog   0.8228612
## Loglikelihood: -23961.31   AIC: 47926.62   BIC: 47939.94
```

Table 26: Chi-Squared Test for Lognormal Distribution
with MeanLog 2.7402942 and SdLog 0.8228612

Pass	Error	Critical Value
Rejected	21.42409	7.814728

5.2.2.2.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic   0.0522794
## Cramer-von Mises statistic    2.6976054
## Anderson-Darling statistic     Inf
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      -Inf
## Bayesian Information Criterion     -Inf
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate

```

```

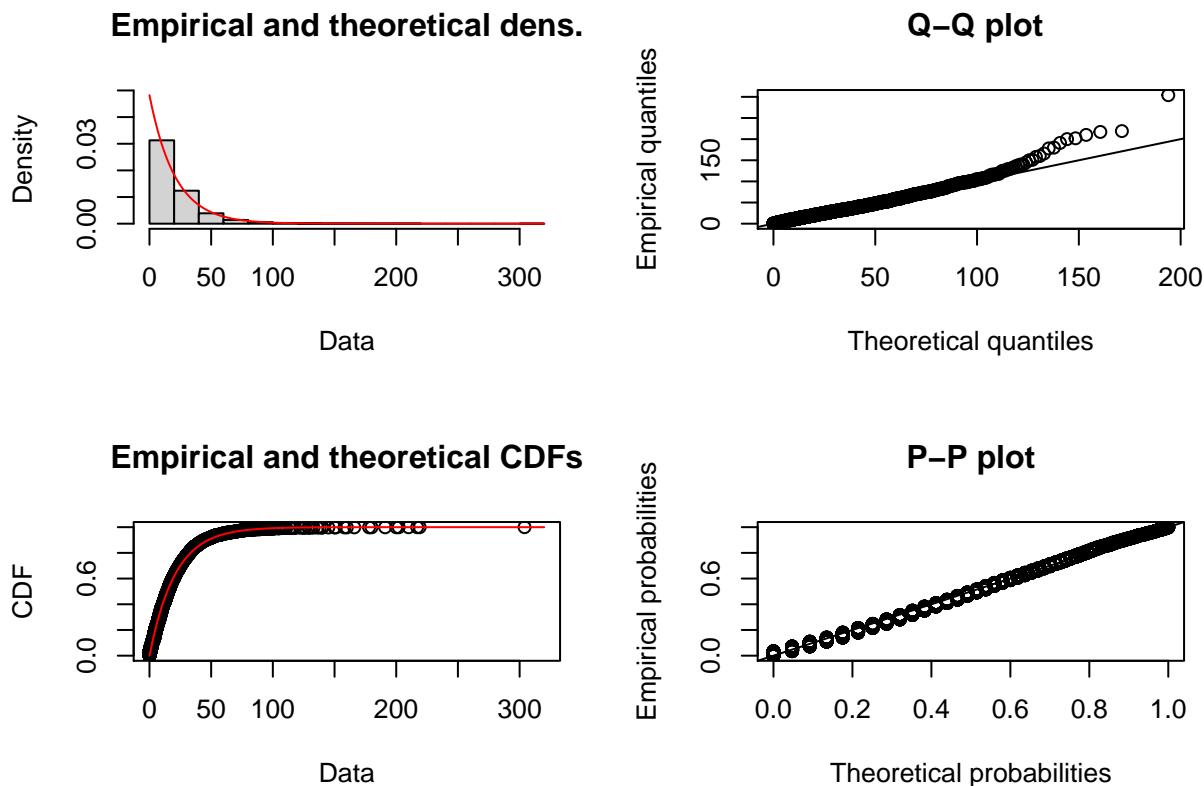
## shape 0.9400198
## rate 0.0453387
## Loglikelihood: Inf AIC: -Inf BIC: -Inf

```

Table 27: Chi-Squared Test for Gamma Distribution with Shape 0.9400198 and Rate 0.0453387

Pass	Error	Critical Value
Not rejected	5.40839	5.991465

5.2.2.2.3 Testing for Exponential Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-exp
## Kolmogorov-Smirnov statistic 0.03887442
## Cramer-von Mises statistic   1.26676599
## Anderson-Darling statistic      Inf
## 
## Goodness-of-fit criteria
##                               1-mme-exp
## Akaike's Information Criterion 46528.28
## Bayesian Information Criterion 46534.94
## 

```

```

## [[2]]
## Fitting of the distribution 'exp' by matching moments
## Parameters :
##     estimate
## rate 0.04823165
## Loglikelihood: -23263.14    AIC: 46528.28    BIC: 46534.94

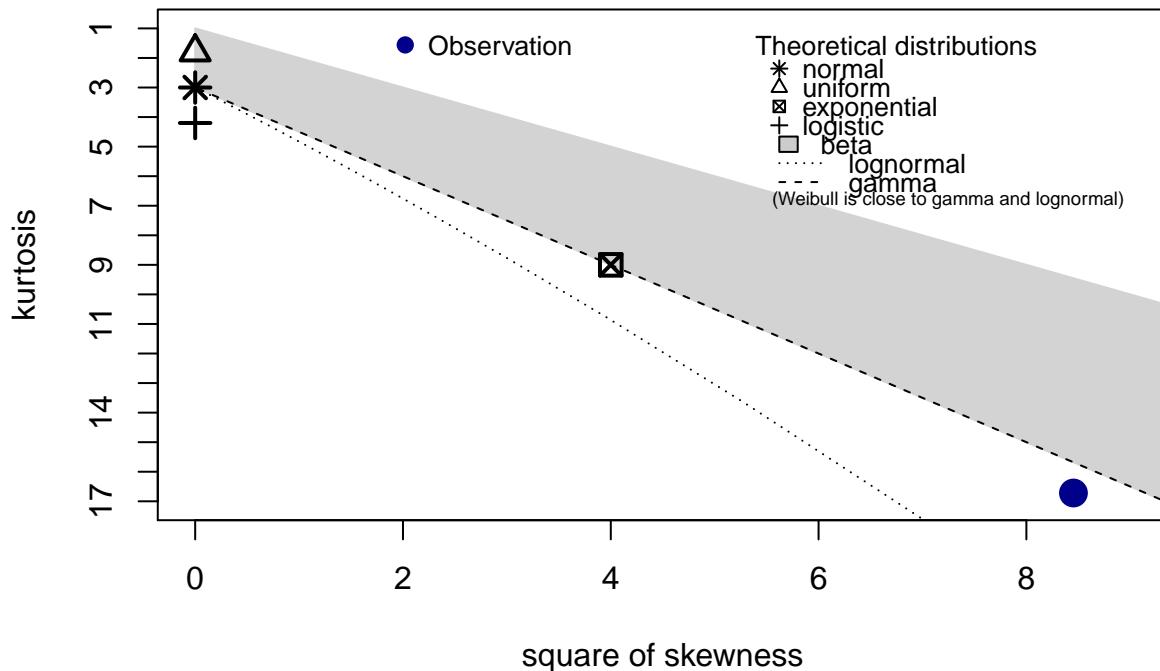
```

Table 28: Chi-Squared Test for Exponential Distribution
with Rate 0.04823165

Pass	Error	Critical Value
Not rejected	11.10927	12.59159

5.2.2.3 ASA 3

Cullen and Frey graph



```

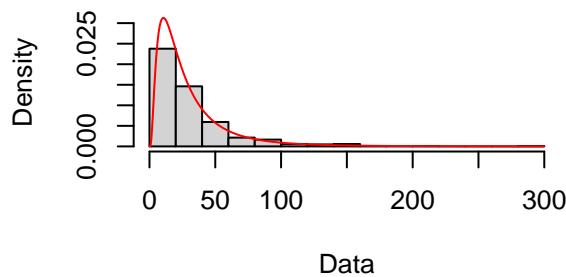
## summary statistics
## -----
## min: 1   max: 292
## median: 22
## mean: 30.81287
## estimated sd: 31.43551
## estimated skewness: 2.907392
## estimated kurtosis: 16.71943

```

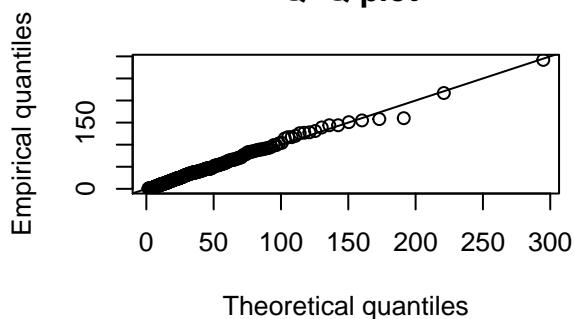
5.2.2.3.1 Testing for Lognormal Distribution

The lognormal distribution requires numbers above 0. Hence, the shifting in this case is by 14, such that the minimum is 1.

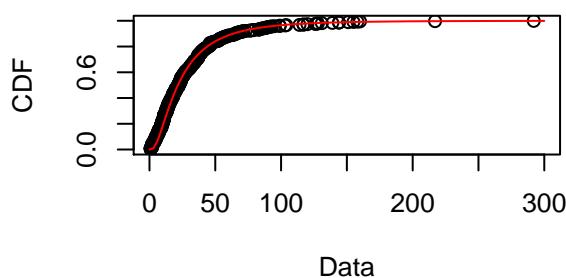
Empirical and theoretical dens.



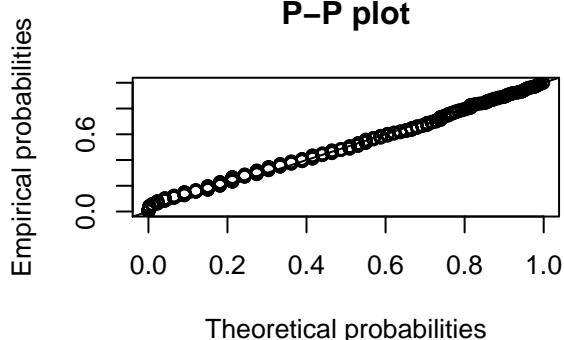
Q-Q plot



Empirical and theoretical CDFs



P-P plot

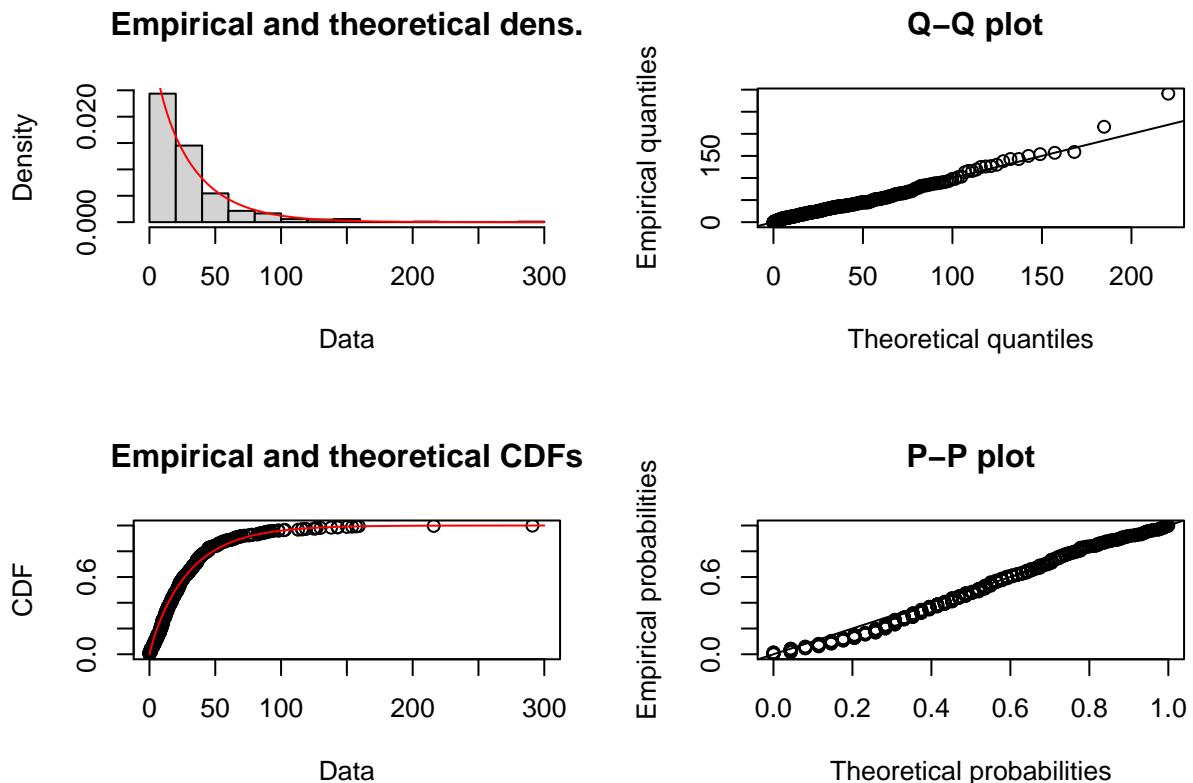


```
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic   0.0636774
## Cramer-von Mises statistic    0.3279006
## Anderson-Darling statistic    5.7790015
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion 4577.690
## Bayesian Information Criterion 4586.171
##
## [[2]]
## Fitting of the distribution 'lnorm' by matching moments
## Parameters :
##       estimate
## meanlog 3.0717530
## sdlog   0.8440134
## Loglikelihood: -2286.845 AIC: 4577.69 BIC: 4586.171
```

Table 29: Chi-Squared Test for Lognormal Distribution
with MeanLog 3.071753 and SdLog 0.8440134

Pass	Error	Critical Value
Not rejected	4.778335	7.814728

5.2.2.3.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.09086619
## Cramer-von Mises statistic   0.72208232
## Anderson-Darling statistic      Inf
## 
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      -Inf
## Bayesian Information Criterion      -Inf
## 
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate

```

```

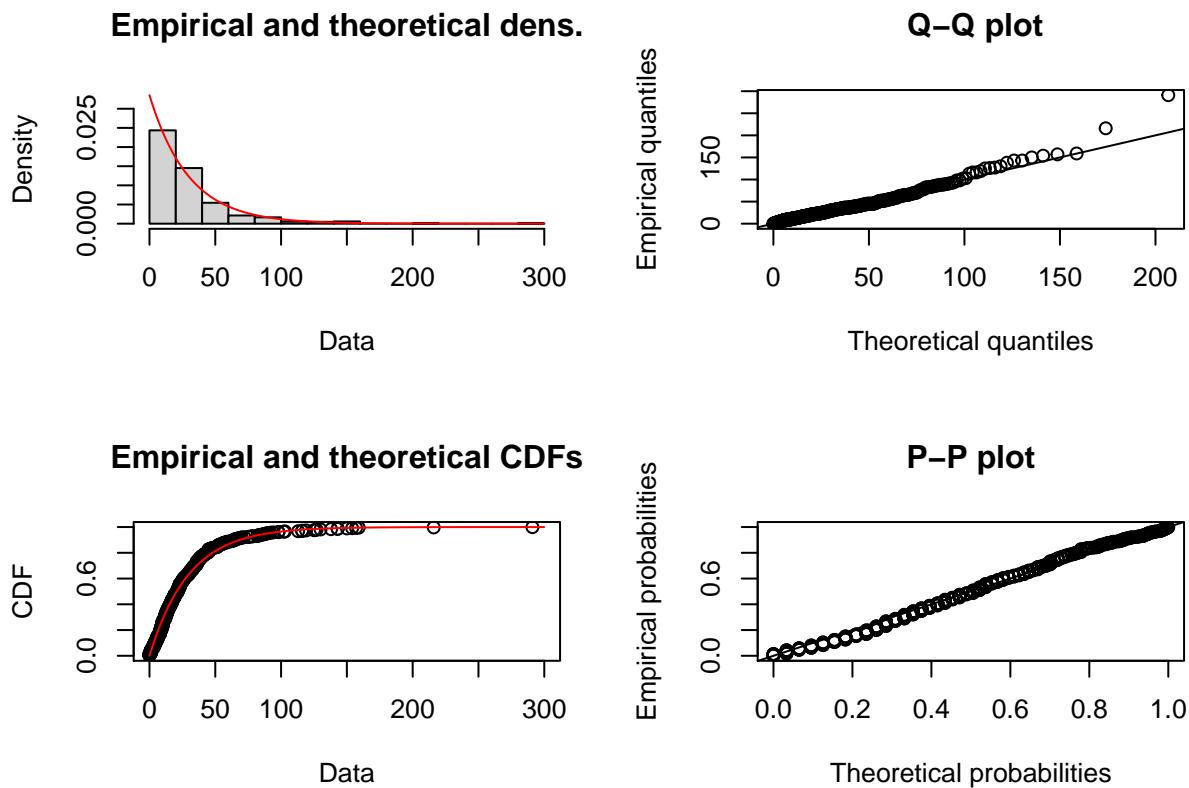
## shape 0.90118456
## rate 0.03022804
## Loglikelihood: Inf AIC: -Inf BIC: -Inf

```

Table 30: Chi-Squared Test for Gamma Distribution with Shape 0.90118456 and Rate 0.03022804

Pass	Error	Critical Value
Not rejected	8.379399	9.487729

5.2.2.3.3 Testing for Exponential Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-exp
## Kolmogorov-Smirnov statistic 0.06771132
## Cramer-von Mises statistic   0.34491026
## Anderson-Darling statistic    Inf
## 
## Goodness-of-fit criteria
##                               1-mme-exp
## Akaike's Information Criterion 4511.208
## Bayesian Information Criterion 4515.449
## 

```

```

## [[2]]
## Fitting of the distribution 'exp' by matching moments
## Parameters :
##     estimate
## rate 0.03354257
## Loglikelihood: -2254.604 AIC: 4511.208 BIC: 4515.449

```

Table 31: Chi-Squared Test for Exponential Distribution with Rate 0.03354257

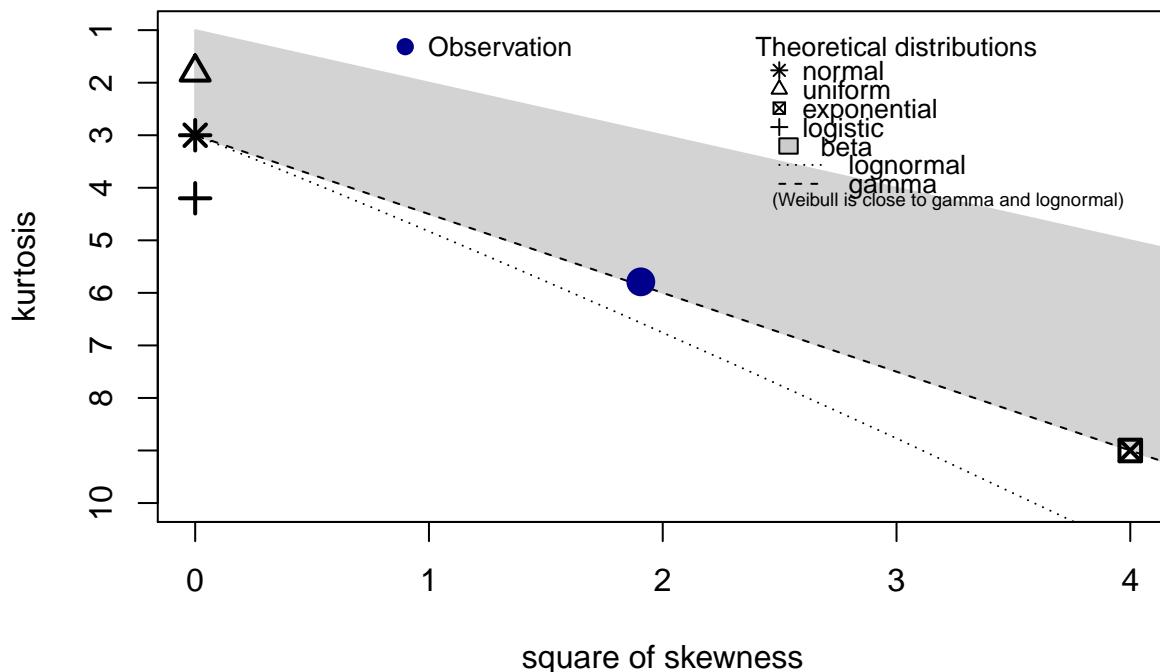
Pass	Error	Critical Value
Not rejected	6.057588	11.0705

5.3 Walk-In Appointments

5.3.1 Queue Time

5.3.1.1 ASA 1

Cullen and Frey graph



```

## summary statistics
## -----
## min: 16 max: 585
## median: 127
## mean: 147.3503
## estimated sd: 88.83391

```

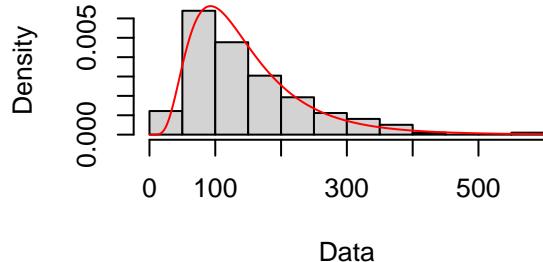
```

## estimated skewness: 1.380647
## estimated kurtosis: 5.790429

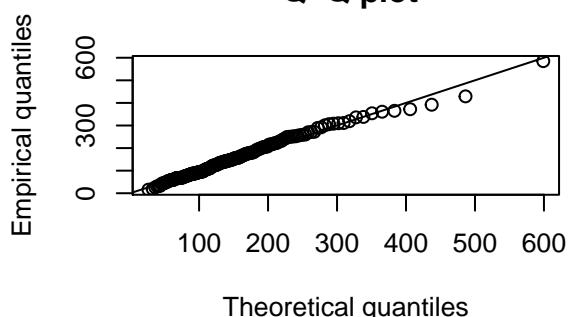
```

5.3.1.1.1 Testing for Lognormal Distribution

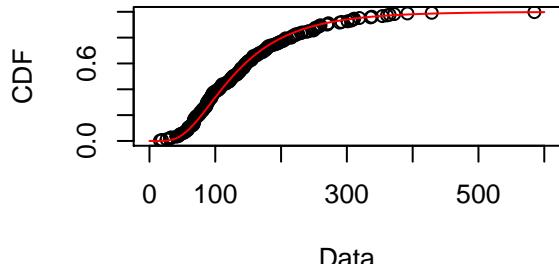
Empirical and theoretical dens.



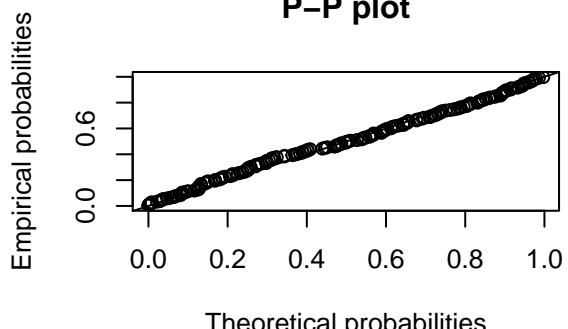
Q–Q plot



Empirical and theoretical CDFs



P–P plot



```

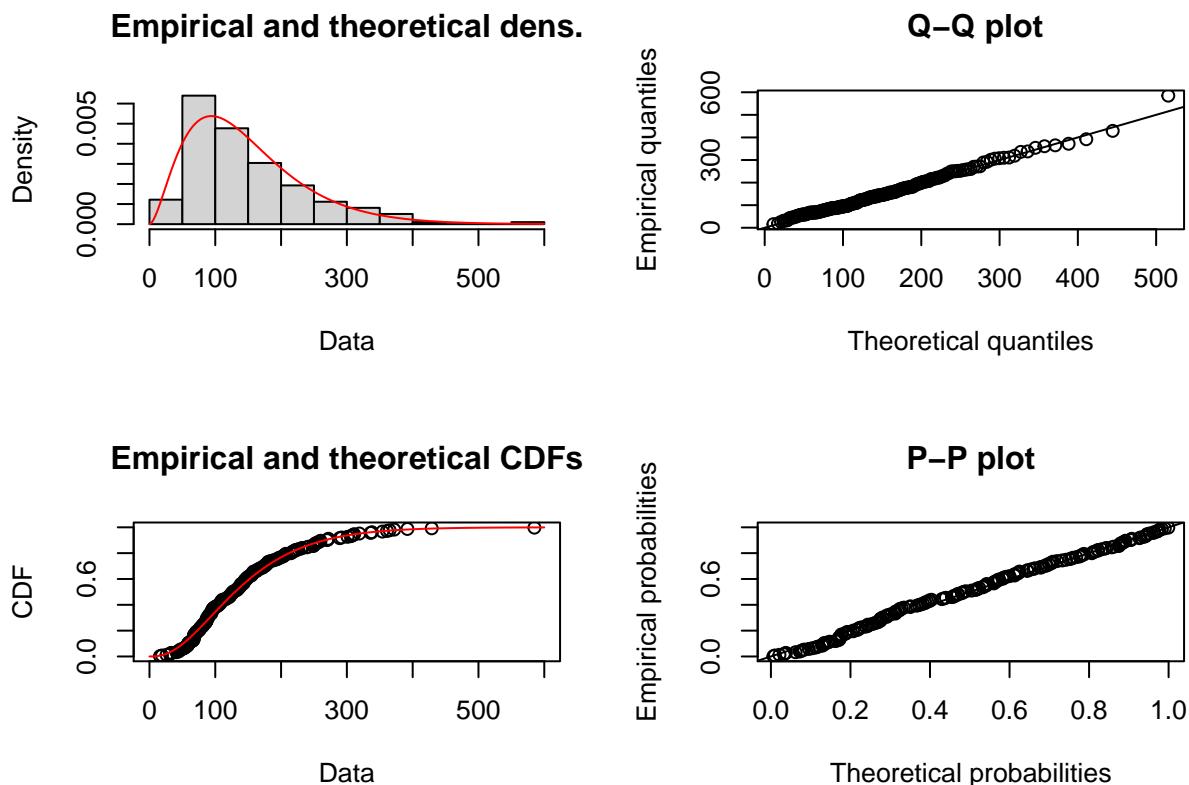
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic   0.0596964
## Cramer-von Mises statistic    0.1086712
## Anderson-Darling statistic    0.7974009
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion 2269.386
## Bayesian Information Criterion 2275.953
##
## [[2]]
## Fitting of the distribution ' lnorm ' by matching moments
## Parameters :
##           estimate
## meanlog 4.8384769
## sdlog   0.5555817
## Loglikelihood: -1132.693 AIC: 2269.386 BIC: 2275.953

```

Table 32: Chi-Squared Test for Lognormal Distribution
with MeanLog 4.8384769 and SdLog 0.5555817

Pass	Error	Critical Value
Not rejected	5.394277	9.487729

5.3.1.1.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.04825587
## Cramer-von Mises statistic  0.08126044
## Anderson-Darling statistic  0.60684980
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion    2265.978
## Bayesian Information Criterion   2272.544
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##      estimate

```

```

## shape 2.76537723
## rate 0.01876737
## Loglikelihood: -1130.989 AIC: 2265.978 BIC: 2272.544

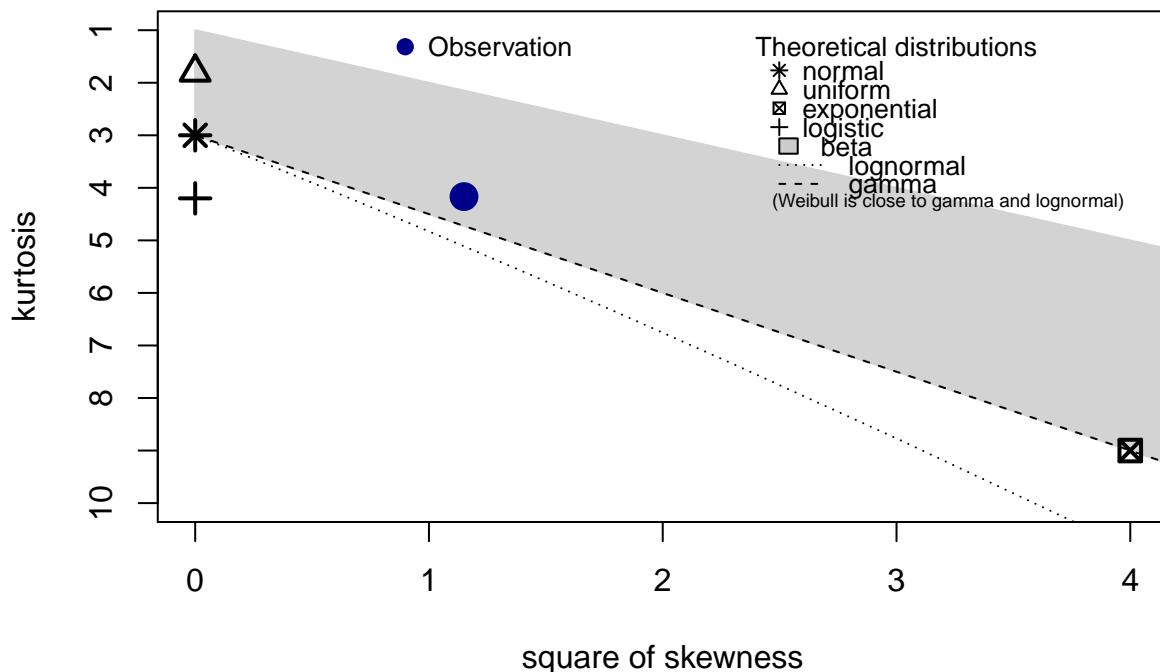
```

Table 33: Chi-Squared Test for Gamma Distribution
with Shape 2.76537723 and Rate 0.01876737

Pass	Error	Critical Value
Not rejected	2.535864	7.814728

5.3.1.2 ASA 2

Cullen and Frey graph

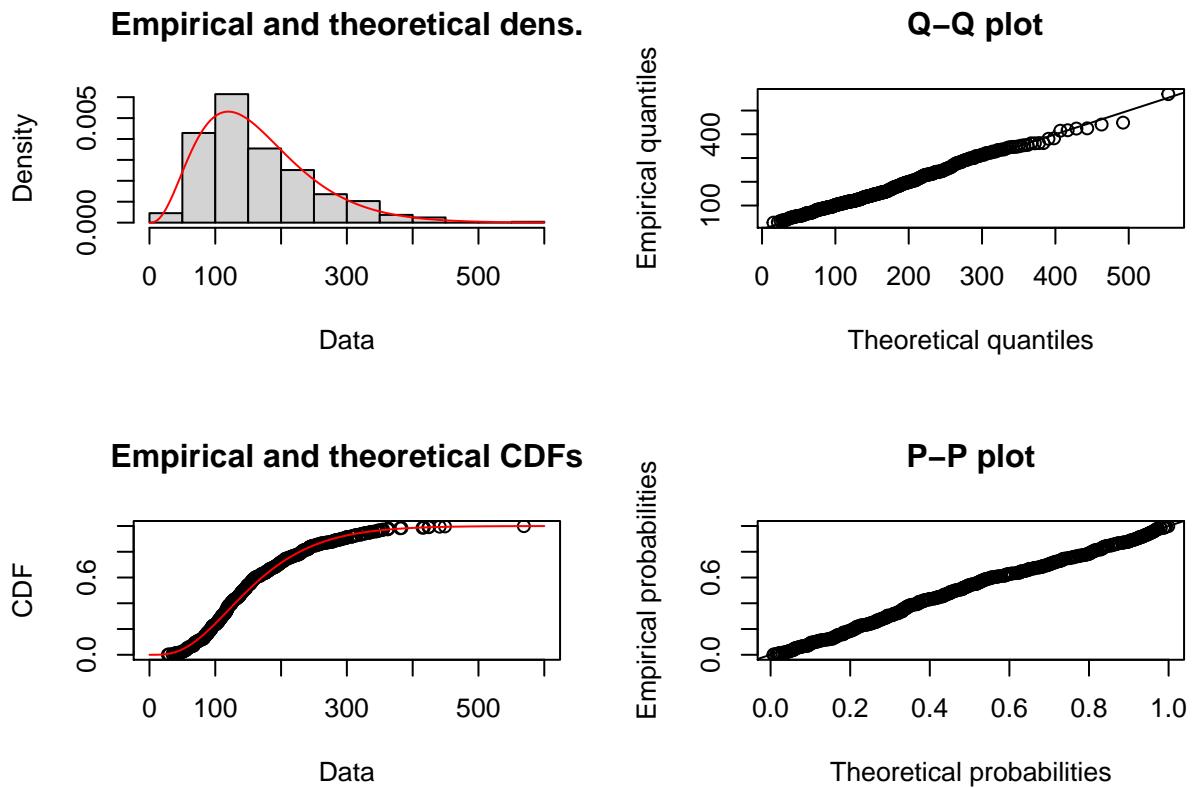


```

## summary statistics
## -----
## min: 28 max: 569
## median: 143
## mean: 164.1196
## estimated sd: 85.41705
## estimated skewness: 1.072297
## estimated kurtosis: 4.166928

```

5.3.1.2.1 Testing for Gamma Distribution



```

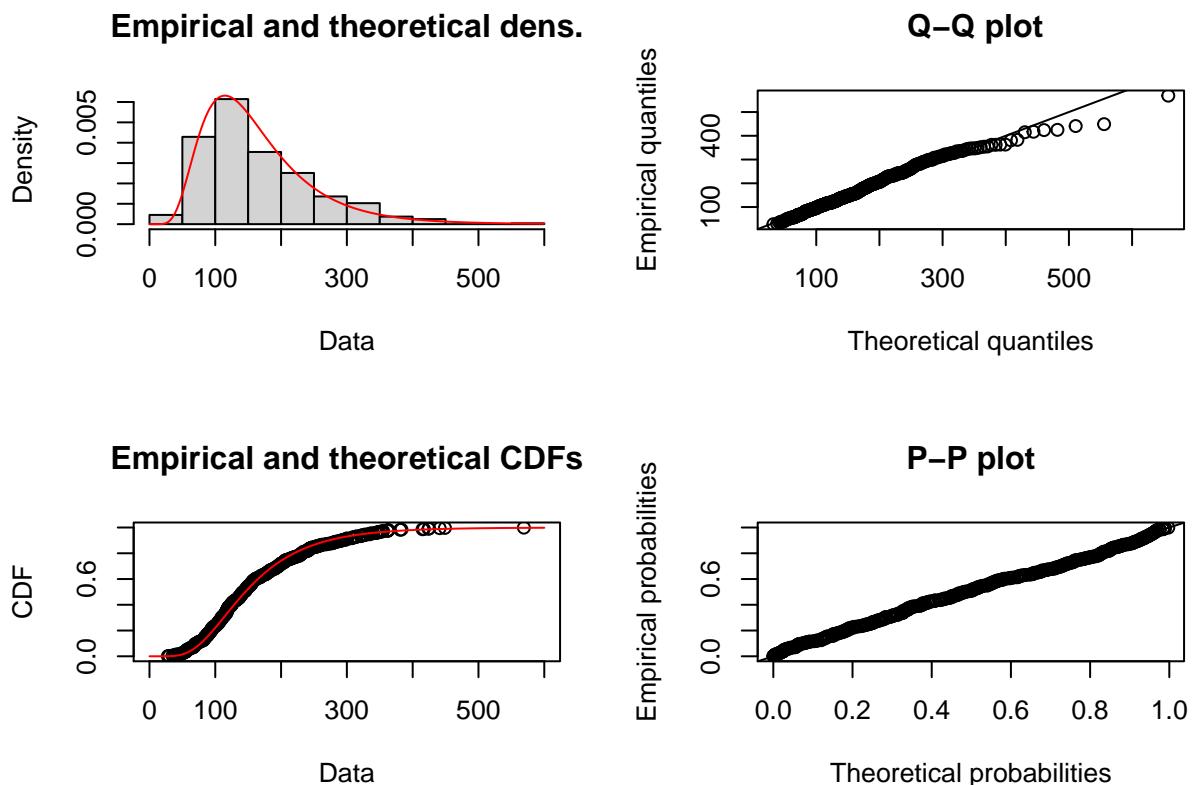
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.04899709
## Cramer-von Mises statistic   0.20490028
## Anderson-Darling statistic   1.22771882
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      5576.171
## Bayesian Information Criterion     5584.539
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate
## shape 3.69937258
## rate  0.02254071
## Loglikelihood: -2786.086    AIC: 5576.171    BIC: 5584.539

```

Table 34: Chi-Squared Test for Gamma Distribution with Shape 3.69937258 and Rate 0.02254071

Pass	Error	Critical Value
Not rejected	21.08321	22.36203

5.3.1.2.2 Testing for Lognormal Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic 0.03889669
## Cramer-von Mises statistic   0.18078797
## Anderson-Darling statistic   1.48333130
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion      5577.235
## Bayesian Information Criterion     5585.603
##
## [[2]]
## Fitting of the distribution 'lnorm' by matching moments
## Parameters :
##       estimate

```

```

## meanlog 4.980962
## sdlog 0.489148
## Loglikelihood: -2786.618 AIC: 5577.235 BIC: 5585.603

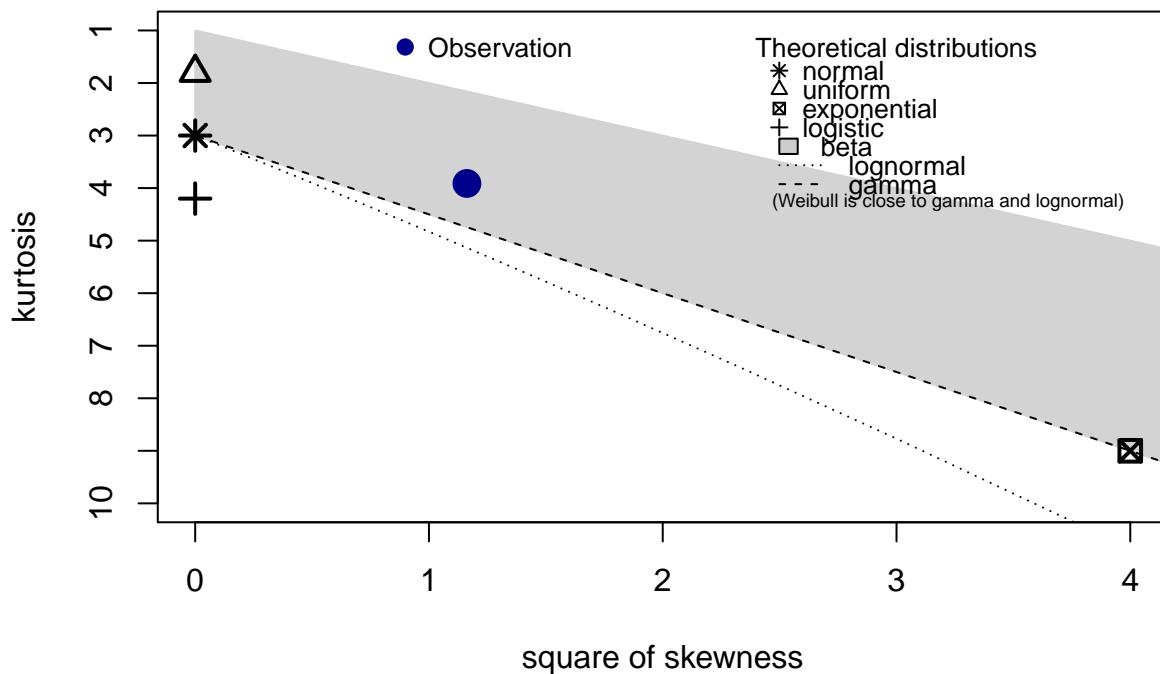
```

Table 35: Chi-Squared Test for Lognormal Distribution
with MeanLog 4.980962 and SdLog 0.489148

Pass	Error	Critical Value
Not rejected	18.26444	22.36203

5.3.1.3 ASA 3

Cullen and Frey graph

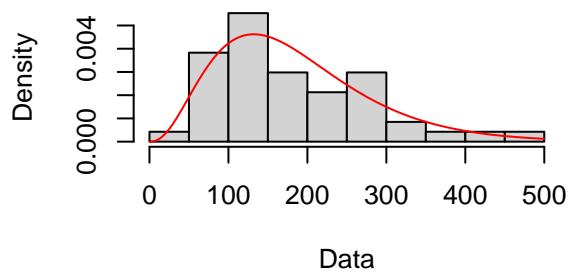
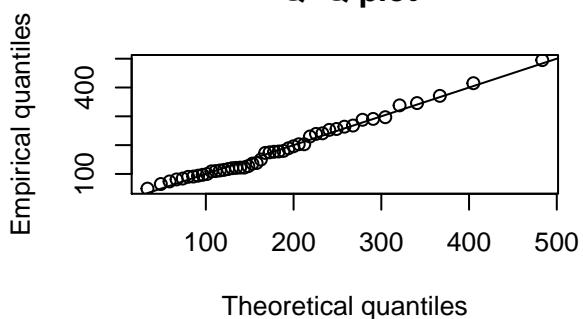
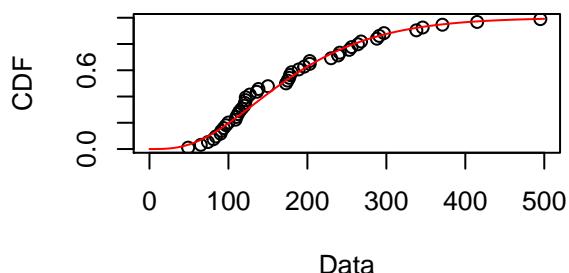
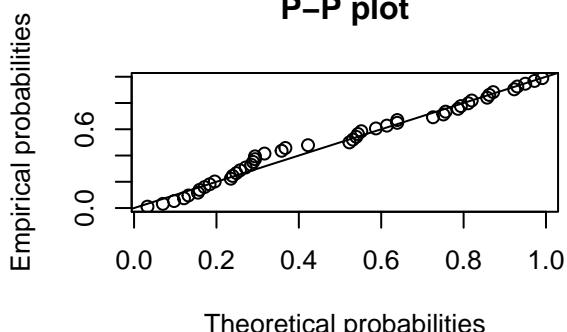


```

## summary statistics
## -----
## min: 49 max: 495
## median: 173
## mean: 184.8723
## estimated sd: 99.8424
## estimated skewness: 1.078161
## estimated kurtosis: 3.911473

```

5.3.1.3.1 Testing for Gamma Distribution

Empirical and theoretical dens.**Q-Q plot****Empirical and theoretical CDFs****P-P plot**

```
## [[1]]  
## Goodness-of-fit statistics  
##                               1-mme-gamma  
## Kolmogorov-Smirnov statistic 0.11069041  
## Cramer-von Mises statistic  0.07231369  
## Anderson-Darling statistic  0.42905363  
##  
## Goodness-of-fit criteria  
##                               1-mme-gamma  
## Akaike's Information Criterion      556.3347  
## Bayesian Information Criterion     560.0350  
##  
## [[2]]  
## Fitting of the distribution ' gamma ' by matching moments  
## Parameters :  
##       estimate  
## shape 3.50311077  
## rate  0.01894881  
## Loglikelihood: -276.1673    AIC: 556.3347    BIC: 560.035
```

Table 36: Chi-Squared Test for Gamma Distribution
with Shape 3.50311077 and Rate 0.01894881

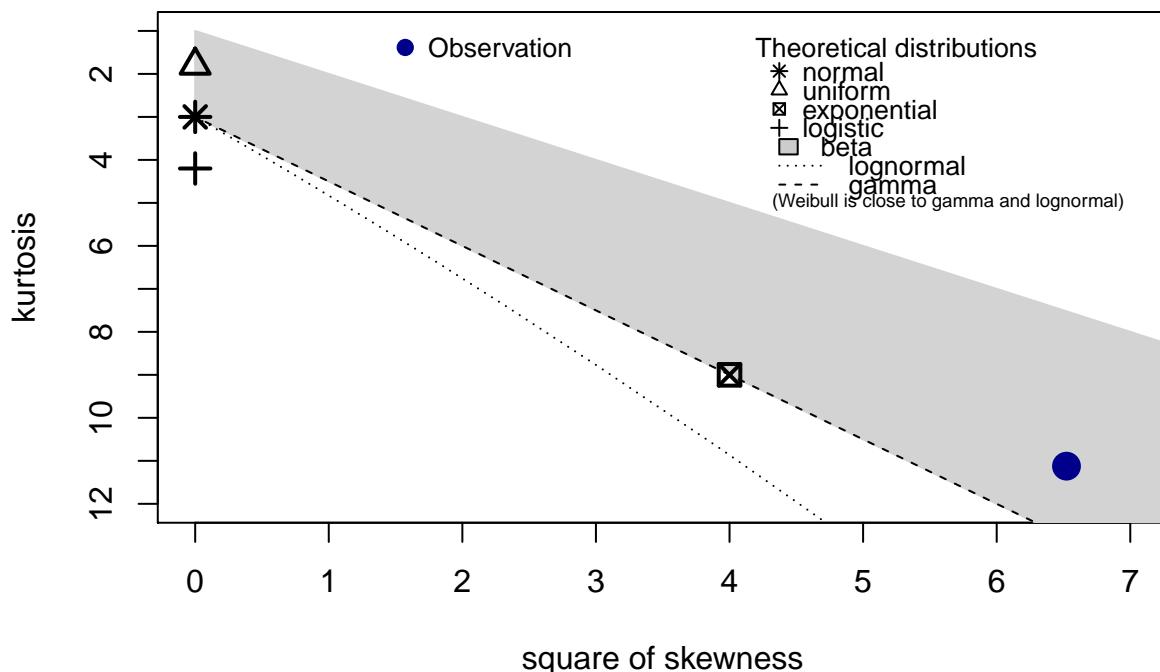
Pass	Error	Critical Value
Not rejected	7.495405	14.06714

5.3.2 Consult Duration

Adjusted version, meaning that the consult duration was shifted by 15 minutes, unless otherwise stated.

5.3.2.1 ASA 1

Cullen and Frey graph

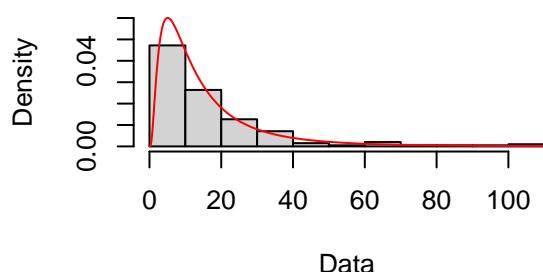


```
## summary statistics
## -----
## min: 0   max: 103
## median: 10
## mean: 15.43655
## estimated sd: 17.98986
## estimated skewness: 2.553924
## estimated kurtosis: 11.12355
```

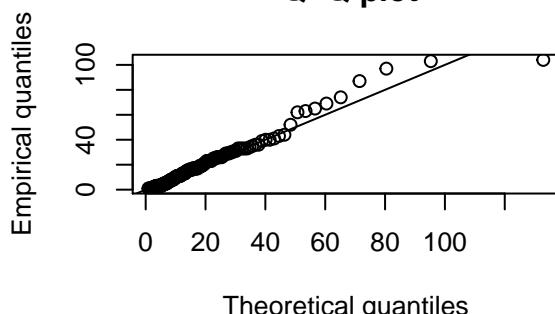
5.3.2.1.1 Testing for Lognormal Distribution

The lognormal distribution requires numbers above 0. Hence, the shifting in this case is by 14, such that the minimum is 1.

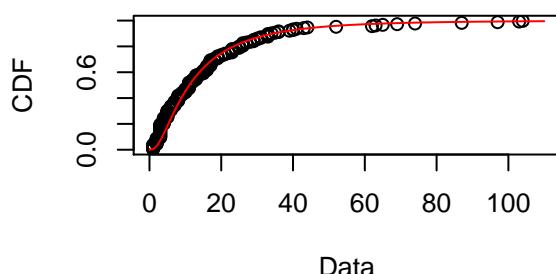
Empirical and theoretical dens.



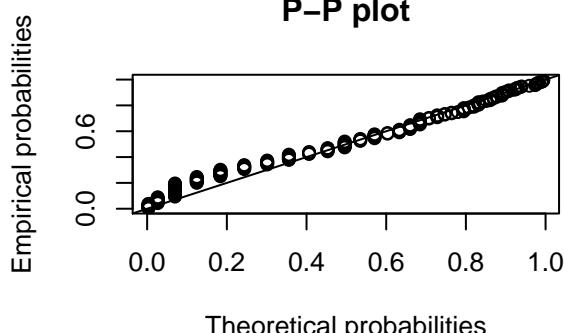
Q-Q plot



Empirical and theoretical CDFs



P-P plot

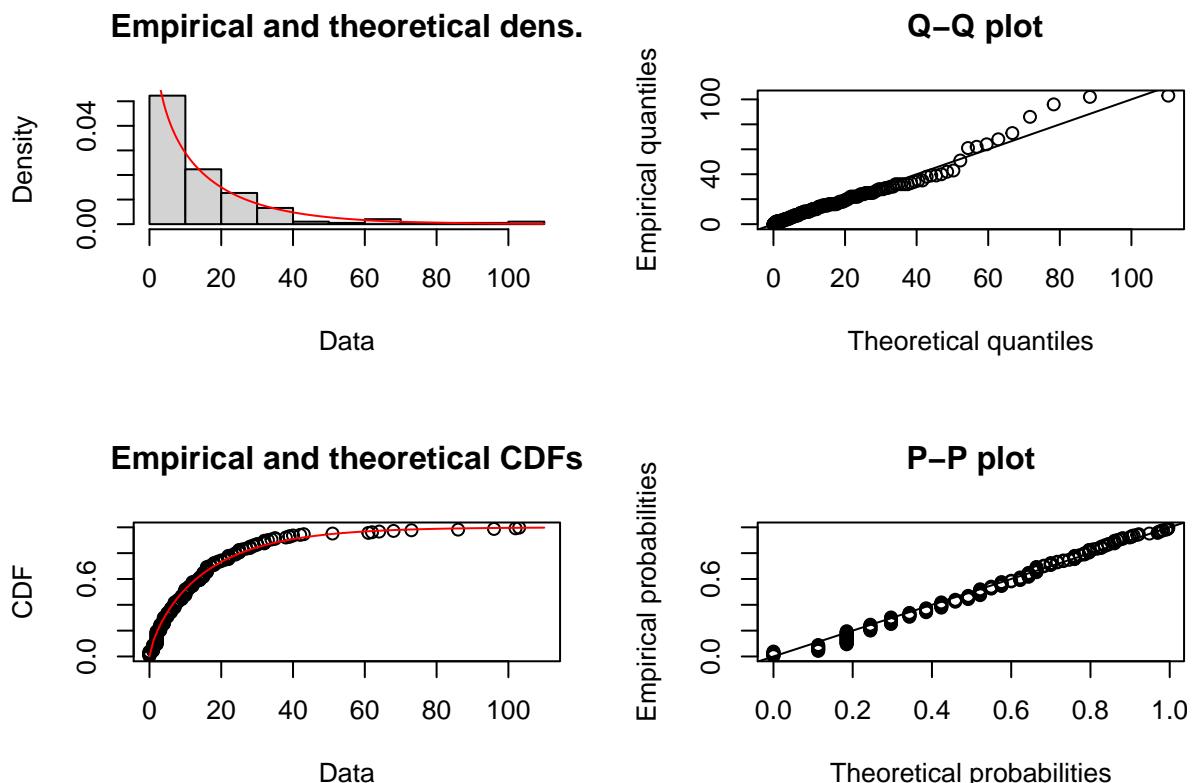


```
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic   0.1281475
## Cramer-von Mises statistic    0.4791926
## Anderson-Darling statistic    4.4066376
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion 1502.302
## Bayesian Information Criterion 1508.868
##
## [[2]]
## Fitting of the distribution 'lnorm' by matching moments
## Parameters :
##       estimate
## meanlog 2.4071329
## sdlog   0.8858606
## Loglikelihood: -749.1508 AIC: 1502.302 BIC: 1508.868
```

Table 3.7: Chi-Squared Test for Lognormal Distribution
with MeanLog 2.4071329 and SdLog 0.8858606

Pass	Error	Critical Value
Not rejected	0.8173222	7.814728

5.3.2.1.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.09339454
## Cramer-von Mises statistic   0.16358727
## Anderson-Darling statistic      Inf
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      -Inf
## Bayesian Information Criterion      -Inf
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate

```

```

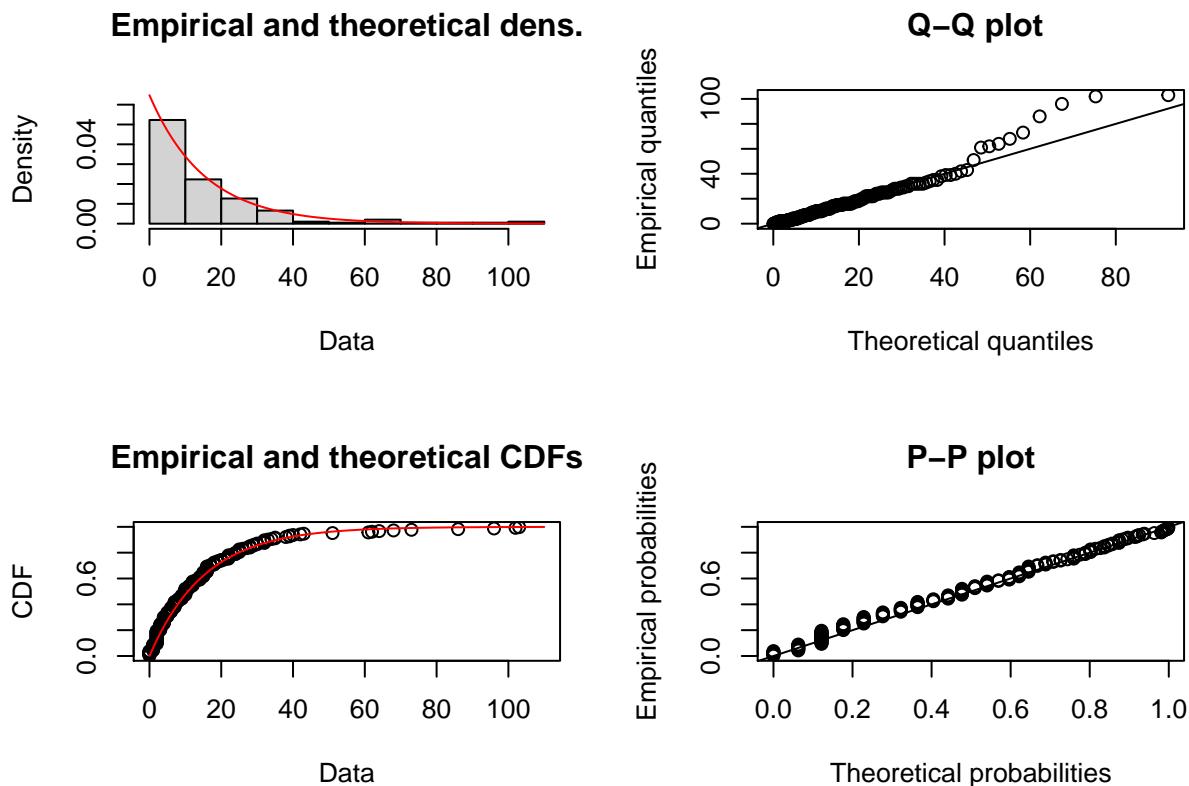
## shape 0.74003981
## rate 0.04794076
## Loglikelihood: Inf AIC: -Inf BIC: -Inf

```

Table 38: Chi-Squared Test for Gamma Distribution with Shape 0.74003981 and Rate 0.04794076

Pass	Error	Critical Value
Not rejected	12.19202	15.50731

5.3.2.1.3 Testing for Exponential Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-exp
## Kolmogorov-Smirnov statistic 0.0764491
## Cramer-von Mises statistic   0.1701794
## Anderson-Darling statistic      Inf
## 
## Goodness-of-fit criteria
##                               1-mme-exp
## Akaike's Information Criterion 1474.275
## Bayesian Information Criterion 1477.558
## 

```

```

## [[2]]
## Fitting of the distribution 'exp' by matching moments
## Parameters :
##     estimate
## rate 0.06478132
## Loglikelihood: -736.1374   AIC: 1474.275   BIC: 1477.558

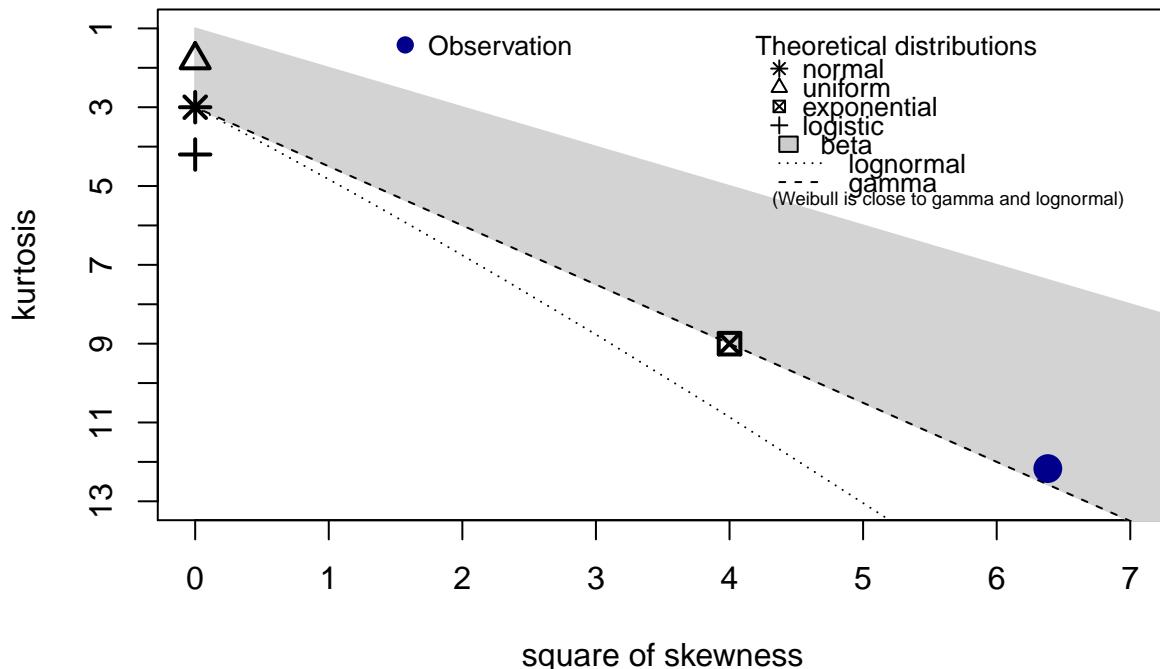
```

Table 39: Chi-Squared Test for Exponential Distribution
with Rate 0.06478132

Pass	Error	Critical Value
Not rejected	10.57594	11.0705

5.3.2.2 ASA 2

Cullen and Frey graph



```

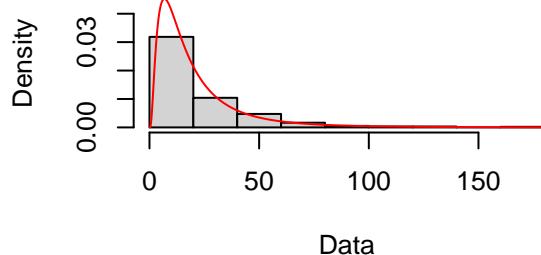
## summary statistics
## -----
## min: 1   max: 171
## median: 14
## mean: 21.72577
## estimated sd: 23.44355
## estimated skewness: 2.526401
## estimated kurtosis: 12.16981

```

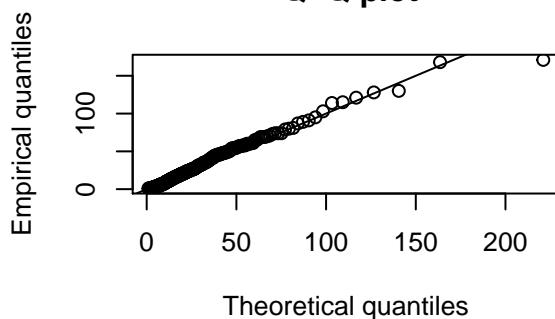
5.3.2.2.1 Testing for Lognormal Distribution

The lognormal distribution requires numbers above 0. Hence, the shifting in this case is by 14, such that the minimum is 1.

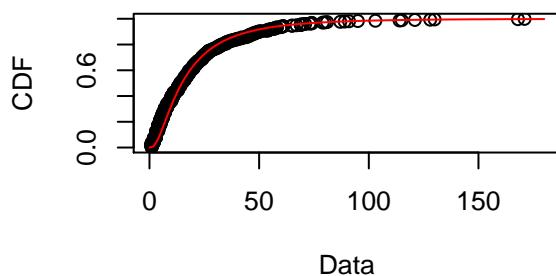
Empirical and theoretical dens.



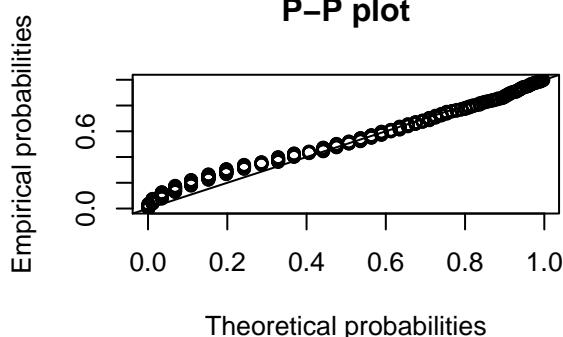
Q-Q plot



Empirical and theoretical CDFs



P-P plot

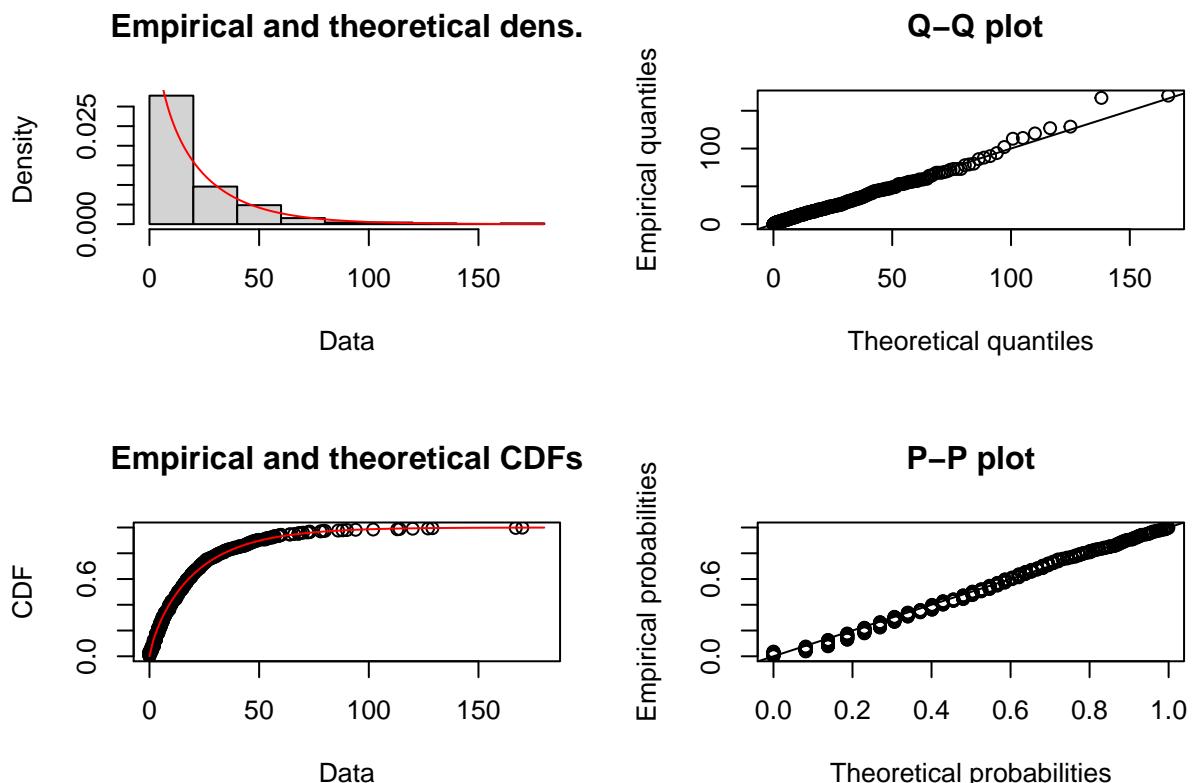


```
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic   0.1140782
## Cramer-von Mises statistic    1.1855089
## Anderson-Darling statistic    13.0342018
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion 4010.304
## Bayesian Information Criterion 4018.673
##
## [[2]]
## Fitting of the distribution 'lnorm' by matching moments
## Parameters :
##       estimate
## meanlog 2.692986
## sdlog   0.878081
## Loglikelihood: -2003.152   AIC: 4010.304   BIC: 4018.673
```

Table 40: Chi-Squared Test for Lognormal Distribution
with MeanLog 2.692986 and SdLog 0.878081

Pass	Error	Critical Value
Not rejected	11.18576	12.59159

5.3.2.2.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.06179999
## Cramer-von Mises statistic   0.21824158
## Anderson-Darling statistic      Inf
##
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      -Inf
## Bayesian Information Criterion      -Inf
##
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate

```

```

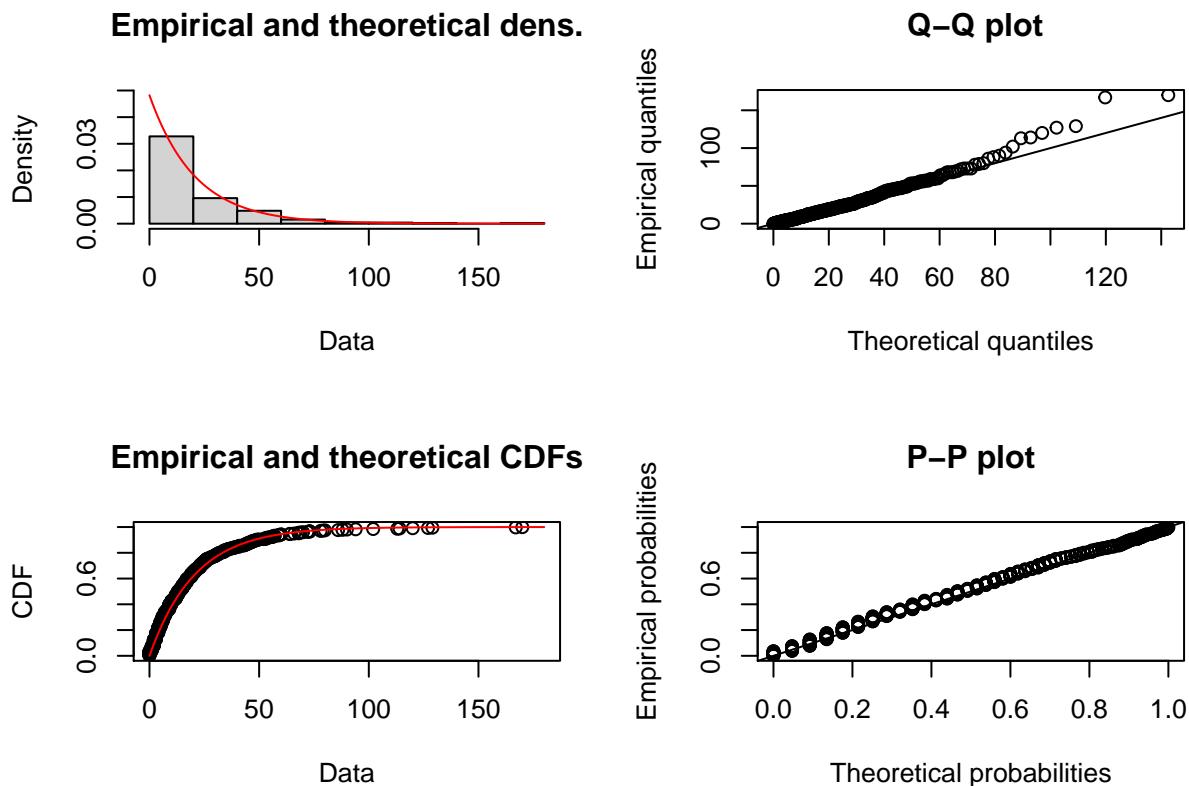
## shape 0.78319684
## rate 0.03778855
## Loglikelihood: Inf AIC: -Inf BIC: -Inf

```

Table 41: Chi-Squared Test for Gamma Distribution with Shape 0.78319684 and Rate 0.03778855

Pass	Error	Critical Value
Not rejected	4.265961	9.487729

5.3.2.2.3 Testing for Exponential Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-exp
## Kolmogorov-Smirnov statistic 0.05585831
## Cramer-von Mises statistic   0.27792163
## Anderson-Darling statistic      Inf
## 
## Goodness-of-fit criteria
##                               1-mme-exp
## Akaike's Information Criterion 3912.437
## Bayesian Information Criterion 3916.621
## 

```

```

## [[2]]
## Fitting of the distribution 'exp' by matching moments
## Parameters :
##     estimate
## rate 0.0482491
## Loglikelihood: -1955.218 AIC: 3912.437 BIC: 3916.621

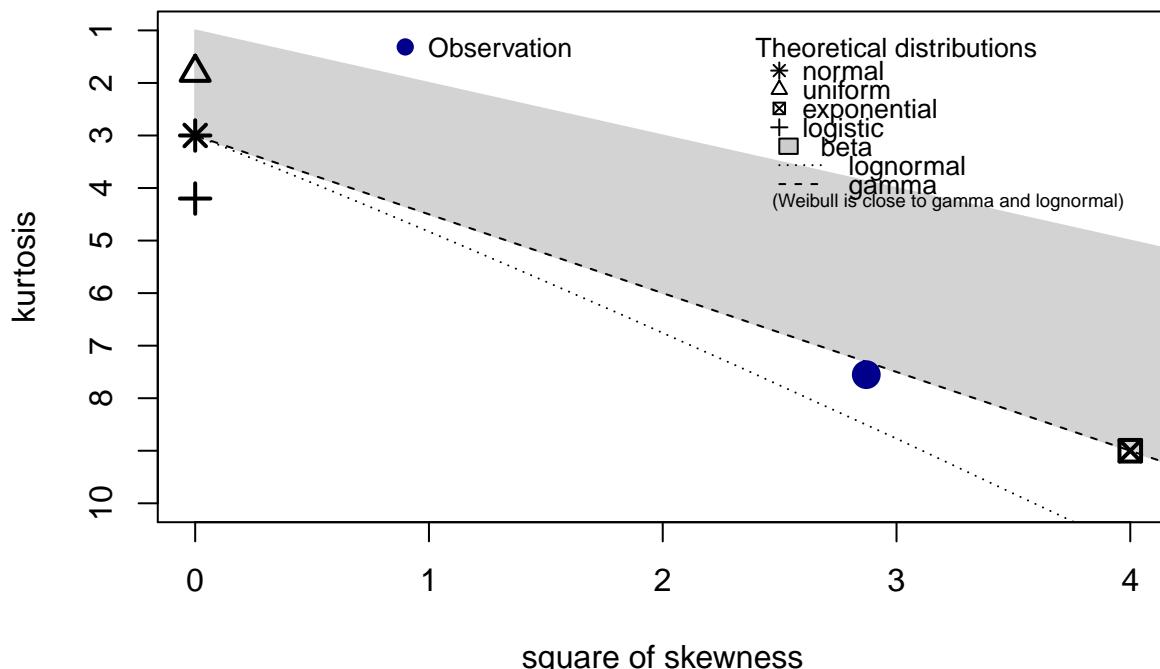
```

Table 42: Chi-Squared Test for Exponential Distribution with Rate 0.0482491

Pass	Error	Critical Value
Not rejected	4.463257	12.59159

5.3.2.3 ASA 3

Cullen and Frey graph



```

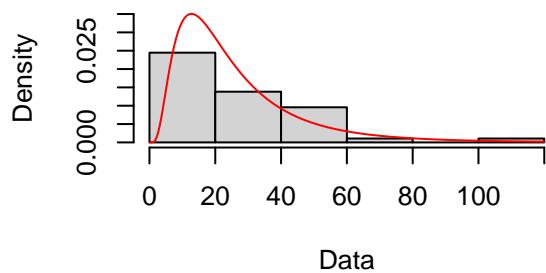
## summary statistics
## -----
## min: 1   max: 113
## median: 21
## mean: 26.55319
## estimated sd: 21.2979
## estimated skewness: 1.694304
## estimated kurtosis: 7.55201

```

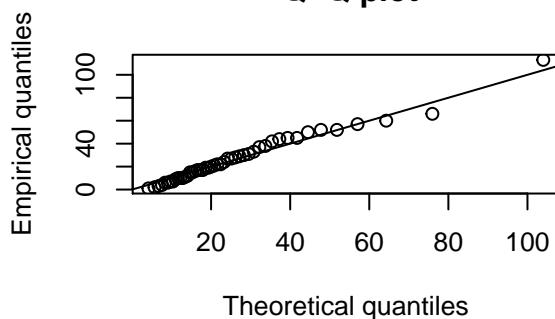
5.3.2.3.1 Testing for Lognormal Distribution

The lognormal distribution requires numbers above 0. Hence, the shifting in this case is by 14, such that the minimum is 1.

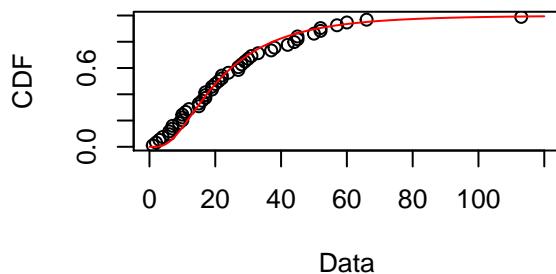
Empirical and theoretical dens.



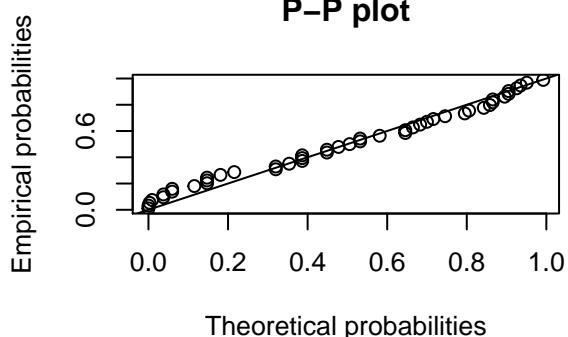
Q-Q plot



Empirical and theoretical CDFs



P-P plot

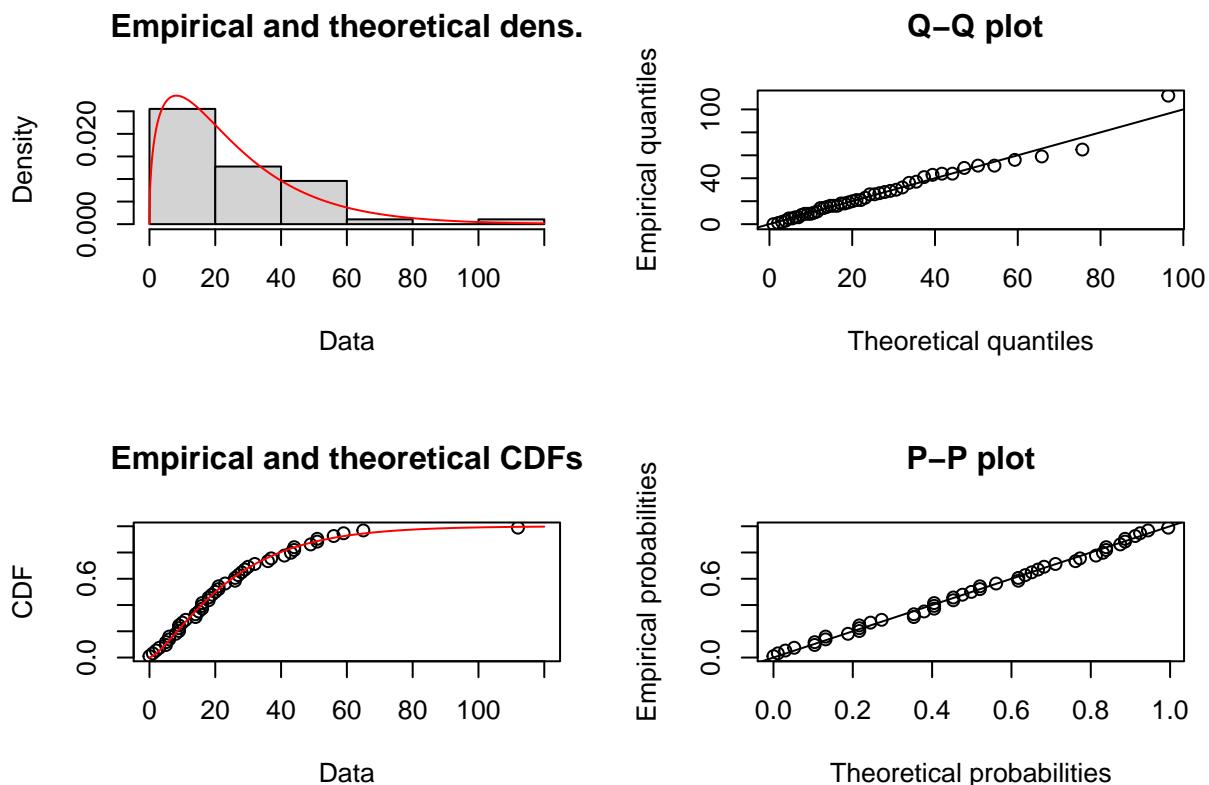


```
## [[1]]
## Goodness-of-fit statistics
##                               1-mme-lnorm
## Kolmogorov-Smirnov statistic   0.1106431
## Cramer-von Mises statistic    0.1018993
## Anderson-Darling statistic    1.5959393
##
## Goodness-of-fit criteria
##                               1-mme-lnorm
## Akaike's Information Criterion 419.0401
## Bayesian Information Criterion 422.7404
##
## [[2]]
## Fitting of the distribution ' lnorm ' by matching moments
## Parameters :
##       estimate
## meanlog 3.0349670
## sdlog   0.6988318
## Loglikelihood: -207.52 AIC: 419.0401 BIC: 422.7404
```

Table 43: Chi-Squared Test for Lognormal Distribution
with MeanLog 3.034967 and SdLog 0.6988318

Pass	Error	Critical Value
Not rejected	2.577932	7.814728

5.3.2.3.2 Testing for Gamma Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-gamma
## Kolmogorov-Smirnov statistic 0.05606922
## Cramer-von Mises statistic   0.01871981
## Anderson-Darling statistic      Inf
## 
## Goodness-of-fit criteria
##                               1-mme-gamma
## Akaike's Information Criterion      Inf
## Bayesian Information Criterion      Inf
## 
## [[2]]
## Fitting of the distribution ' gamma ' by matching moments
## Parameters :
##       estimate

```

```

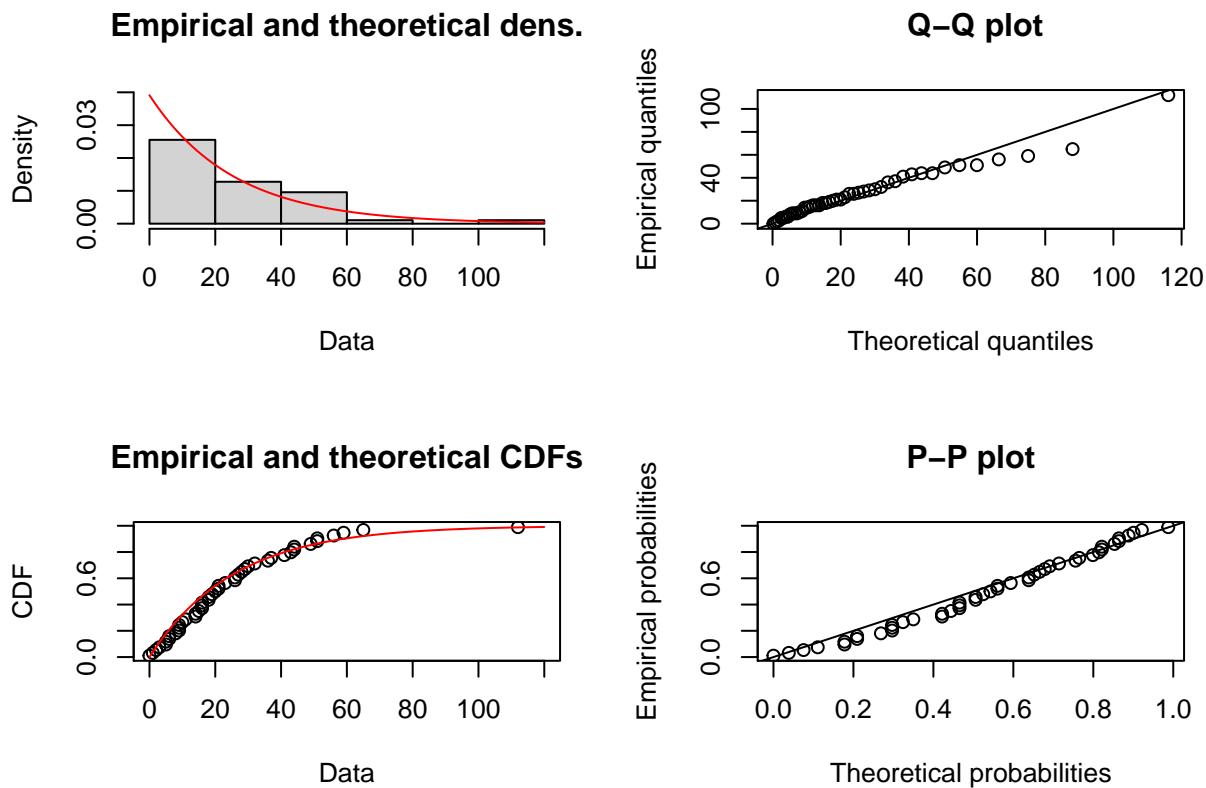
## shape 1.47081119
## rate 0.05755881
## Loglikelihood: -Inf AIC: Inf BIC: Inf

```

Table 44: Chi-Squared Test for Gamma Distribution with Shape 1.47081119 and Rate 0.05755881

Pass	Error	Critical Value
Not rejected	2.209917	9.487729

5.3.2.3.3 Testing for Exponential Distribution



```

## [[1]]
## Goodness-of-fit statistics
##                               1-mme-exp
## Kolmogorov-Smirnov statistic 0.1239516
## Cramer-von Mises statistic   0.1281206
## Anderson-Darling statistic      Inf
## 
## Goodness-of-fit criteria
##                               1-mme-exp
## Akaike's Information Criterion 400.6316
## Bayesian Information Criterion 402.4818
## 

```

```

## [[2]]
## Fitting of the distribution ' exp ' by matching moments
## Parameters :
##     estimate
## rate 0.03913405
## Loglikelihood: -199.3158 AIC: 400.6316 BIC: 402.4818

```

Table 45: Chi-Squared Test for Exponential Distribution with Rate 0.03913405

Pass	Error	Critical Value
Not rejected	6.167518	11.0705

6 Summary and Conclusion

6.1 Planned and Walk-In Appointments

6.1.1 Queue Time

Table 46: Distributions for each ASA Score

ASA Score	Distribution	Error	Critical Values
1	Lognormal(4.7441447, 0.4887809)	3.790103	9.487729
2	Gamma(4.51396193, 0.02991051)	17.96091	18.30704
3	Gamma(4.4903452, 0.0290352)	13.37659	18.30704

6.1.2 Consult Duration

Table 47: Distributions for each ASA Score

ASA Score	Distribution	Error	Critical Values
1	Lognormal(2.4525327, 0.8756247)	9.605517	15.50731
2	Exp(0.048233)	5.7713	5.991465
3	Lognormal(3.0657644, 0.8372545)	5.50356	12.59159
	Gamma(0.92089709, 0.03126416)	5.842161	5.991465
	Exp(0.03394968)	4.483978	7.814728

6.2 Planned Appointments

6.2.1 Queue Time

Table 48: Distributions for each ASA Score

ASA Score	Distribution	Error	Critical Values
1	Lognormal(4.7362772, 0.4766837)	5.192523	9.487729
2	Gamma(4.6350196, 0.0309402)	20.84311	21.02607
3	Gamma(4.77692467, 0.03145134)	13.61228	14.06714

6.2.2 Consult Duration

Table 49: Distributions for each ASA Score

ASA Score	Distribution	Error	Critical Values
1	Lognormal(2.456952, 0.874598)	16.66601	16.91898
	Gamma(0.7716552, 0.0479119)	13.26114	14.06714
2	Gamma(0.9400198, 0.0453387)	5.40839	5.991465
	Exp(0.04823165)	11.10927	12.59159
3	Lognormal(3.0717530, 0.8440134)	4.778335	7.814728
	Gamma(0.90118456, 0.03022804)	8.379399	9.487729
	Exp(0.03354257)	6.057588	11.0705

6.3 Walk-In Appointments

6.3.1 Queue Time

Table 50: Distributions for each ASA Score

ASA Score	Distribution	Error	Critical Values
1	Lognormal(4.8384769, 0.5555817)	5.394277	9.487729
	Gamma(2.76537723, 0.01876737)	2.535864	7.814728
2	Gamma(3.69937258, 0.02254071)	21.08321	22.36203
	Lognormal(4.980962, 0.489148)	18.26444	22.36203
3	Gamma(3.50311077, 0.01894881)	7.495405	14.06714

6.3.2 Consult Duration

Table 51: Distributions for each ASA Score

ASA Score	Distribution	Error	Critical Values
1	Lognormal(2.4071329, 0.8858606)	0.8173222	7.814728
	Gamma(0.74003981, 0.04794076)	12.19202	15.50731
	Exp(0.06478132)	10.57594	11.0705
2	Lognormal(2.692986, 0.878081)	11.18576	12.59159
	Gamma(0.78319684, 0.03778855)	4.265961	9.487729
	Exp(0.0482491)	4.463257	12.59159
3	Lognormal(3.0349670, 0.6988318)	2.577932	7.814728
	Gamma(1.47081119, 0.05755881)	2.209917	9.487729
	Exp(0.03913405)	6.167518	11.0705