

# Kausalanalyse Resistenz

15.03.2022

## Bibliotheken laden, Hilfsfunktion

```
library(stringr)    # String-verarbeitung
library(ggplot2)    # moderne plots
#library(gridExtra)

debug <- T  # debug printout
debug <- F  # kein debug printout
Log <- function(string) {
  if(debug){print(string)}
}
```

## Resistenzen.Rmd erzeugte Resistenzen.csv, dieses einlesen

Und evtl. ansehen

```
Resistenzen <- read.csv("Resistenzen.csv")

# csv rausschreiben u. wieder einlesen fügt vorne Index-Spalte an; diese entfernen :
Resistenzen[,1] <- NULL

View(Resistenzen)
```

## Verteilungen

```
# Hilfs-Dataframes, implizit sollte genügen!

ResistenzenWM1 <- Resistenzen[Resistenzen["WM.group"] == "1",] # waste milk Group
ResistenzenWM2 <- Resistenzen[Resistenzen["WM.group"] == "2",] # no waste milk Group
#View(ResistenzenWM2)

ResistenzenOLS0 <- Resistenzen[Resistenzen["OLS.group"] == "0",] # other livestock Group
ResistenzenOLS1 <- Resistenzen[Resistenzen["OLS.group"] == "1",] # no other livestock Group
#View(ResistenzenOLS0);View(ResistenzenOLS1)

ResistenzenIAC0 <- Resistenzen[Resistenzen["IAC.group"] == "0",] # ill animals in calving box Group
ResistenzenIAC1 <- Resistenzen[Resistenzen["IAC.group"] == "1",] # no ill animals in calving box Group
#View(ResistenzenIAC0);View(ResistenzenIAC1)

ResistenzenHSC0 <- Resistenzen[Resistenzen["HSC.group"] == "0",] # stable w/o outlet
ResistenzenHSC1 <- Resistenzen[Resistenzen["HSC.group"] == "1",] # stable with outlet
ResistenzenHSC2 <- Resistenzen[Resistenzen["HSC.group"] == "2",] # outdoors
ResistenzenHSC3 <- Resistenzen[Resistenzen["HSC.group"] == "3",] # 0+1
ResistenzenHSC4 <- Resistenzen[Resistenzen["HSC.group"] == "4",] # 1+2
ResistenzenHSC5 <- Resistenzen[Resistenzen["HSC.group"] == "5",] # 0+2
#View(ResistenzenHSC0);View(ResistenzenHSC1);View(ResistenzenHSC2);View(ResistenzenHSC3);View(ResistenzenHSC4);View(ResistenzenHSC5)
```

Graphiken und Deskriptive Analyse: Für diesen Fall analysieren wir die (meist links und/oder rechts abgeschnittenen) Verteilungen

```
graphisch <- function(groups,antib, anfang,ende, schrittBin,schrittLab) {
```

```

if (ende < 0) {                # kleiner Trick um zusätzliches Funktionsargument zu vermeiden
  Ende=F
  ende = -ende
} else{
  Ende=T
}
Log(paste("Ende, ende =",Ende,ende))

if(groups == "WM.group" ){
  listdfs <- list(Resistenzen      , ResistenzenWM1 , ResistenzenWM2 ) # implizit sollte genügen! (Vektor klappt
  Titel   <- c(  "WM or not", "WM              ", "no WM          ")
}
if(groups == "OLS.group" ){
  listdfs <- list(Resistenzen      , ResistenzenOLS1 , ResistenzenOLS0 )
  Titel   <- c(  "OLS or not", "OLS              ", "no OLS          ")
}
if(groups == "IAC.group" ){
  listdfs <- list(Resistenzen      , ResistenzenIAC1 , ResistenzenIAC0 )
  Titel   <- c(  "IAC or not", "IAC              ", "no IAC          ")
}
if(groups == "HSC.group"){
  listdfs <- list(Resistenzen      , ResistenzenHSC0, ResistenzenHSC1,
                  ResistenzenHSC2, ResistenzenHSC3, ResistenzenHSC4, ResistenzenHSC5)
  Titel   <- c(  "arbitrary HSC          ",
                  "0: stable w\\o outlet", "1: stable with outlet", "2: outdoors          ", "0+1
}

for (i in 2:length(Titel)){    # nicht 1. plot "XY oder nicht" deskriptive Statistik - geht sicher o. eigene D
  DF <- listdfs[[i]]          # listdfs kürzer: nur hier explizit?

  numstrings <- str_replace(DF[[antib]], paste0("<=",anfang), as.character(anfang))
  # z.B. "1" als numerischer Platzhalter für "<="
  numstrings <- str_replace(numstrings      , paste0(">",ende)    , as.character(ende)) #+1))
  # z.B. "33" als numerischer Platzhalter für ">32"
  numbers <- as.numeric(numstrings )        # jetzt alles als Zahlen

  Log("numbers =");Log(numbers)
  # Median könnte im "<=" Bereich liegen oder im ">=", entsprechend reagieren:
  median <- median(numbers, na.rm=T) # (na.rm=T fürs Lesen aus file, vorher war das "NA")
  rel <- "="                          # Relations-Symbol
  Log(paste( "median, anfang =",median, anfang ))
  if(median == anfang){
    rel <- "<="
  }
  if(Ende && median == ende){
    rel <- ">"
  }

  print(paste(antib,"- Resistance,", Titel[i], ":"))
  print(paste(" Median              ", rel, median))

  if(Ende && (max(numbers, na.rm=T) > ende)){ # gibt overflow bin, ist nicht leer: Verteilung nicht nach oben b

    # kleinste Werte kleinstmöglich und grösste Werte kleinstmöglich ergibt Mindestwert des Mittelwertes
    mean <- mean(replace(numbers, numbers==anfang, 0), na.rm=T)

    print(paste(" Mean              >= ", mean ))
    print("")
  } else {                          # Verteilung nach oben beschränkt
    if (anfang %in% numbers) { # Verteilung nach oben beschränkt, nicht nach unten
      # (underflow bin gibt's FAST immer)
      mean1 <- mean(numbers, na.rm=T) # kleinste Werte grösstmöglich gibt Höchstwert des Mittelwertes

```

```

    numbers0 <- replace(numbers, numbers==anfang, 0)      # kleinste Werte kleinstmöglich
    mean0 <- mean(numbers0, na.rm=T)                    # ergibt Mindestwert des Mittelwertes
    print(paste(" Mean in ", sprintf("%.3f",mean0), "...", sprintf("%.3f",mean1) ))
    print("")
  } else {
    # Verteilung nach oben und unten beschränkt : einfachster Fall
    print(paste(" Mean = ", sprintf("%.3f",mean(numbers, na.rm=T)) ) )
    print("")
  }
}
}

Log(1)
DF2 <- Resistenzen # listdfs[[i]]
Log(2)

numstrings <- str_replace(DF2[[antib]], paste0("<=",anfang), as.character(anfang)) # \\ OBEN SCHON: factor ou
# z.B. "1" als numerischer Platzhalter für "<=1"
numstrings <- str_replace(numstrings, paste0(">",ende), as.character(ende)) #+1))
# z.B. "33" als numerischer Platzhalter für ">32"
numbers <- as.numeric(numstrings) # jetzt alles als Zahlen
Log(3)

DF2$numbers <- numbers
Log("i, numbers=");Log(i);Log(numbers)

# https://stackoverflow.com/questions/23944355/r-hist-right-left-clump-binning war hier eine Inspiration,
# fieseln für die tick labels weil R sonst aus Platzproblemen das wichtige letzte tick label unterdrückt:
if(Ende) {
  seqAt <- seq(schrittBin,ende+schrittBin,by=schrittLab) # kleineres ende+... klappt nicht
  seqAt[length(seqAt)] <- seqAt[length(seqAt)]-schrittBin # also zurückkorrigieren
  #seqAt <- seq(schrittBin,ende+0.001,by=schrittLab)
} else {
  seqAt <- seq(schrittBin,ende,by=schrittLab) # 1 Bin weniger
}
Log("seqAt:"); Log(seqAt)
seqLab <- seq(schrittBin+schrittLab,ende,by=schrittLab)
seqLab <- seq(schrittBin,ende+schrittBin,by=schrittLab)

Log("seqLab:");Log(seqLab)

seqLab_cutR <- seqLab[1:length(seqLab)-1]
Log("seqLab_cutR:");Log(seqLab_cutR)

seqLab_cutLR <- seqLab_cutR[2:length(seqLab_cutR)] # ... [2:...] klappt nicht
Log("seqLab_cutLR:");Log(seqLab_cutLR)

Labels <- c(paste0("<=",anfang),seqLab_cutLR)
Log("Labels, 1:");Log(Labels)

if(Ende) { Labels <- c(Labels,paste0(">",ende)) }
Log("Labels, 2:");Log(Labels)

#Ylab <- paste("Frequenz",antib,Titel[i])
Ylab <- "Frequency"
Xlab <- "Dose"

Log("breaks="); Log(seqAt)
Log("labels ="); Log(Labels)

plot <- ggplot(DF2, aes(x=numbers)) +
  scale_x_continuous(trans = "log10", breaks=seqAt, labels=Labels, limits=c(anfang*.8,ende*1.2)) +
  # limits=anfang...ende aber bisschen mehr um dort zu plotten
  # -0.01 o. *.0.9; +1 o. *.1.1 genügt nicht

```

```

geom_histogram()
theme(axis.text.x = element_text(size=12))
theme(axis.text.y = element_text(size=12))
xlab(Xlab) + ylab(Ylab)
facet_grid(reformulate(".",groups))
ggtitle(paste(antib,"for different",groups))
print(plot)
}

```

### III Animals in Calving Box - Gruppen

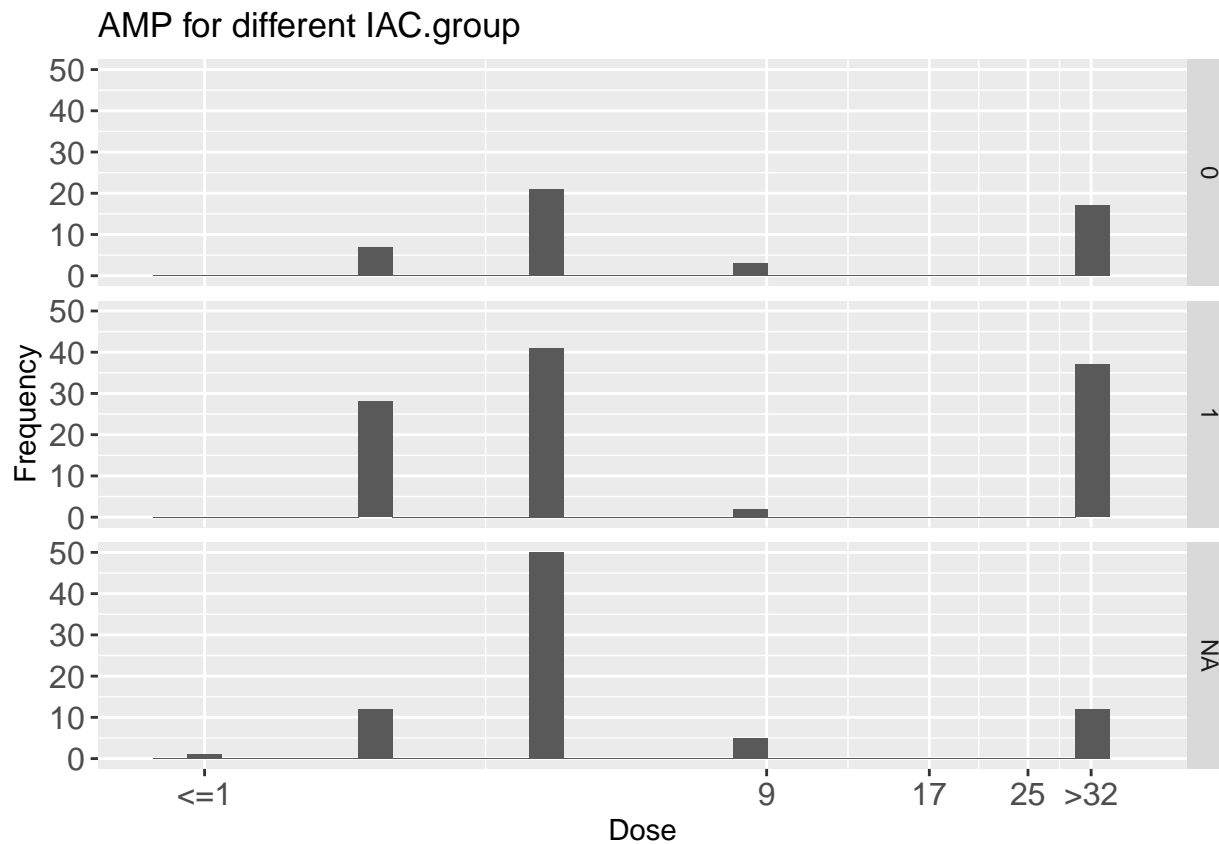
Mit "IAC" abgekürzt.

```
graphisch("IAC.group", "AMP", 1,32, 1,8)
```

```

## [1] "AMP - Resistance, IAC          :"
## [1] "  Median      = 4"
## [1] "  Mean   = 13.148"
## [1] ""
## [1] "AMP - Resistance, no IAC       :"
## [1] "  Median      = 4"
## [1] "  Mean   = 13.875"
## [1] ""

```



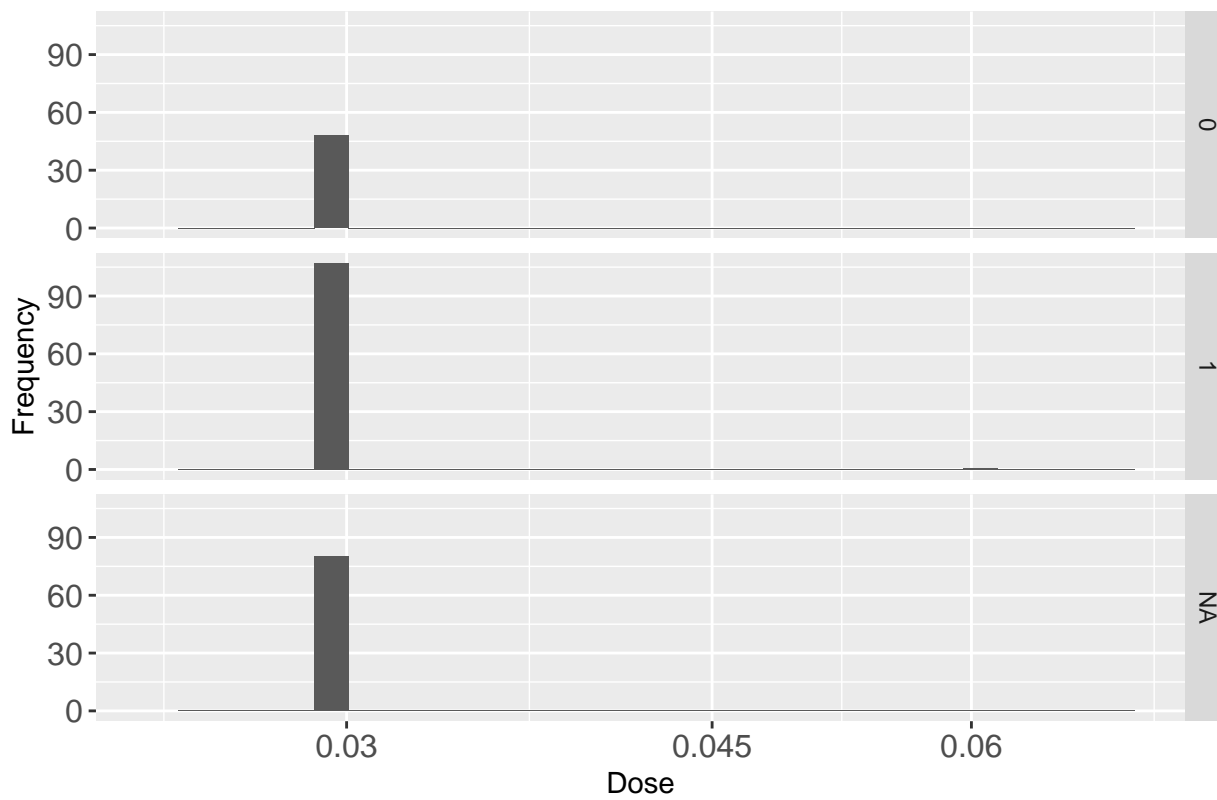
```
graphisch("IAC.group", "MERO", 0.03,-0.06, 0.015,0.015 )
```

```

## [1] "MERO - Resistance, IAC          :"
## [1] "  Median      <= 0.03"
## [1] "  Mean   in 0.001 ... 0.030"
## [1] ""
## [1] "MERO - Resistance, no IAC       :"
## [1] "  Median      <= 0.03"
## [1] "  Mean   in 0.000 ... 0.030"
## [1] ""

```

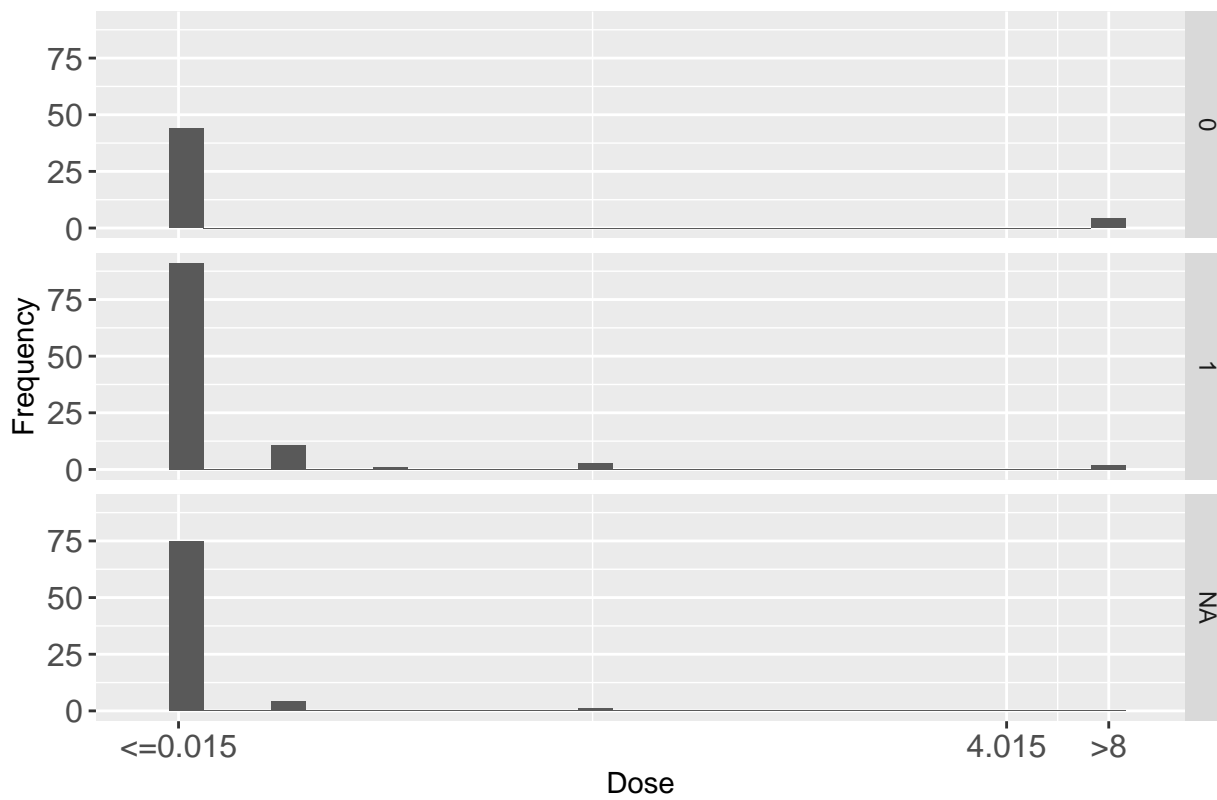
MERO for different IAC.group



```
graphisch("IAC.group", "CIP" , 0.015, 8 , 0.015, 4 )
```

```
## [1] "CIP - Resistance, IAC          :"  
## [1] "  Median          <= 0.015"  
## [1] "  Mean   in 0.159 ... 0.171"  
## [1] ""  
## [1] "CIP - Resistance, no IAC      :"  
## [1] "  Median          <= 0.015"  
## [1] "  Mean   in 0.667 ... 0.680"  
## [1] ""
```

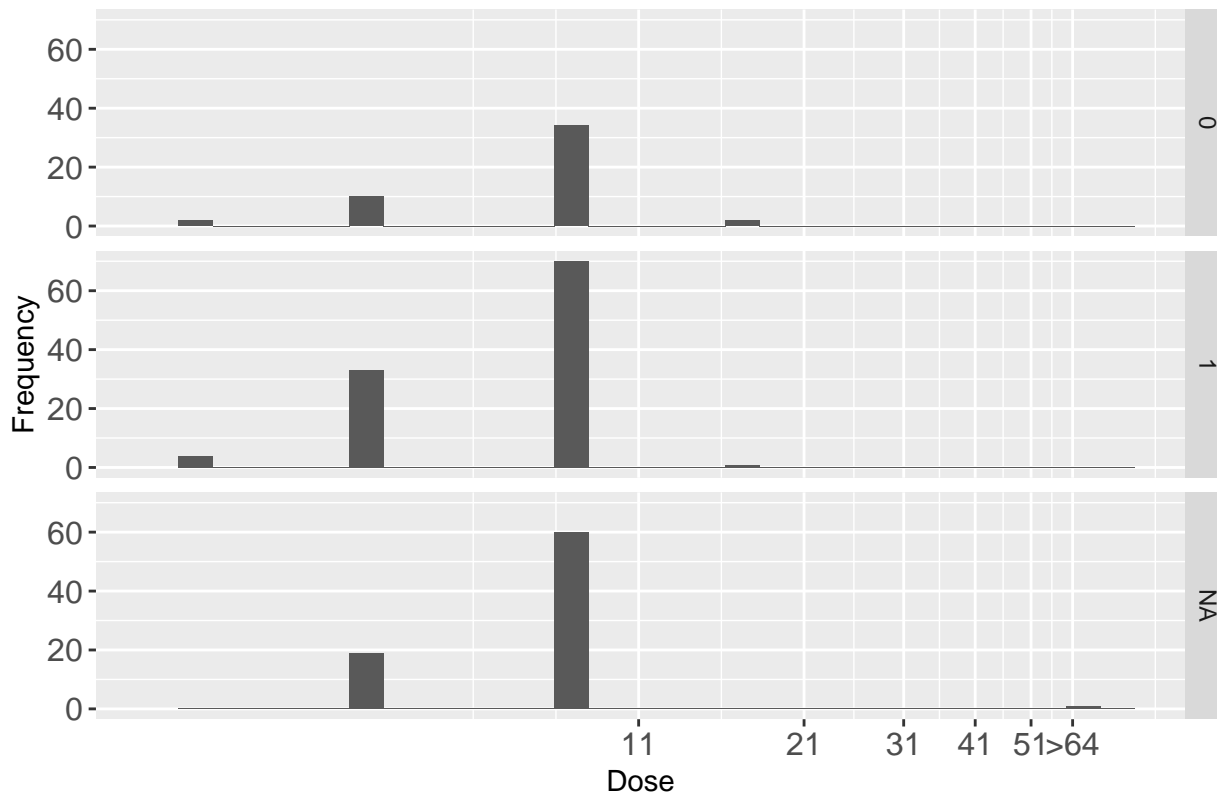
CIP for different IAC.group



```
graphisch("IAC.group","AZI" , 2,64, 1,10)
```

```
## [1] "AZI - Resistance, IAC      :"
## [1] "  Median      = 8"
## [1] "  Mean   in  6.556 ... 6.630"
## [1] ""
## [1] "AZI - Resistance, no IAC   :"
## [1] "  Median      = 8"
## [1] "  Mean   in  7.167 ... 7.250"
## [1] ""
```

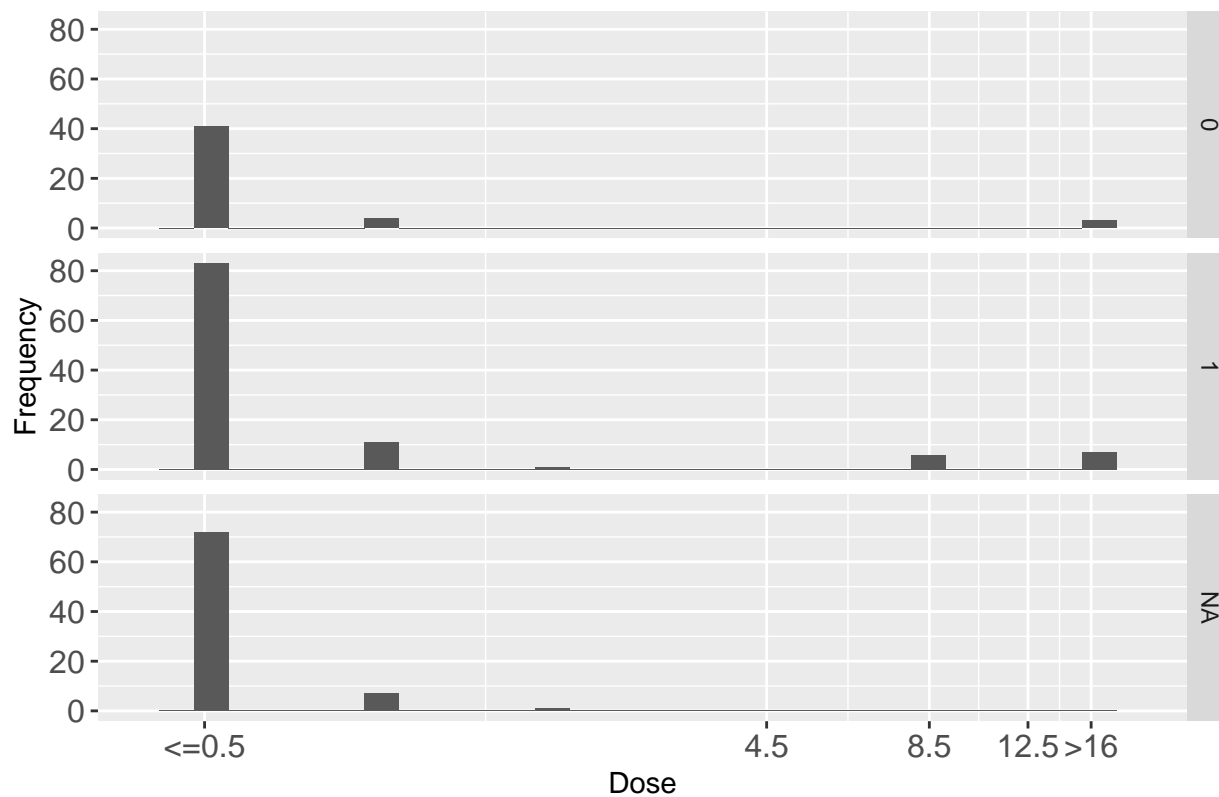
AZI for different IAC.group



```
graphisch("IAC.group", "GEN" , 0.5 , 16 , 0.5 , 4 )
```

```
## [1] "GEN - Resistance, IAC          :"  
## [1] "  Median          <= 0.5"  
## [1] "  Mean   in  1.602 ... 1.986"  
## [1] ""  
## [1] "GEN - Resistance, no IAC      :"  
## [1] "  Median          <= 0.5"  
## [1] "  Mean   in  1.083 ... 1.510"  
## [1] ""
```

GEN for different IAC.group

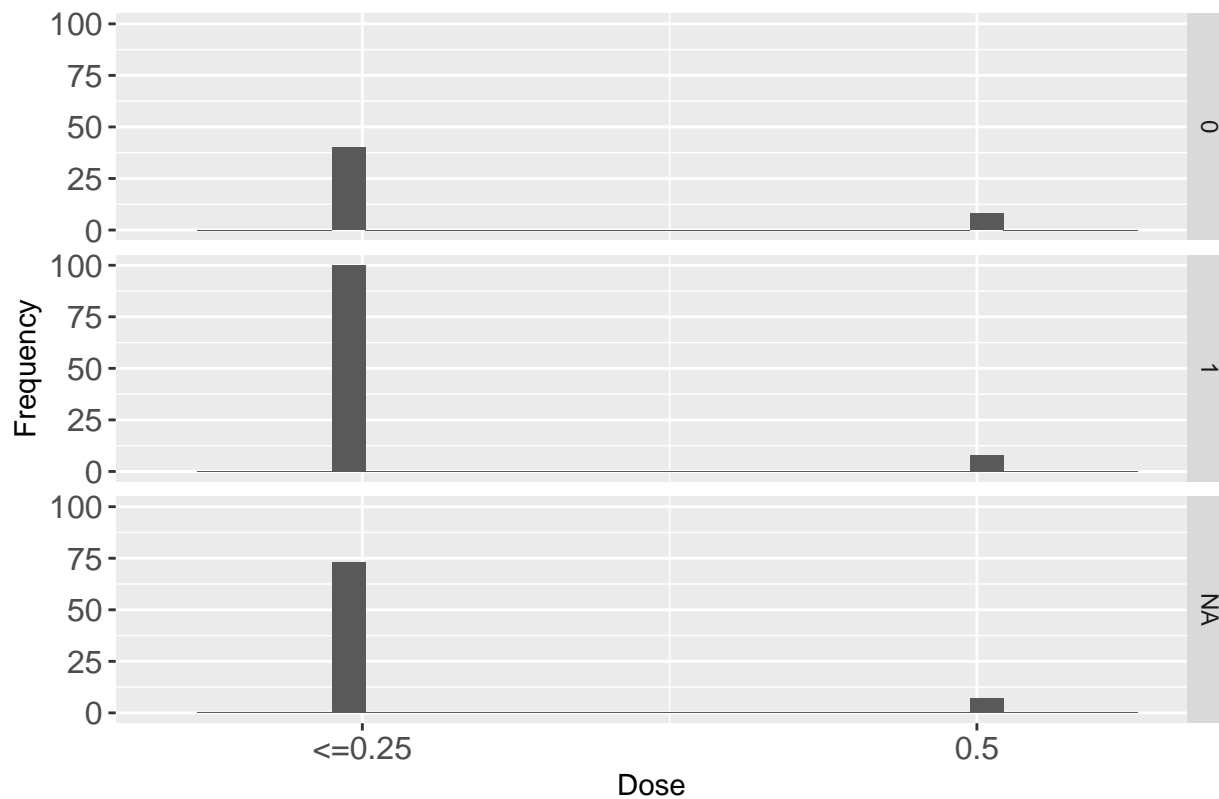


```
graphisch("IAC.group", "TGC" , 0.25 , -0.5 , 0.25 , 0.25 )
```

```
## [1] "TGC - Resistance, IAC          :"
## [1] "  Median          <= 0.25"
## [1] "  Mean   in  0.037 ... 0.269"
## [1] ""
## [1] "TGC - Resistance, no IAC      :"
## [1] "  Median          <= 0.25"
## [1] "  Mean   in  0.083 ... 0.292"
## [1] ""
```



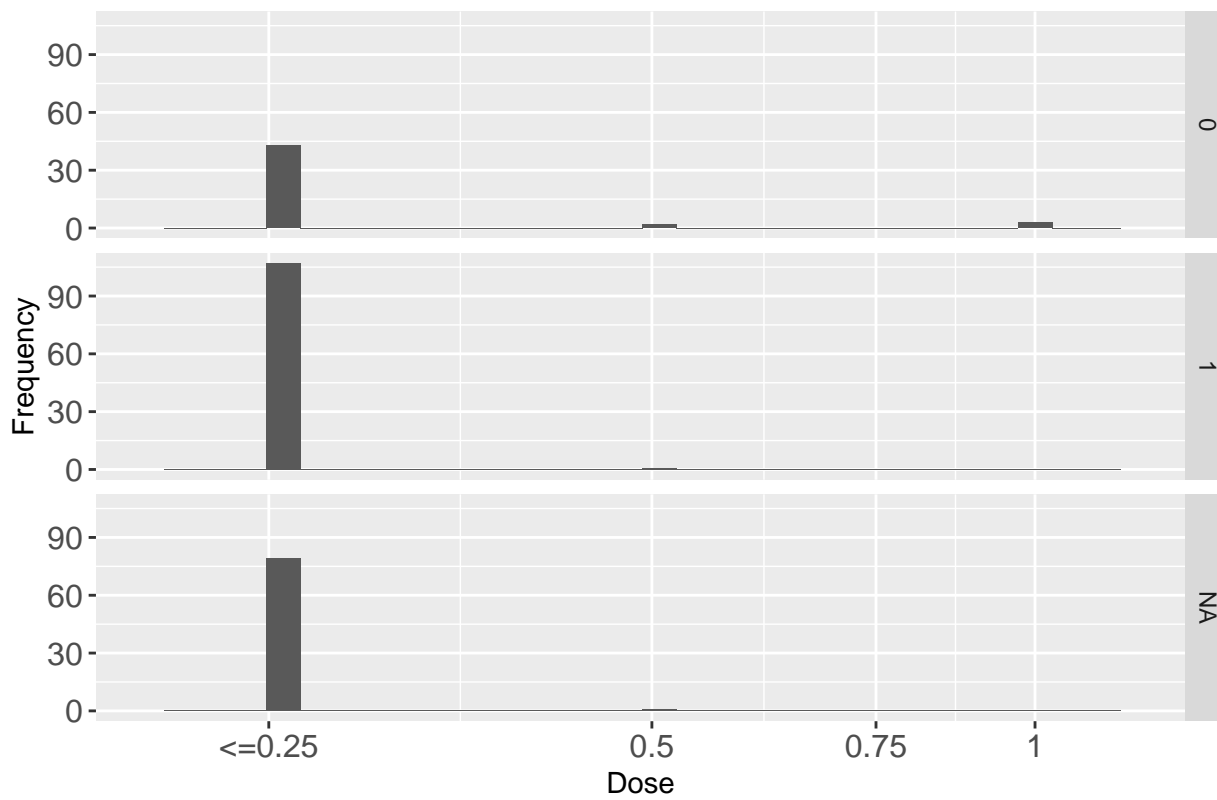
TGC for different IAC.group



```
graphisch("IAC.group", "TAZ" , 0.25,-1, 0.25,0.25 )
```

```
## [1] "TAZ - Resistance, IAC      :"  
## [1] "  Median      <= 0.25"  
## [1] "  Mean   in  0.005 ... 0.252"  
## [1] ""  
## [1] "TAZ - Resistance, no IAC   :"  
## [1] "  Median      <= 0.25"  
## [1] "  Mean   in  0.083 ... 0.307"  
## [1] ""
```

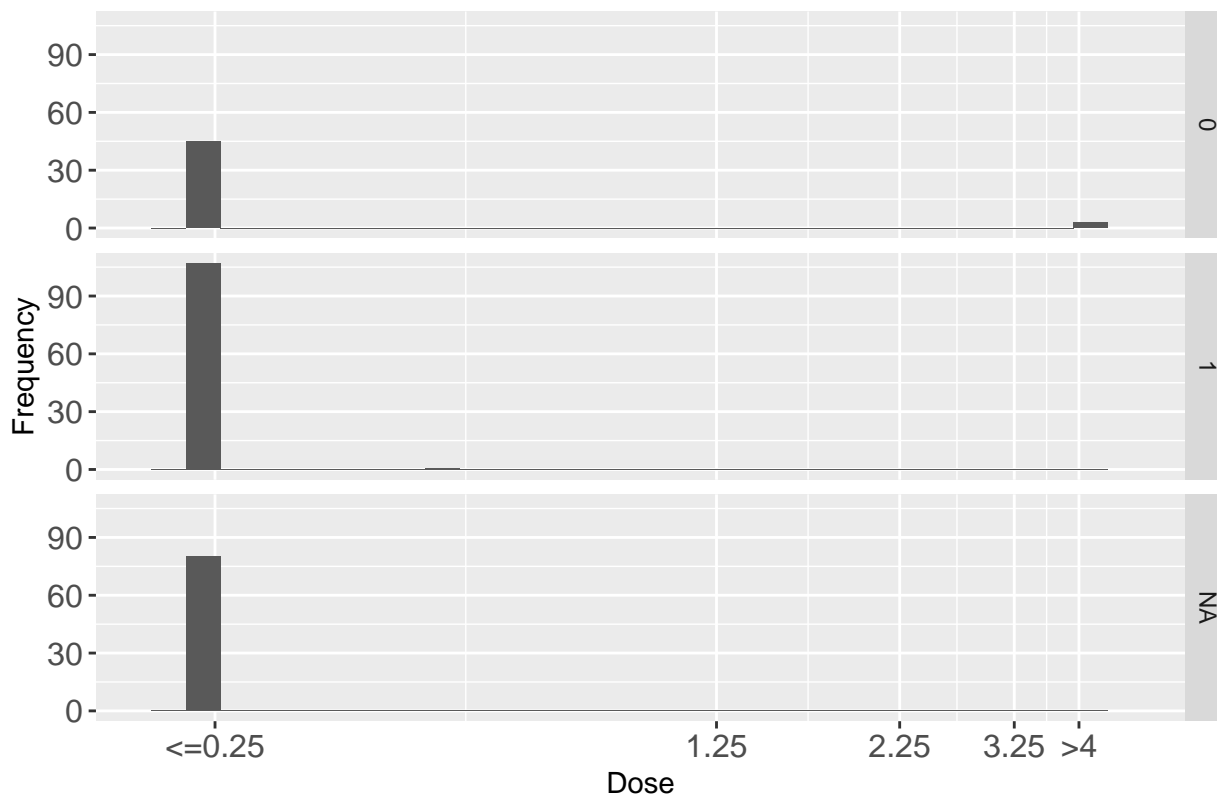
TAZ for different IAC.group



```
graphisch("IAC.group", "FOT" , 0.25,4 , 0.25,1 )
```

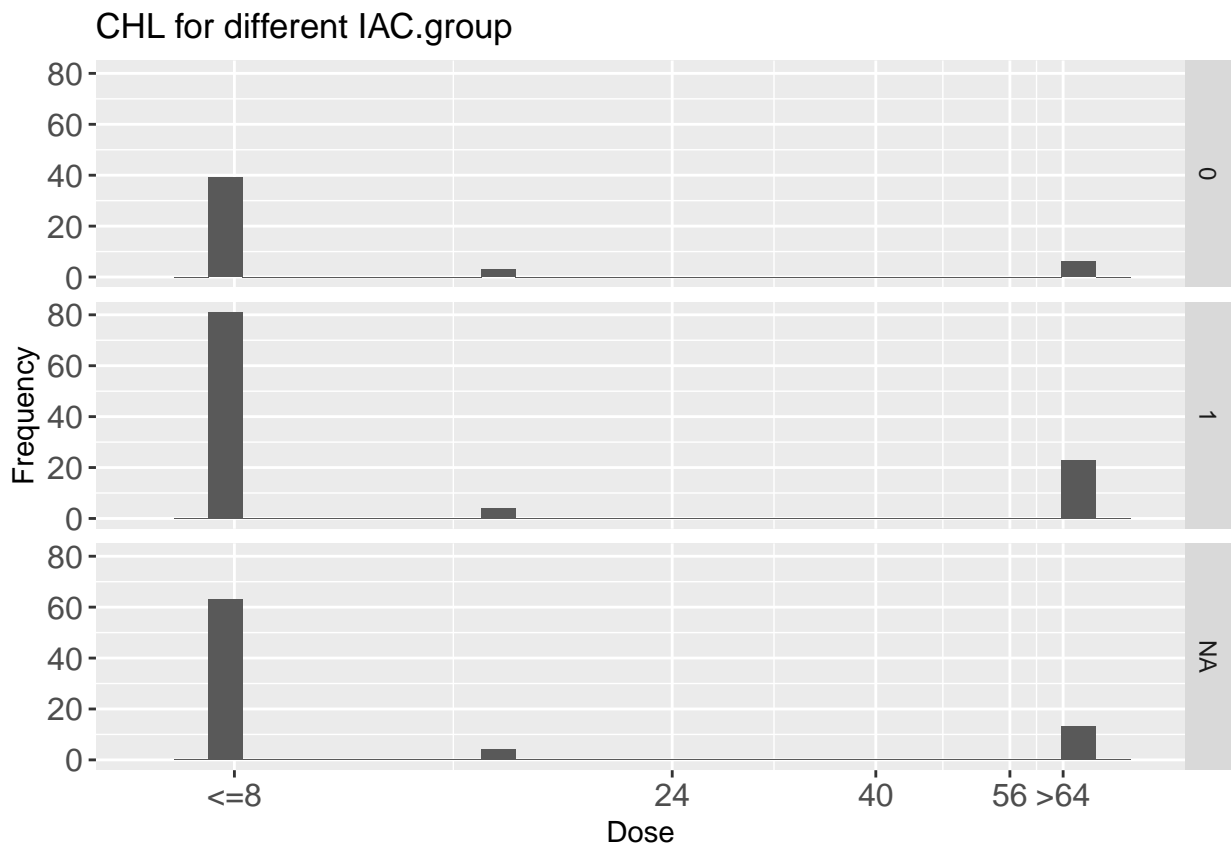
```
## [1] "FOT - Resistance, IAC          :"  
## [1] "  Median          <= 0.25"  
## [1] "  Mean   in 0.005 ... 0.252"  
## [1] ""  
## [1] "FOT - Resistance, no IAC      :"  
## [1] "  Median          <= 0.25"  
## [1] "  Mean   in 0.250 ... 0.484"  
## [1] ""
```

FOT for different IAC.group



```
graphisch("IAC.group", "CHL" , 8 , 64 , 8,16 )
```

```
## [1] "CHL - Resistance, IAC      :"  
## [1] "  Median      <= 8"  
## [1] "  Mean   in 14.222 ... 20.222"  
## [1] ""  
## [1] "CHL - Resistance, no IAC   :"  
## [1] "  Median      <= 8"  
## [1] "  Mean   in  9.000 ... 15.500"  
## [1] ""
```



```
graphisch("IAC.group", "NAL" , 4,64, 4,16 )
```

```
## [1] "NAL - Resistance, IAC          :"
```

```
## [1] "  Median          <= 4"
```

```
## [1] "  Mean   in  2.815 ... 6.444"
```

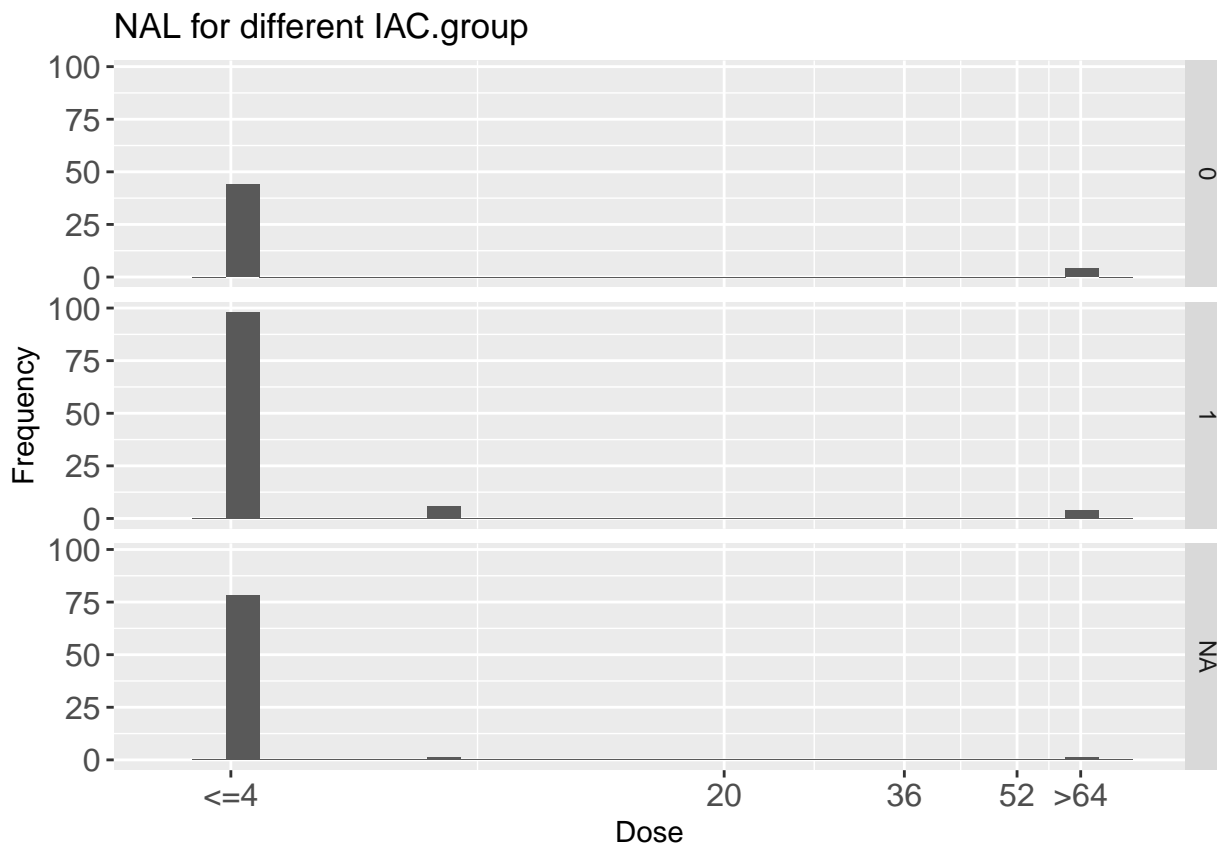
```
## [1] ""
```

```
## [1] "NAL - Resistance, no IAC       :"
```

```
## [1] "  Median          <= 4"
```

```
## [1] "  Mean   in  5.333 ... 9.000"
```

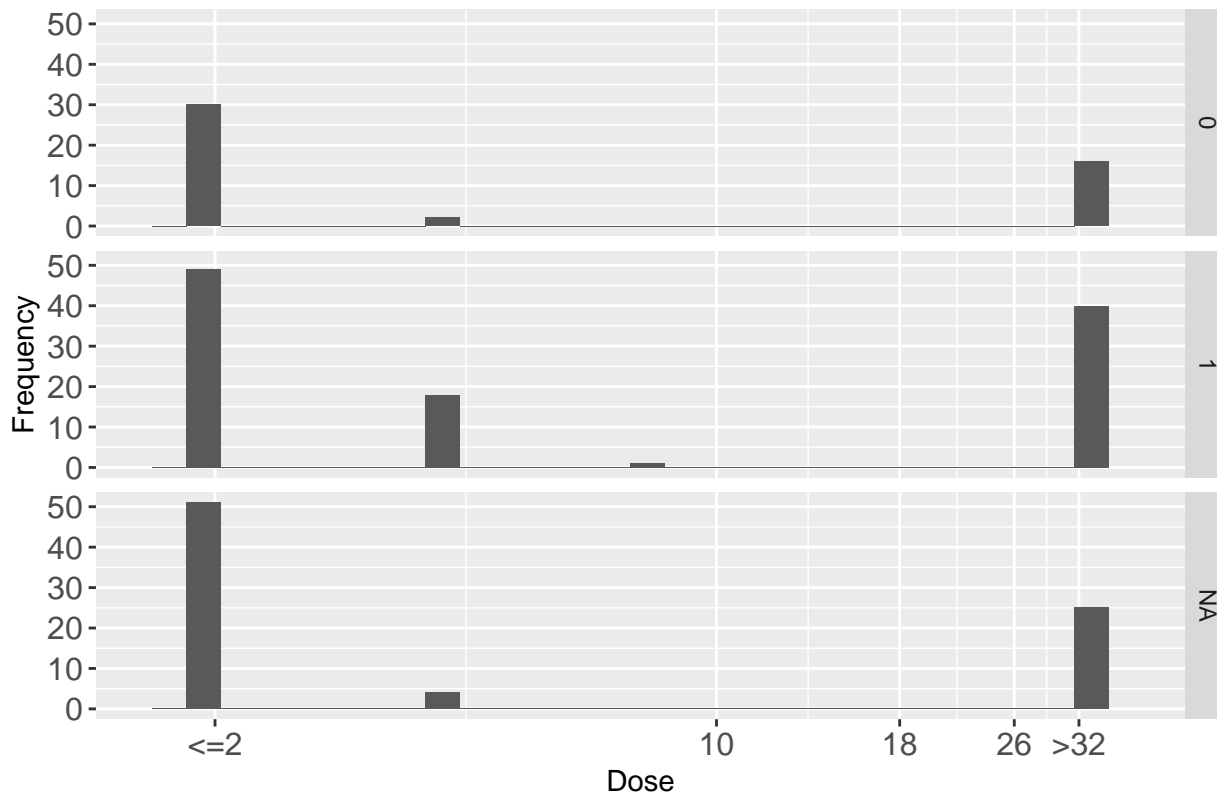
```
## [1] ""
```



```
graphisch("IAC.group", "TET" , 2,32, 2,8 )
```

```
## [1] "TET - Resistance, IAC          :"  
## [1] "  Median          = 4"  
## [1] "  Mean   in 12.593 ... 13.500"  
## [1] ""  
## [1] "TET - Resistance, no IAC      :"  
## [1] "  Median          <= 2"  
## [1] "  Mean   in 10.833 ... 12.083"  
## [1] ""
```

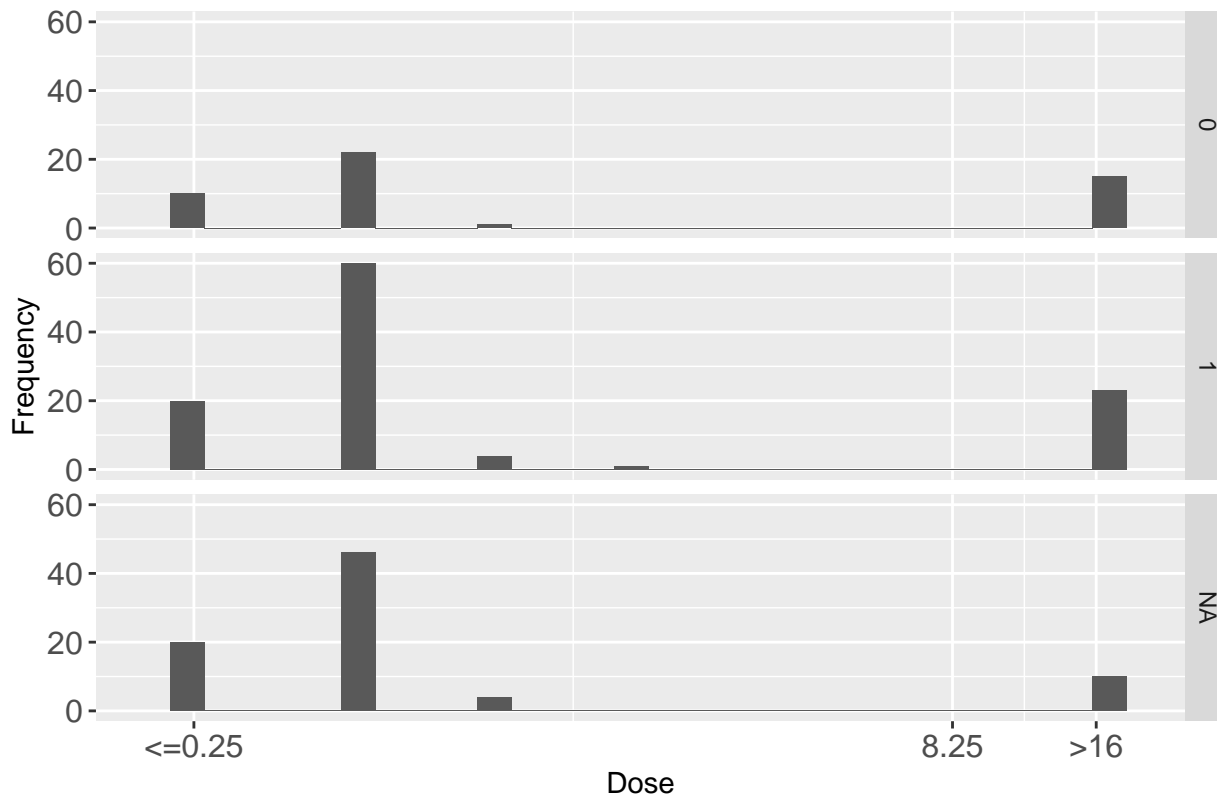
TET for different IAC.group



```
graphisch("IAC.group", "TMP" , 0.25 , 16 , 0.25,8 )
```

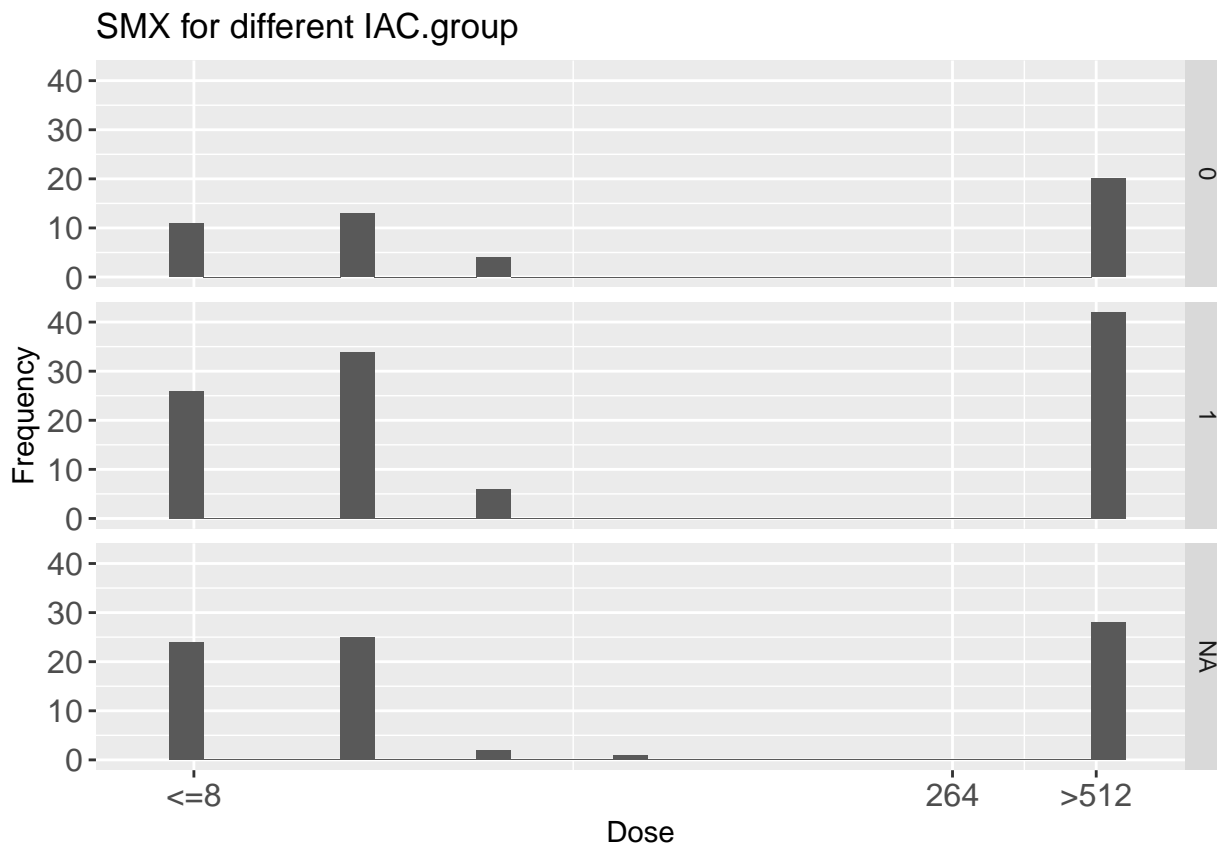
```
## [1] "TMP - Resistance, IAC      :"
## [1] "  Median      = 0.5"
## [1] "  Mean   in  3.741 ... 3.787"
## [1] ""
## [1] "TMP - Resistance, no IAC   :"
## [1] "  Median      = 0.5"
## [1] "  Mean   in  5.250 ... 5.302"
## [1] ""
```

TMP for different IAC.group



```
graphisch("IAC.group", "SMX" , 8 , 512 , 8,256 )
```

```
## [1] "SMX - Resistance, IAC          :"  
## [1] "  Median          = 16"  
## [1] "  Mean   in  205.926 ... 207.852"  
## [1] ""  
## [1] "SMX - Resistance, no IAC      :"  
## [1] "  Median          = 24"  
## [1] "  Mean   in  220.333 ... 222.167"  
## [1] ""
```



```
#stop the script - by error
```

Die Mittelwerte der Resistenz sind für 5 Antibiotika vergleichbar (AMP, MERO, TGC, TAZ, CHL), für GEN tendenziell grösser im Fall *Ill Animals in Calving box*, für 3 Antibiotika tendenziell kleiner in diesem Fall (ZIP, AZI, NAL), für TET definitiv grösser in diesem Fall und für 3 Antibiotika definitiv kleiner in diesem Fall (FOT, TMP, SMX). Diese Relationen sind im wesentlichen gleich gerichtet wie in WM - keine WM.

Der Vergleich des Medians der 2 Gruppen zeigt Unterschiede nur für TET und SMX, in der gleichen Richtung wie der Mittelwert. Deshalb diskutiere ich den Median nicht weiter.

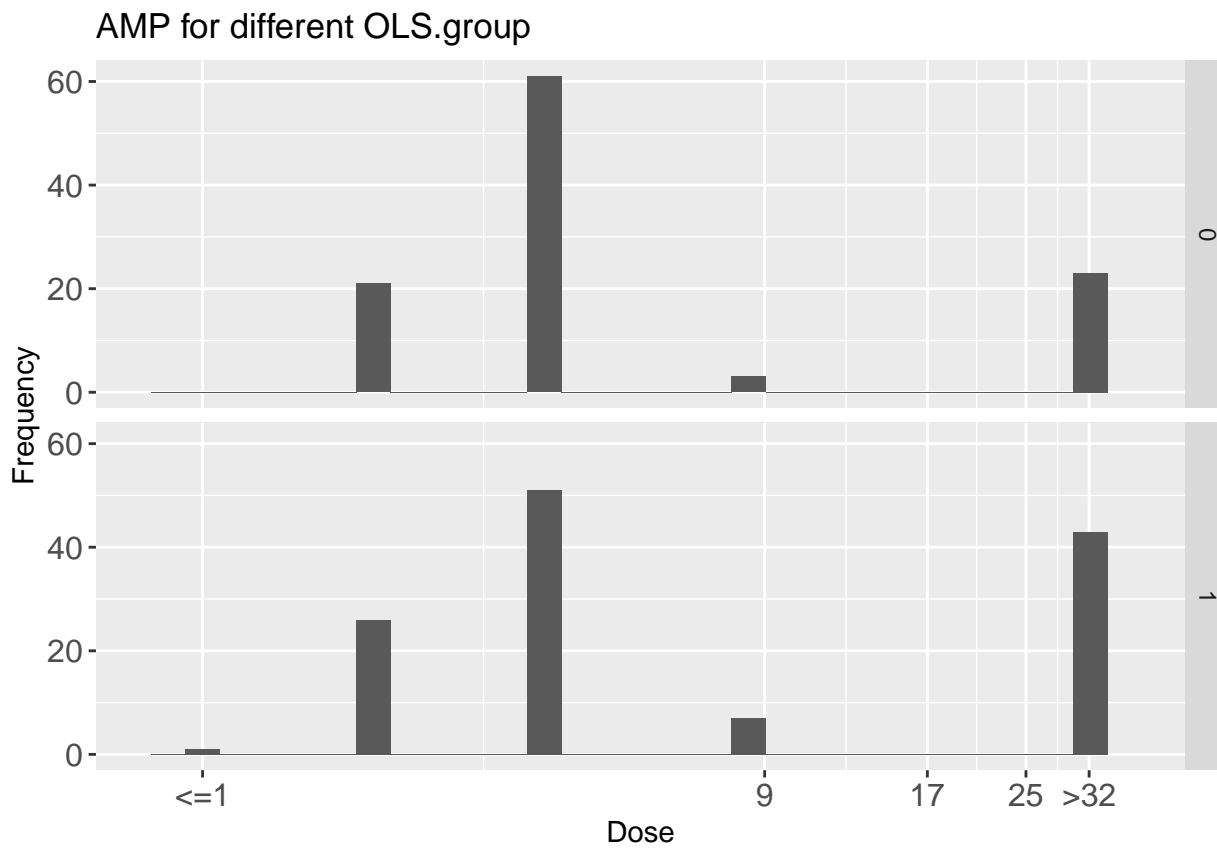
## Other Live Stock - Gruppen

Mit "OLS" abgekürzt.

```
graphisch("OLS.group", "AMP", 1,32, 1,8)
```

```
## [1] "AMP - Resistance, OLS          :"
## [1] "  Median          = 4"
## [1] "  Mean   in 13.188 ... 13.195"
## [1] ""
## [1] "AMP - Resistance, no OLS      :"
## [1] "  Median          = 4"
## [1] "  Mean   = 9.685"
## [1] ""
```





```
graphisch("OLS.group", "MERO", 0.03 , -0.06, 0.015, 0.015 )
```

```
## [1] "MERO - Resistance, OLS      :"
```

```
## [1] "  Median      <= 0.03"
```

```
## [1] "  Mean   in  0.000 ... 0.030"
```

```
## [1] ""
```

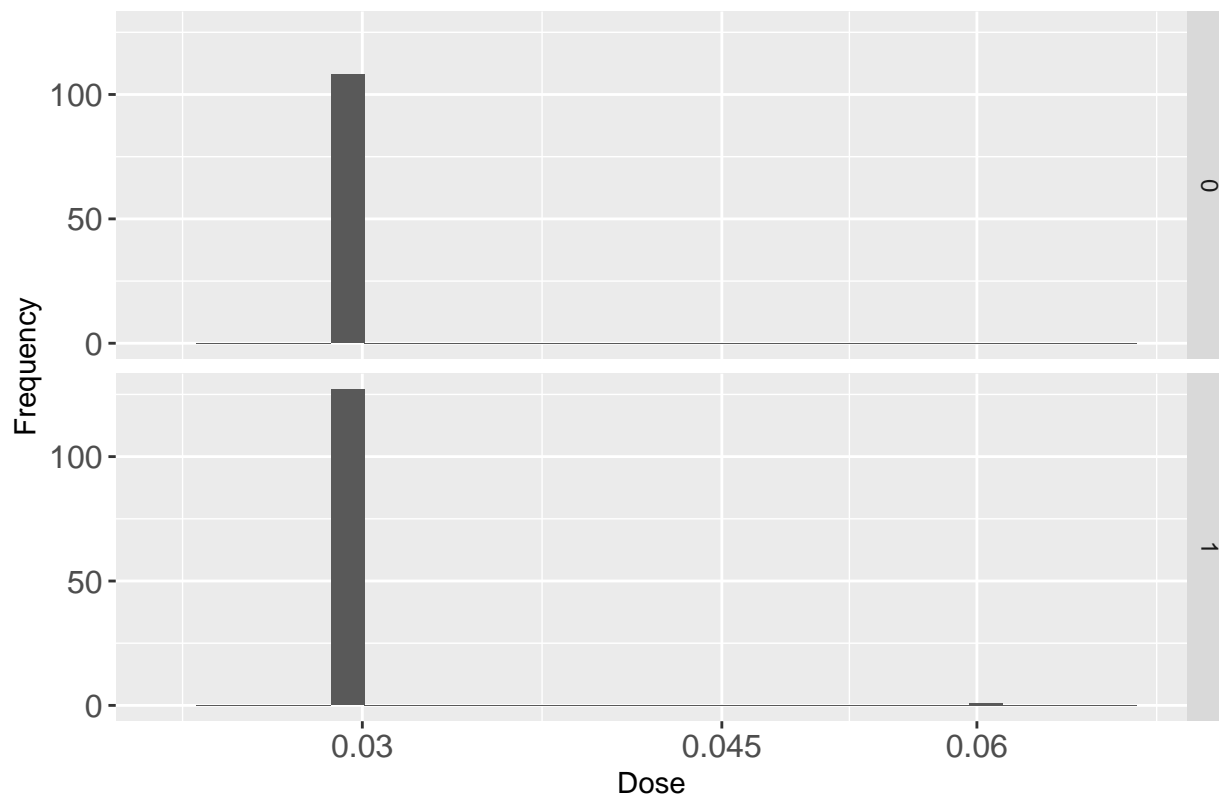
```
## [1] "MERO - Resistance, no OLS   :"
```

```
## [1] "  Median      <= 0.03"
```

```
## [1] "  Mean   in  0.000 ... 0.030"
```

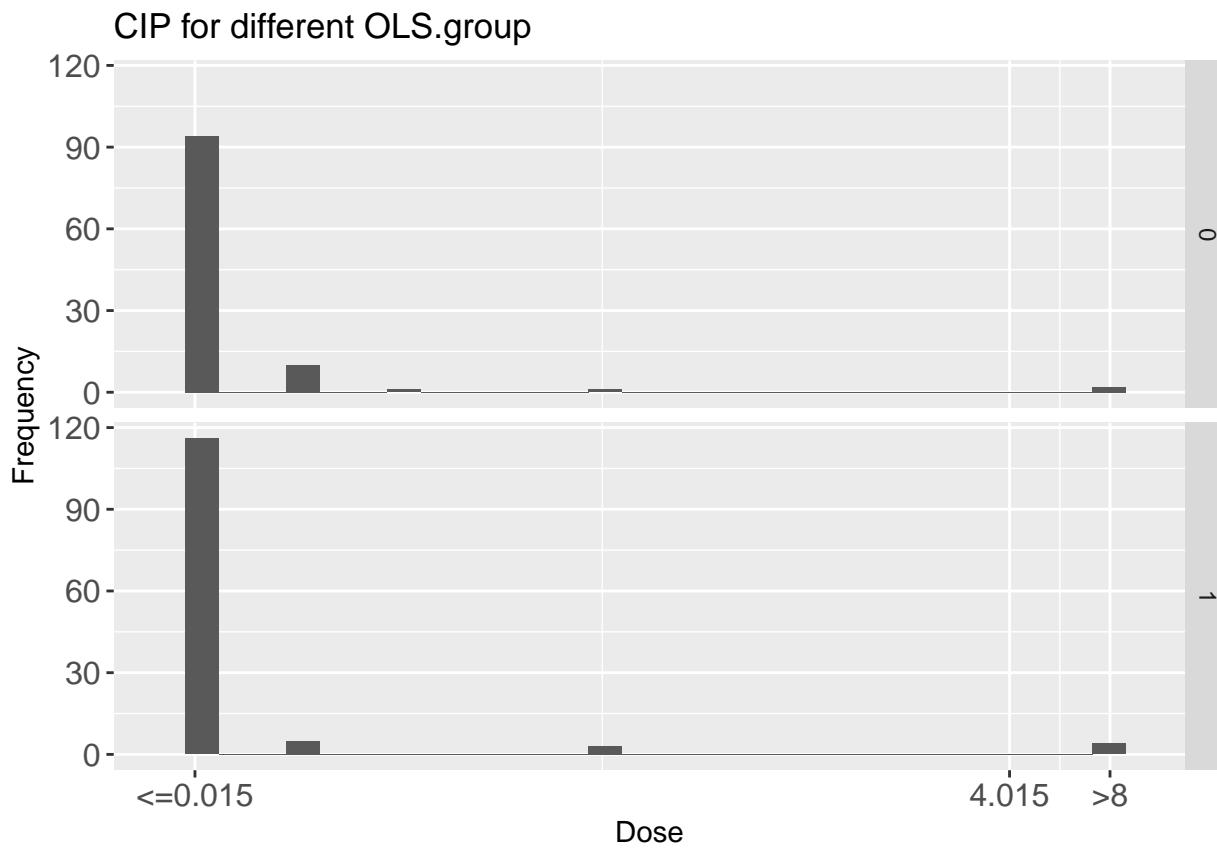
```
## [1] ""
```

MERO for different OLS.group



```
graphisch("OLS.group", "CIP" , 0.015, 8 , 0.015, 4 )
```

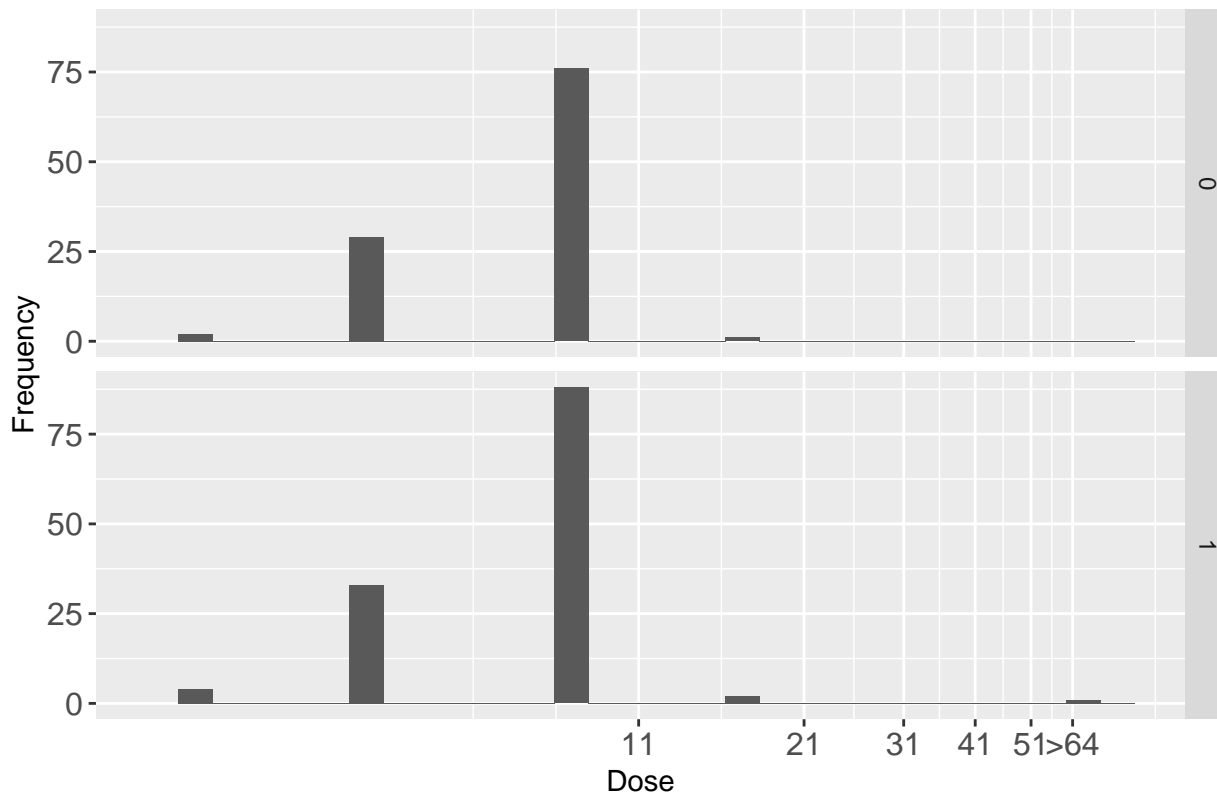
```
## [1] "CIP - Resistance, OLS      :"  
## [1] "  Median      <= 0.015"  
## [1] "  Mean   in  0.257 ... 0.271"  
## [1] ""  
## [1] "CIP - Resistance, no OLS   :"  
## [1] "  Median      <= 0.015"  
## [1] "  Mean   in  0.154 ... 0.167"  
## [1] ""
```



```
graphisch("OLS.group","AZI", 2,64, 1,10 )
```

```
## [1] "AZI - Resistance, OLS      :"
## [1] "  Median      = 8"
## [1] "  Mean   in  7.281 ... 7.344"
## [1] ""
## [1] "AZI - Resistance, no OLS   :"
## [1] "  Median      = 8"
## [1] "  Mean   in  6.852 ... 6.889"
## [1] ""
```

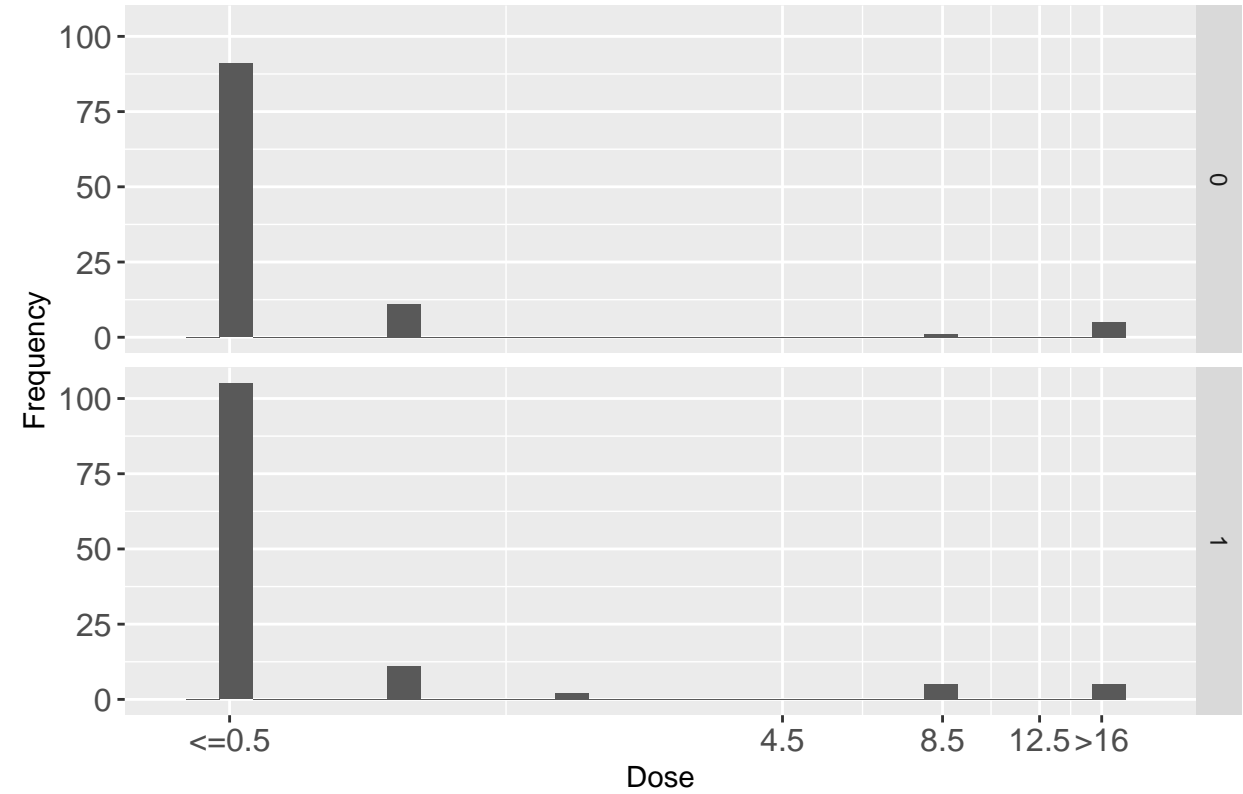
AZI for different OLS.group



```
graphisch("OLS.group", "GEN" , 0.5 , 16 , 0.5 , 4 )
```

```
## [1] "GEN - Resistance, OLS      :"
## [1] "  Median      <= 0.5"
## [1] "  Mean   in  1.055 ... 1.465"
## [1] ""
## [1] "GEN - Resistance, no OLS   :"
## [1] "  Median      <= 0.5"
## [1] "  Mean   in  0.917 ... 1.338"
## [1] ""
```

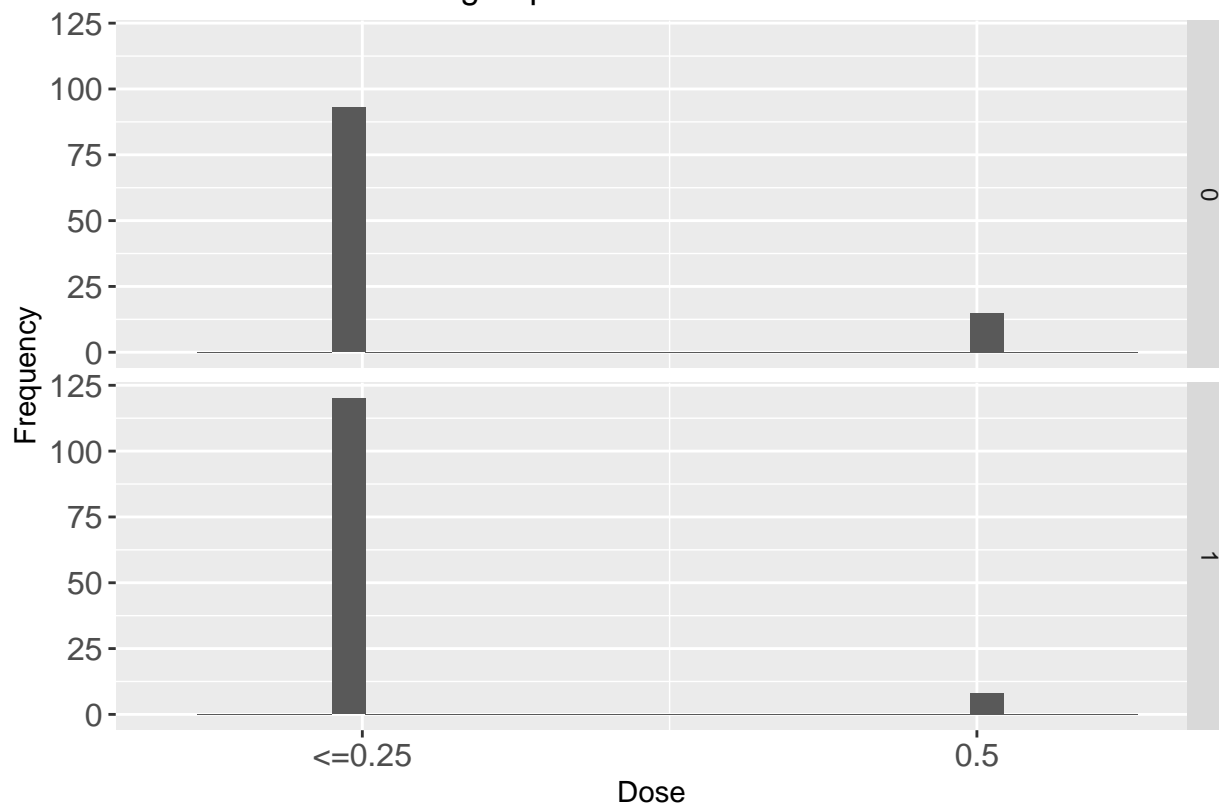
GEN for different OLS.group



```
graphisch("OLS.group", "TGC" , 0.25 , -0.5 , 0.25 , 0.25 )
```

```
## [1] "TGC - Resistance, OLS      :"  
## [1] "  Median      <= 0.25"  
## [1] "  Mean   in  0.031 ... 0.266"  
## [1] ""  
## [1] "TGC - Resistance, no OLS   :"  
## [1] "  Median      <= 0.25"  
## [1] "  Mean   in  0.069 ... 0.285"  
## [1] ""
```

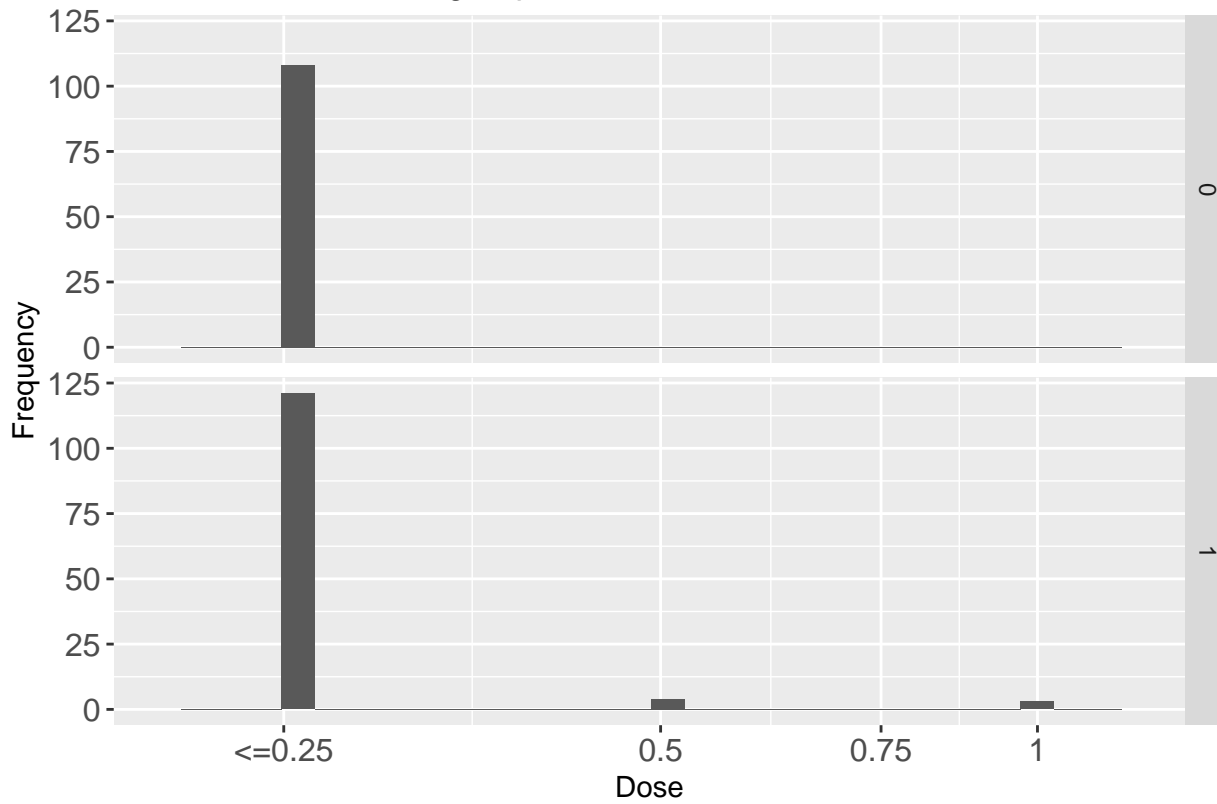
TGC for different OLS.group



```
graphisch("OLS.group", "TAZ" , 0.25,-1 , 0.25,0.25 )
```

```
## [1] "TAZ - Resistance, OLS      :"  
## [1] "  Median      <= 0.25"  
## [1] "  Mean   in  0.039 ... 0.275"  
## [1] ""  
## [1] "TAZ - Resistance, no OLS   :"  
## [1] "  Median      <= 0.25"  
## [1] "  Mean   in  0.000 ... 0.250"  
## [1] ""
```

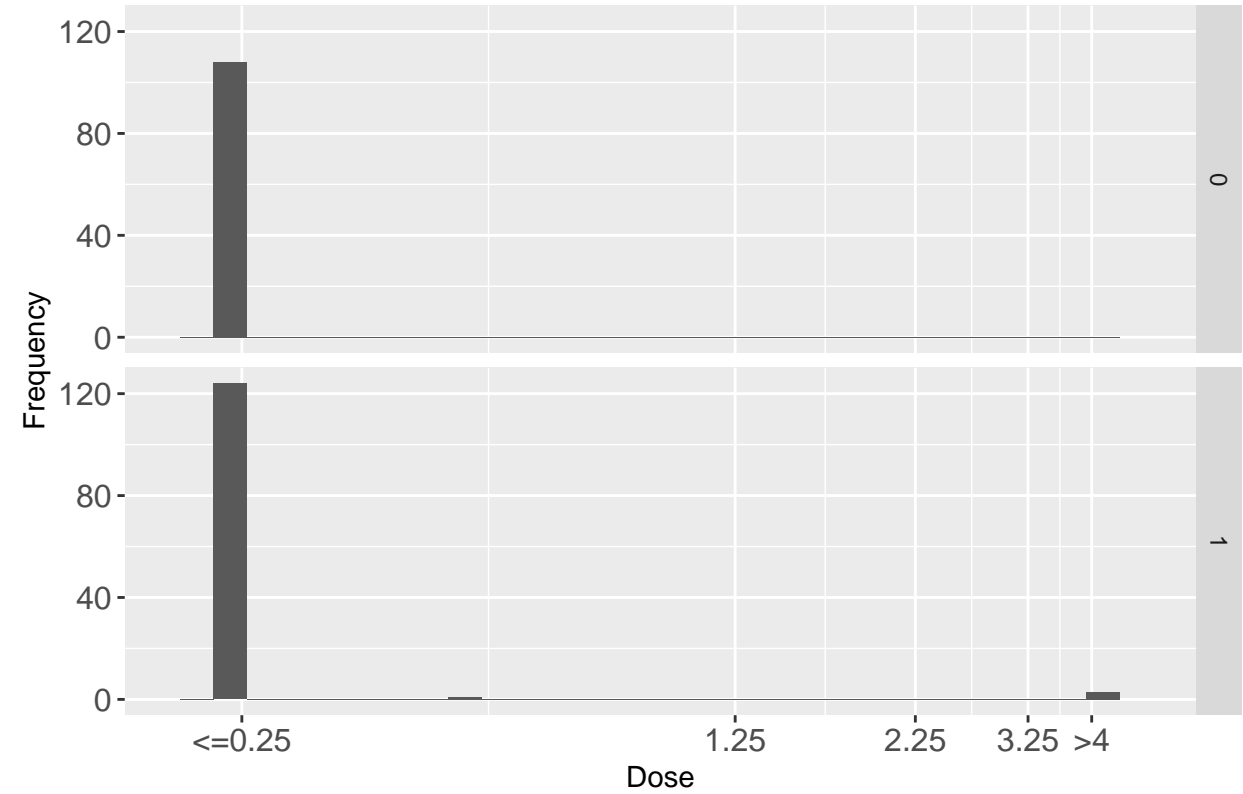
TAZ for different OLS.group



```
graphisch("OLS.group", "FOT" , 0.25 , 4 , 0.25 , 1 )
```

```
## [1] "FOT - Resistance, OLS      :"
## [1] "  Median      <= 0.25"
## [1] "  Mean   in  0.098 ... 0.340"
## [1] ""
## [1] "FOT - Resistance, no OLS   :"
## [1] "  Median      <= 0.25"
## [1] "  Mean   in  0.000 ... 0.250"
## [1] ""
```

FOT for different OLS.group

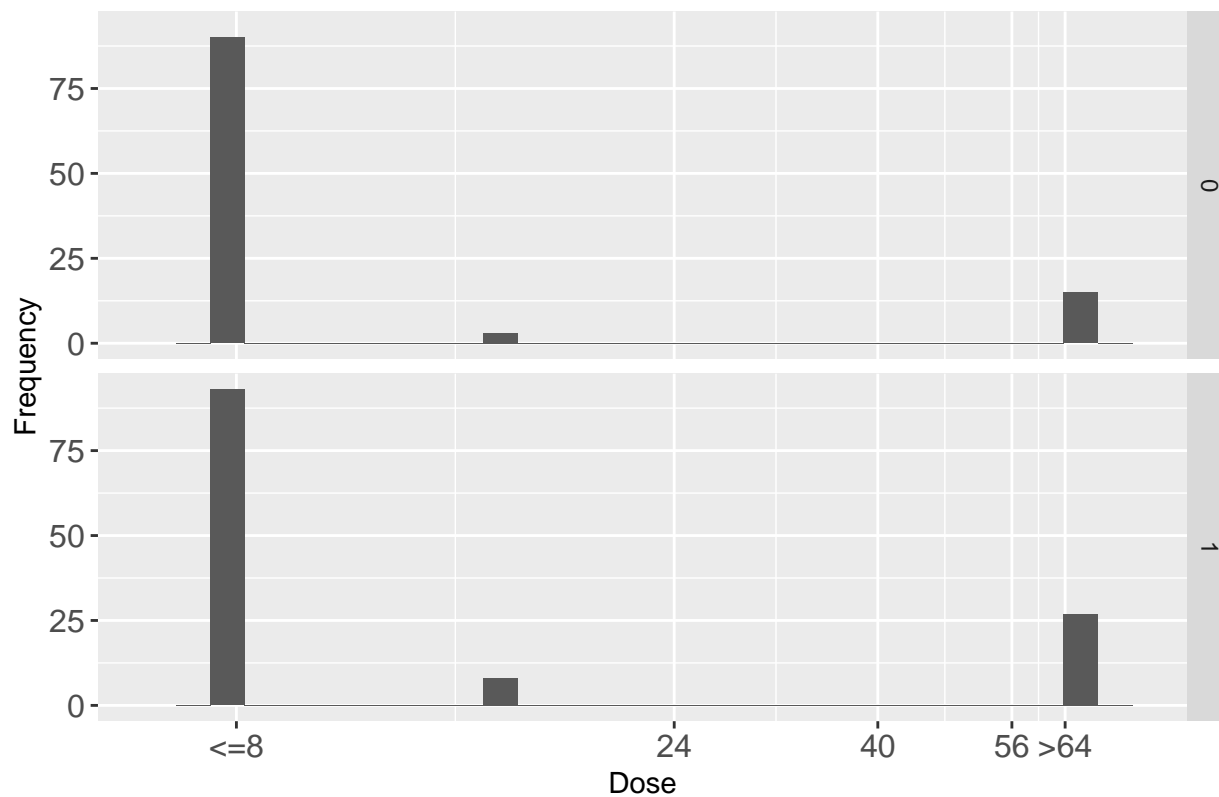


```
graphisch("OLS.group", "CHL" , 8 , 64 , 8,16 )
```

```
## [1] "CHL - Resistance, OLS      :"  
## [1] "  Median      <= 8"  
## [1] "  Mean   in 14.500 ... 20.312"  
## [1] ""  
## [1] "CHL - Resistance, no OLS   :"  
## [1] "  Median      <= 8"  
## [1] "  Mean   in  9.333 ... 16.000"  
## [1] ""
```



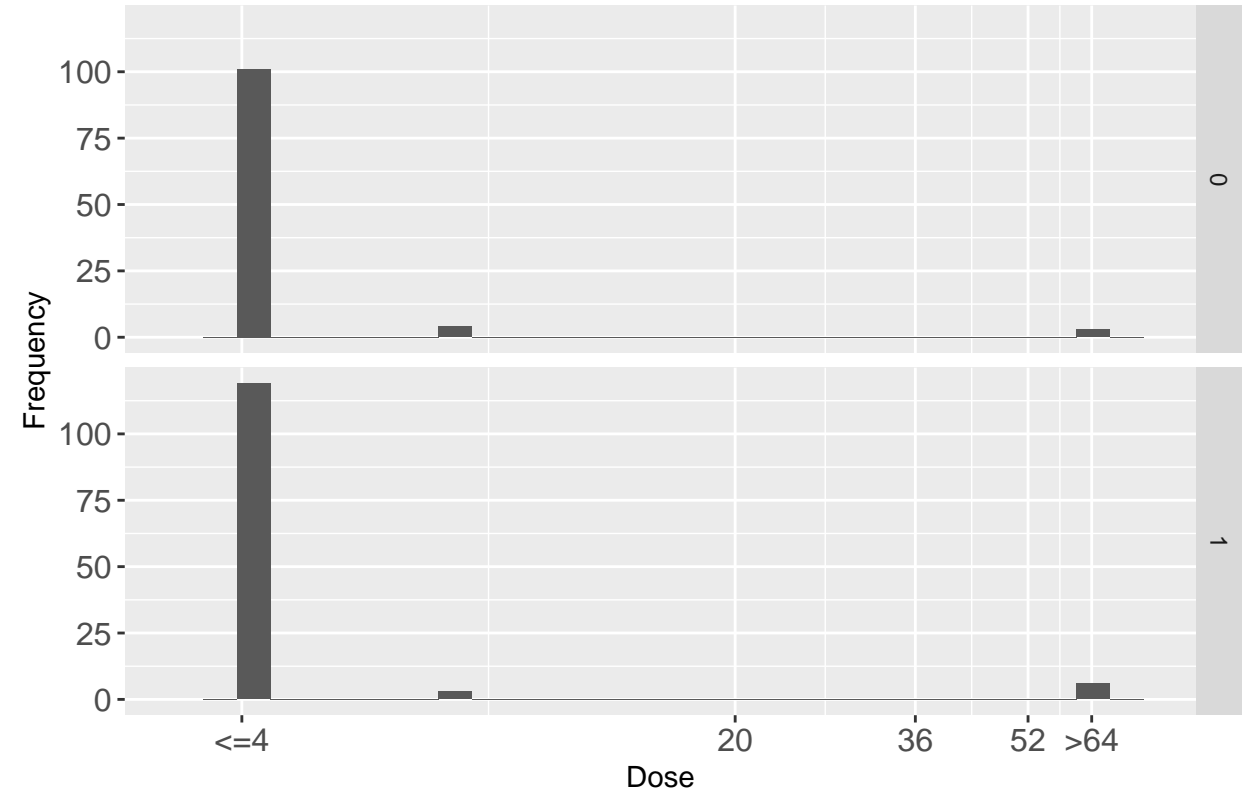
CHL for different OLS.group



```
graphisch("OLS.group", "NAL" , 4 , 64 , 4,16 )
```

```
## [1] "NAL - Resistance, OLS      :"
## [1] "  Median      <= 4"
## [1] "  Mean   in  3.188 ... 6.906"
## [1] ""
## [1] "NAL - Resistance, no OLS   :"
## [1] "  Median      <= 4"
## [1] "  Mean   in  2.074 ... 5.815"
## [1] ""
```

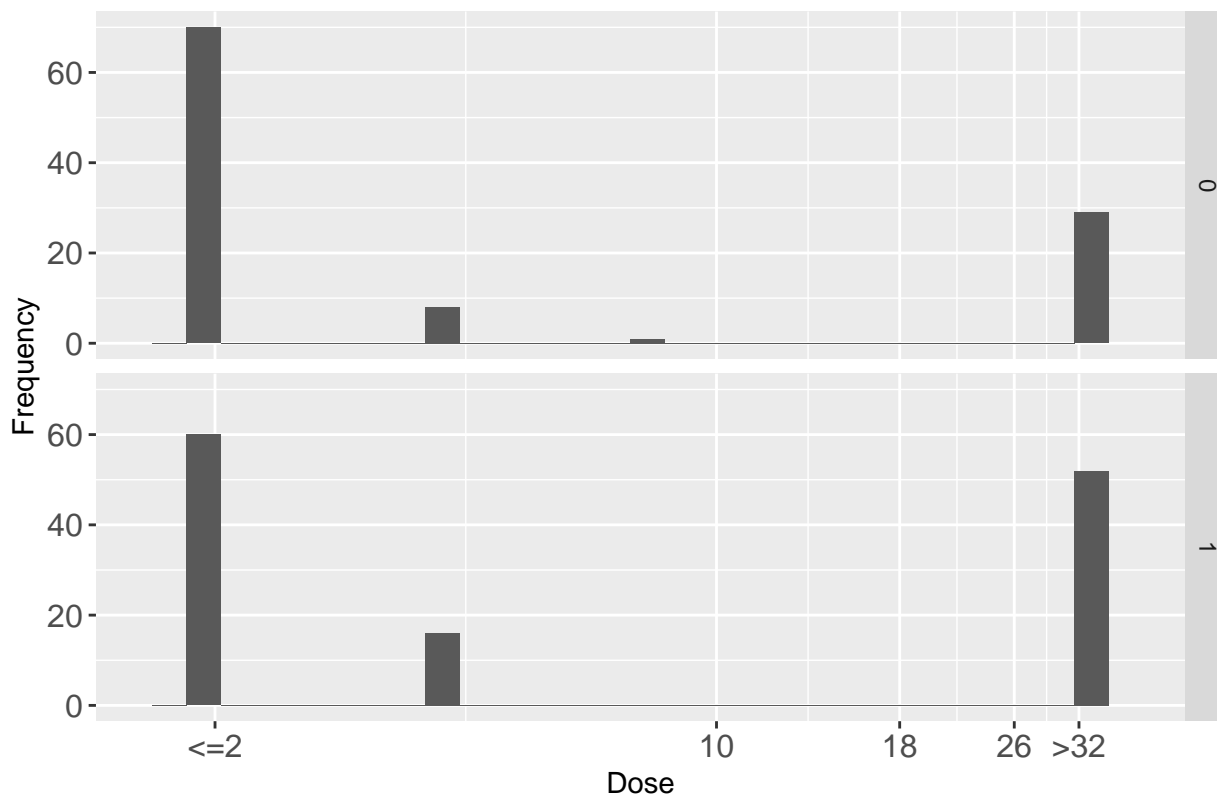
NAL for different OLS.group



```
graphisch("OLS.group", "TET" , 2 , 32 , 2,8 )
```

```
## [1] "TET - Resistance, OLS      :"  
## [1] "  Median      = 4"  
## [1] "  Mean   in 13.500 ... 14.438"  
## [1] ""  
## [1] "TET - Resistance, no OLS   :"  
## [1] "  Median      <= 2"  
## [1] "  Mean   in  8.963 ... 10.259"  
## [1] ""
```

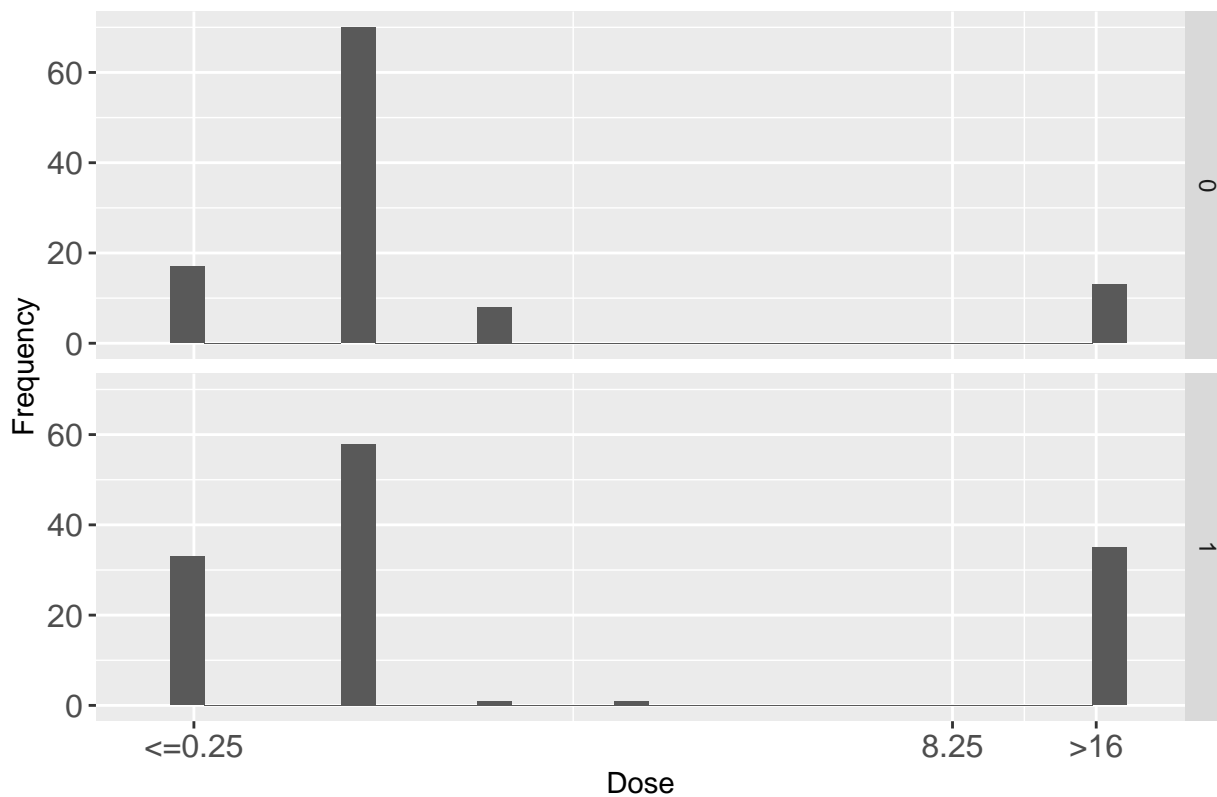
TET for different OLS.group



```
graphisch("OLS.group", "TMP" , 0.25 , 16 , 0.25,8 )
```

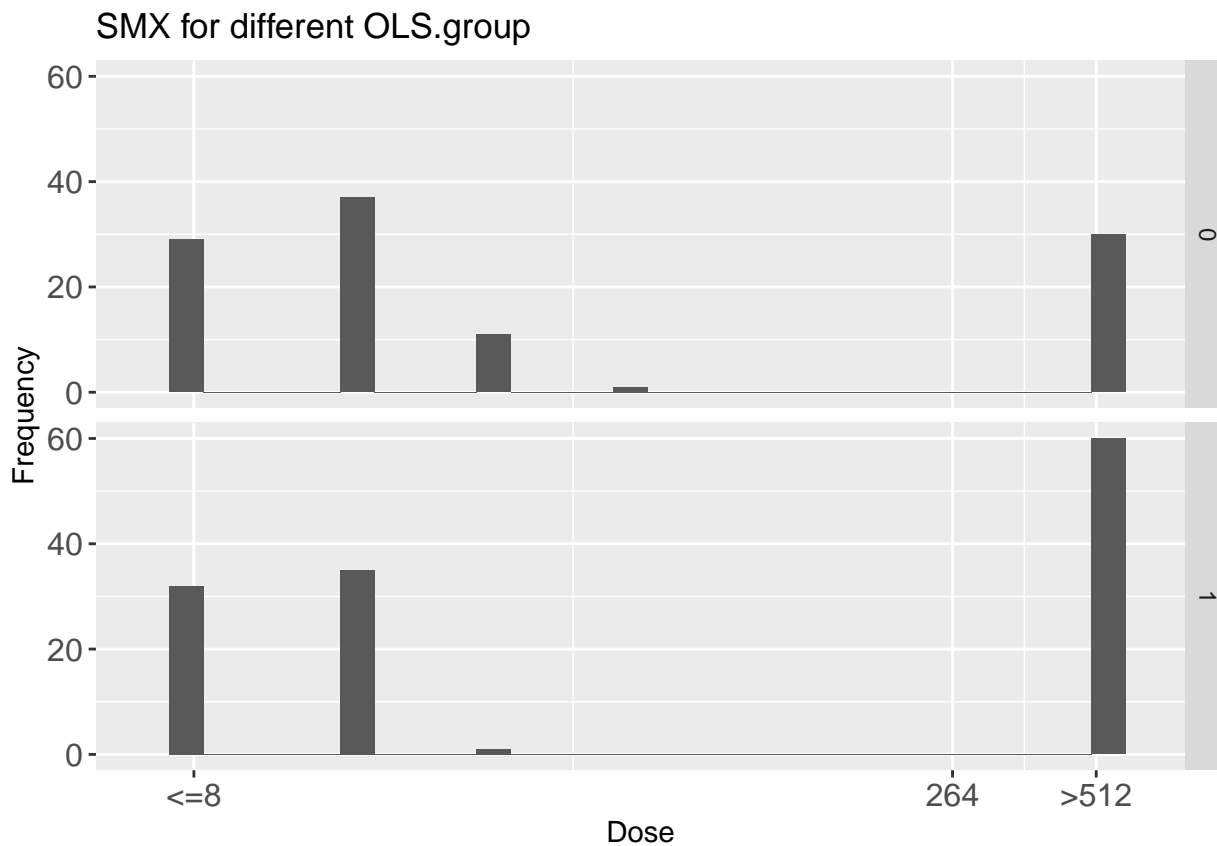
```
## [1] "TMP - Resistance, OLS      :"  
## [1] "  Median      = 0.5"  
## [1] "  Mean   in  4.625 ... 4.689"  
## [1] ""  
## [1] "TMP - Resistance, no OLS   :"  
## [1] "  Median      = 0.5"  
## [1] "  Mean   in  2.324 ... 2.363"  
## [1] ""
```

TMP for different OLS.group



```
graphisch("OLS.group", "SMX" , 8 , 512 , 8,256 )
```

```
## [1] "SMX - Resistance, OLS      :"  
## [1] "  Median      = 16"  
## [1] "  Mean   in  244.625 ... 246.625"  
## [1] ""  
## [1] "SMX - Resistance, no OLS   :"  
## [1] "  Median      = 16"  
## [1] "  Mean   in  151.556 ... 153.704"  
## [1] ""
```



```
#stop the script
```

Die Mittelwerte der Resistenz sind für MERO, GEN und TAZ vergleichbar, für 5 Antibiotika tendenziell grösser im Fall *Other Livestock* (CIP, FOT, CHL, NAL, SMX), für TGC tendenziell kleiner in diesem Fall und für 4 Antibiotika definitiv kleiner in diesem Fall (AMP, AZI, TET, TMP). Diese Relationen sind im wesentlichen entgegengesetzt zu WM - keine WM!

## Waste Milk - Gruppen

```
graphisch("WM.group", "AMP", 1,32, 1,8)
```

```
## [1] "AMP - Resistance, WM      :"
```

```
## [1] "  Median      = 4"
```

```
## [1] "  Mean   in  9.517 ... 9.526"
```

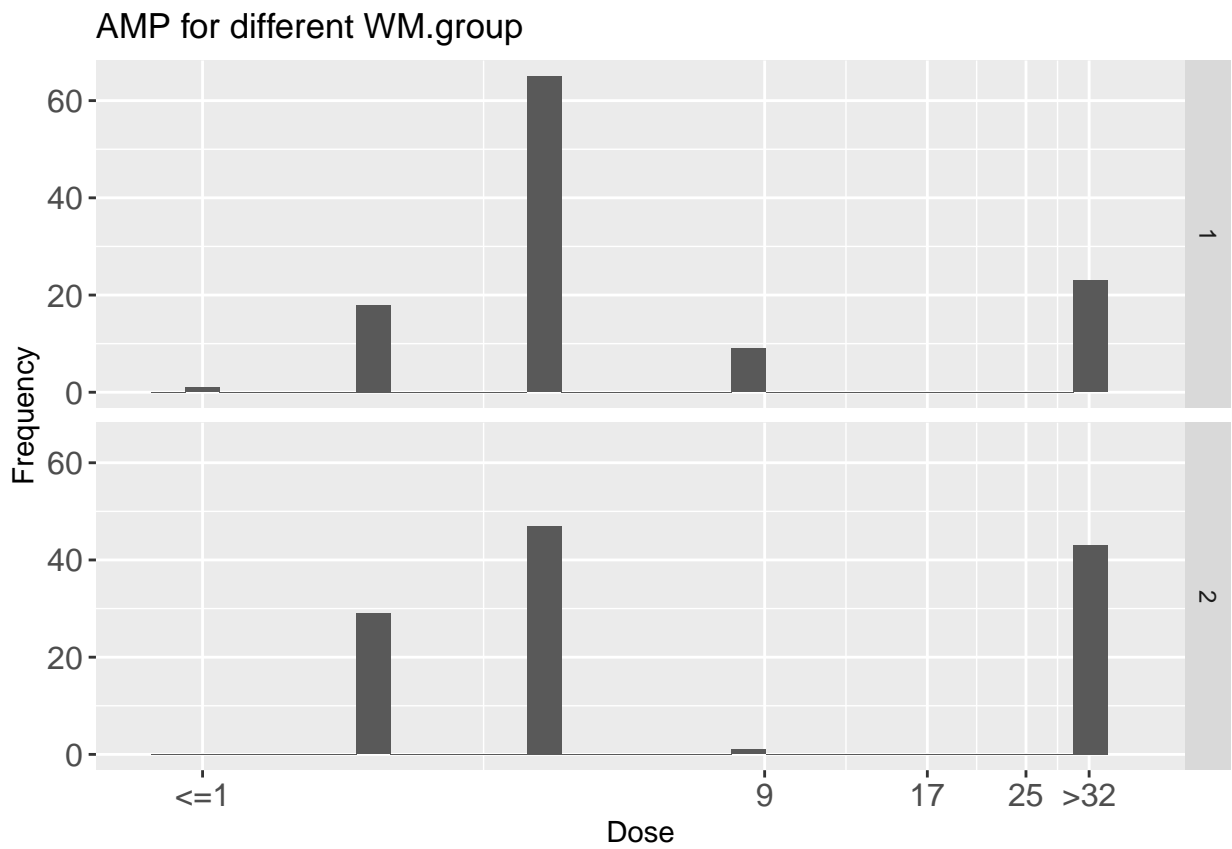
```
## [1] ""
```

```
## [1] "AMP - Resistance, no WM   :"
```

```
## [1] "  Median      = 4"
```

```
## [1] "  Mean   = 13.583"
```

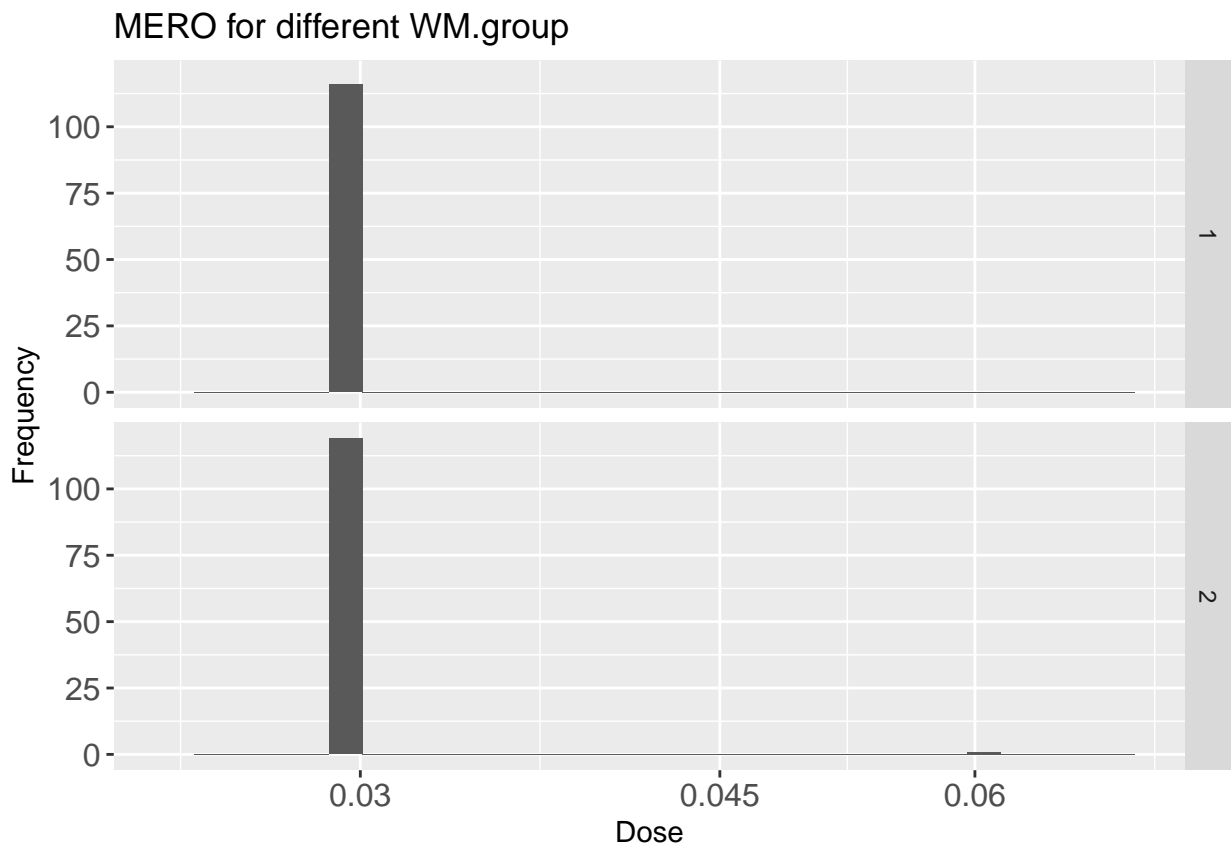
```
## [1] ""
```



Der Mittelwert ist höher ohne WM.

```
graphisch("WM.group", "MERO", .03,-0.06, .015,.015)
```

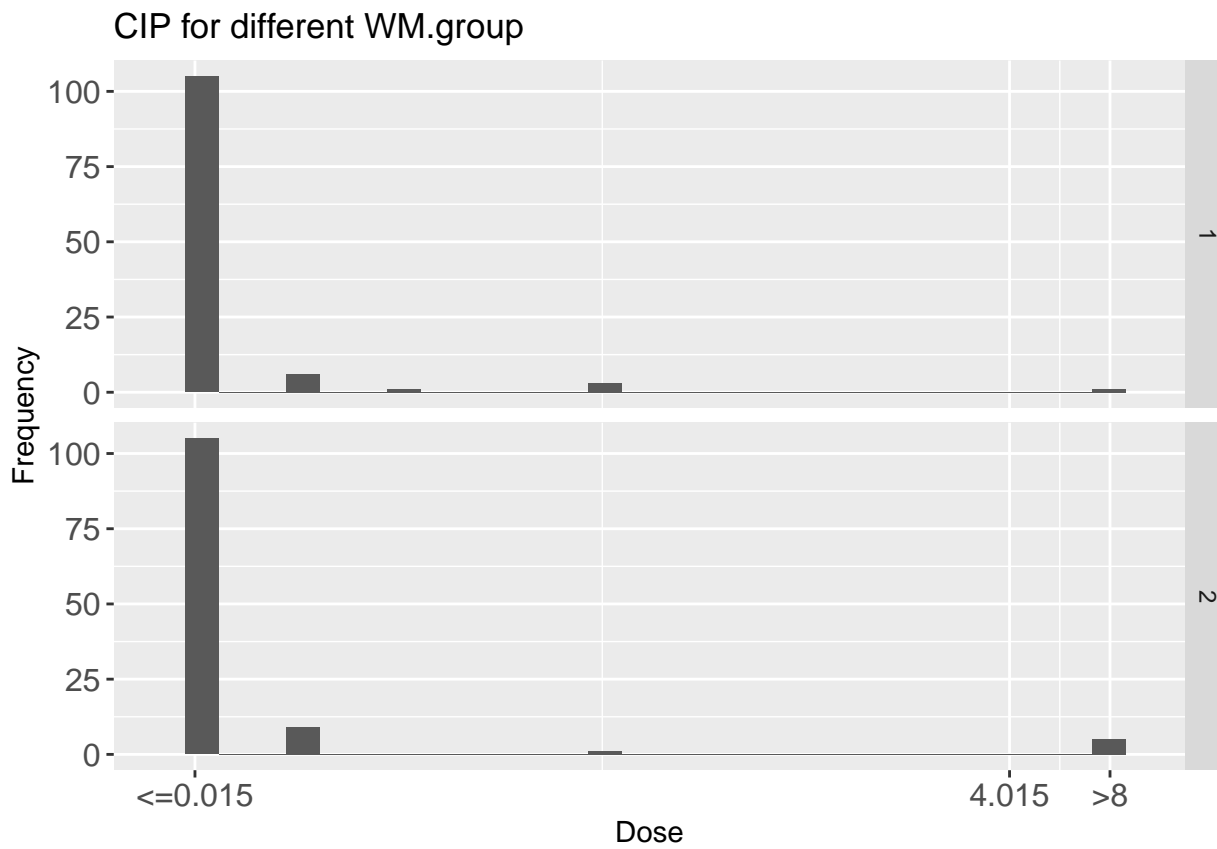
```
## [1] "MERO - Resistance, WM      :"  
## [1] "  Median      <= 0.03"  
## [1] "  Mean   in  0.000 ... 0.030"  
## [1] ""  
## [1] "MERO - Resistance, no WM   :"  
## [1] "  Median      <= 0.03"  
## [1] "  Mean   in  0.001 ... 0.030"  
## [1] ""
```



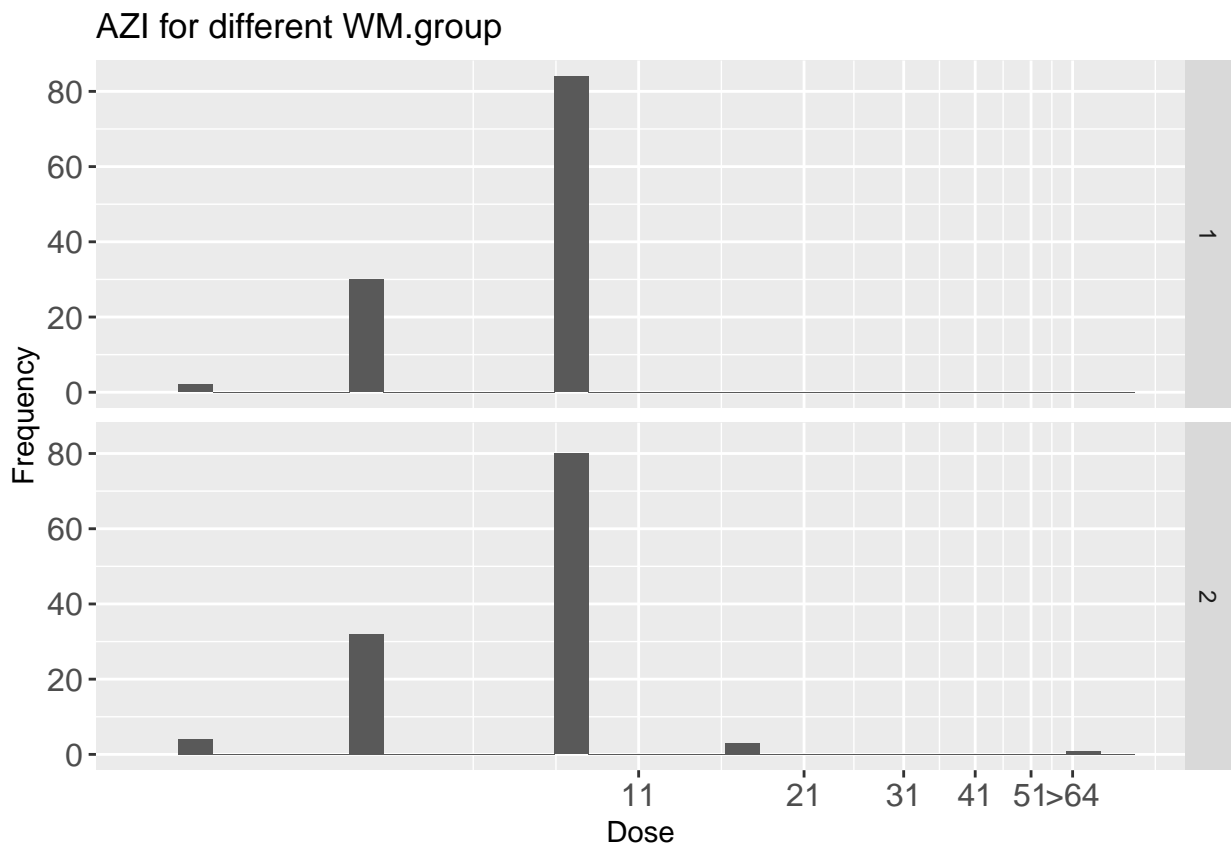
Der Mittelwert ist vergleichbar ohne WM (tatsächlich tendenziell minimal höher - das ist leicht zu kontrollieren: MERO ist immer  $\leq 3$  - ausser einmal 0.06 für Betrieb 4 und der ist WM group 2).

```
graphisch("WM.group", "CIP", 0.015,8, .015,4)
```

```
## [1] "CIP - Resistance, WM      :"
## [1] "  Median      <= 0.015"
## [1] "  Mean   in  0.077 ... 0.091"
## [1] ""
## [1] "CIP - Resistance, no WM   :"
## [1] "  Median      <= 0.015"
## [1] "  Mean   in  0.338 ... 0.351"
## [1] ""
```



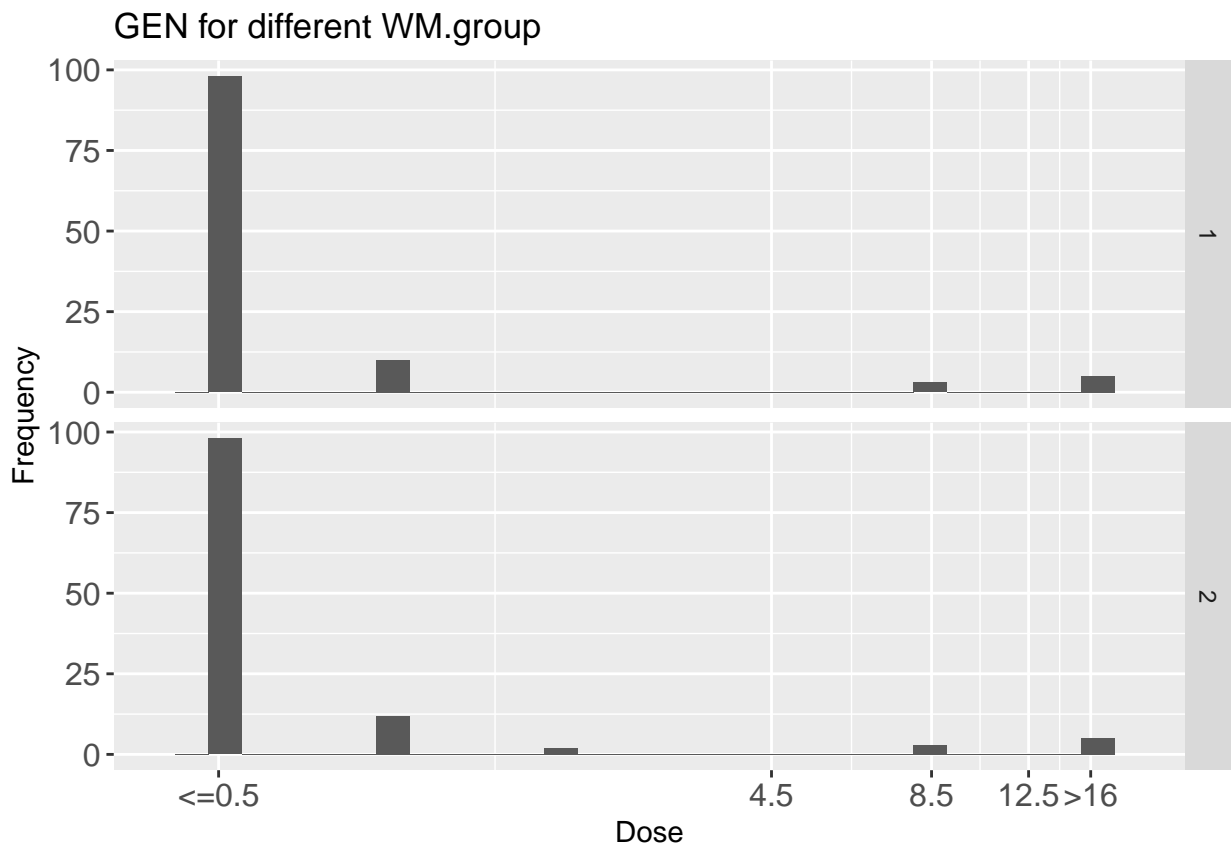




Der Mittelwert ist höher ohne WM.

```
graphisch("WM.group", "GEN", 0.5,16, 0.5,4)
```

```
## [1] "GEN - Resistance, WM      :"  
## [1] "  Median      <= 0.5"  
## [1] "  Mean   in  0.983 ... 1.405"  
## [1] ""  
## [1] "GEN - Resistance, no WM   :"  
## [1] "  Median      <= 0.5"  
## [1] "  Mean   in  1.000 ... 1.408"  
## [1] ""
```



Der Mittelwert ist vergleichbar ohne WM.

```
graphisch("WM.group", "TGC", 0.25,-0.5, 0.25,0.25)
```

```
## [1] "TGC - Resistance, WM      :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.056 ... 0.278"
```

```
## [1] ""
```

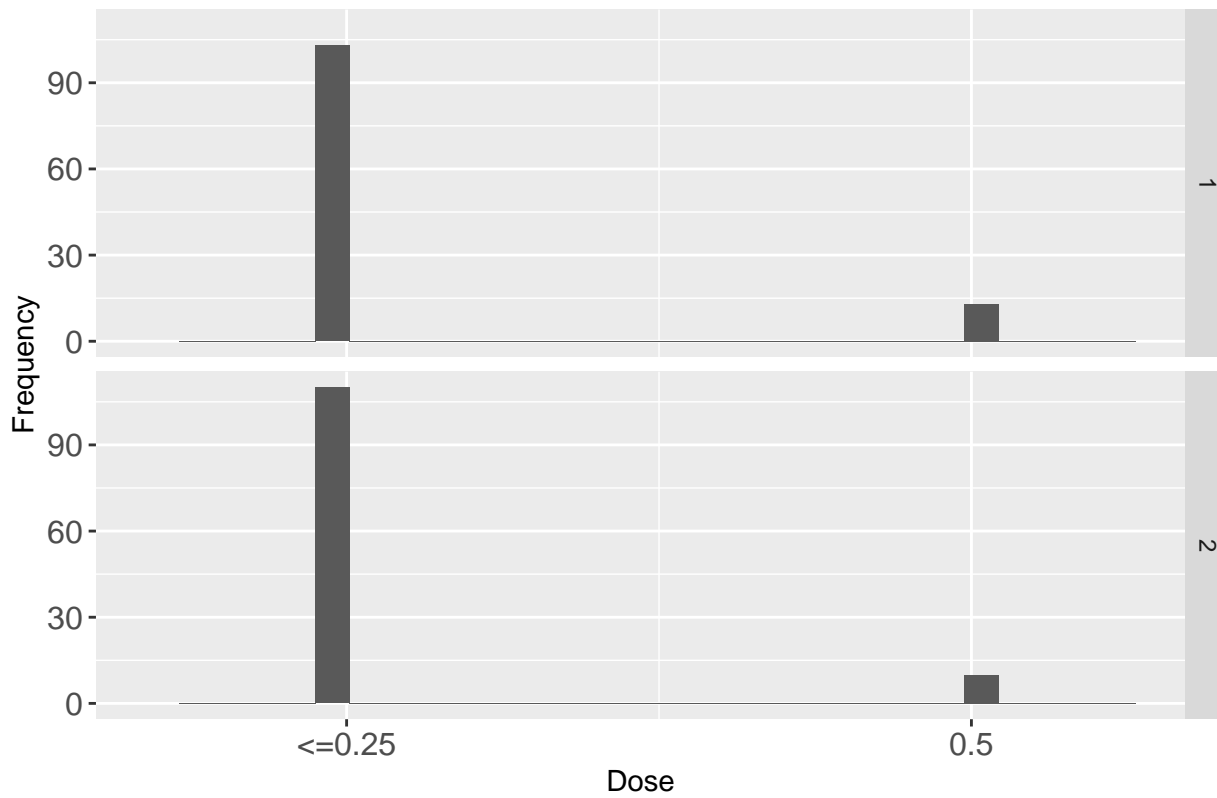
```
## [1] "TGC - Resistance, no WM   :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.042 ... 0.271"
```

```
## [1] ""
```

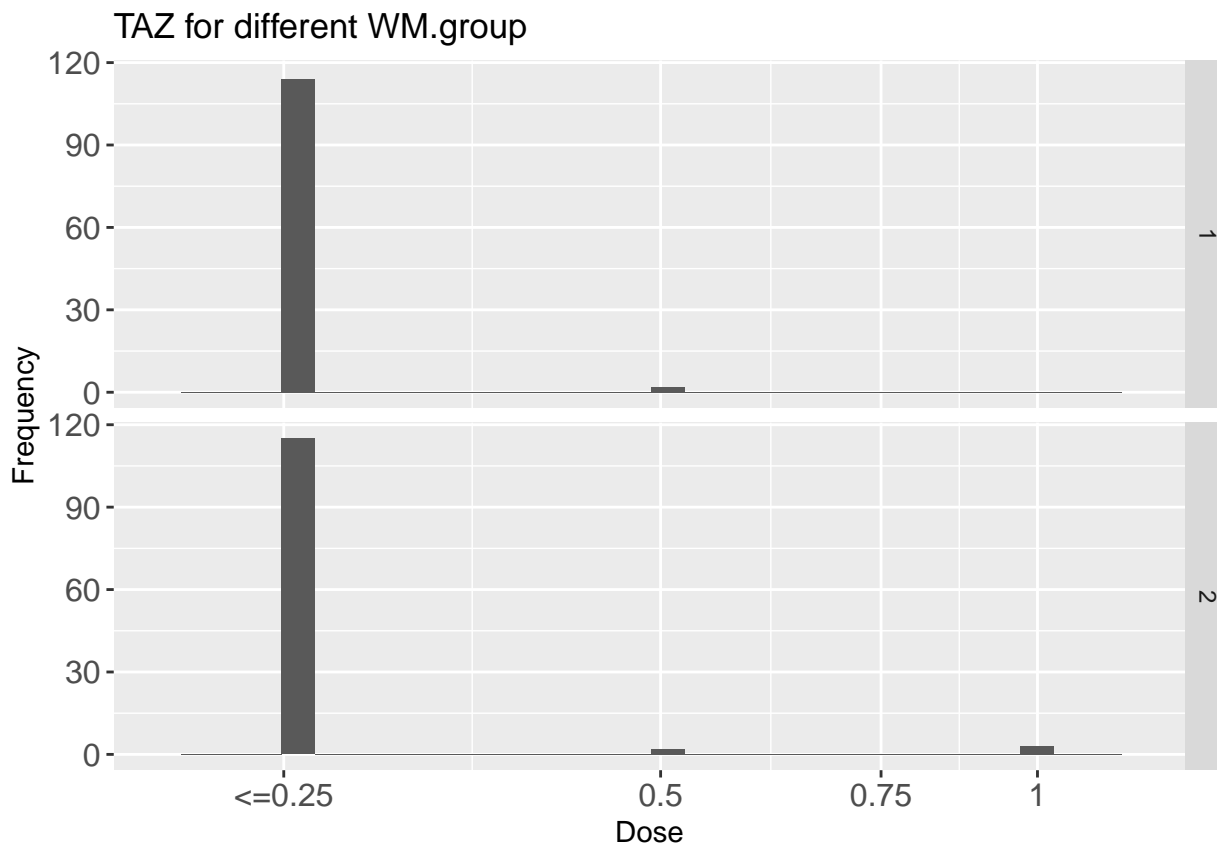
TGC for different WM.group



Der Mittelwert ist vergleichbar ohne WM.

```
graphisch("WM.group", "TAZ", 0.25, -1, .25, .25)
```

```
## [1] "TAZ - Resistance, WM      :"  
## [1] "  Median      <= 0.25"  
## [1] "  Mean   in  0.009 ... 0.254"  
## [1] ""  
## [1] "TAZ - Resistance, no WM   :"  
## [1] "  Median      <= 0.25"  
## [1] "  Mean   in  0.033 ... 0.273"  
## [1] ""
```



Der Mittelwert ist vergleichbar ohne WM. Genauer: tendenziell höher - das kann man auch noch per Hand kontrollieren: TAZ ist immer  $\leq 0.25$  ausser für:

- Waste Milk: 0.5 für Betriebe 11 und 15
- Keine Waste Milk: 0.5 für Betriebe 12, 59 und 3\*1 für Betrieb 52

(Betrieb 30 wurde ganz am Anfang schon gelöscht)

Die Werte 0.5 balancieren sich also aus für Waste Milk oder nicht, und der Unterschied kommt von den 3 Werten 1: Ohne WM ist resistenter.

```
graphisch("WM.group", "FOT", 0.25, 4, .25, 1)
```

```
## [1] "FOT - Resistance, WM      :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.004 ... 0.252"
```

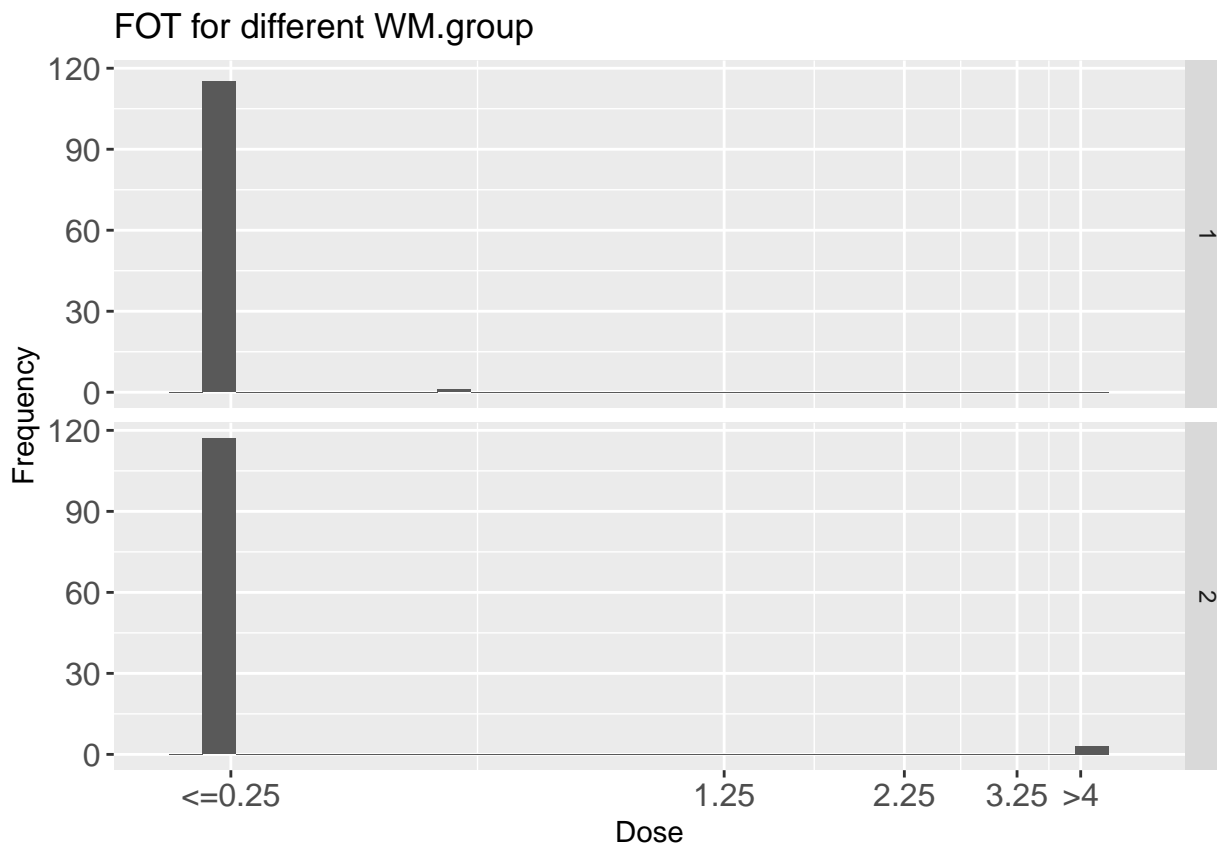
```
## [1] ""
```

```
## [1] "FOT - Resistance, no WM   :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.100 ... 0.344"
```

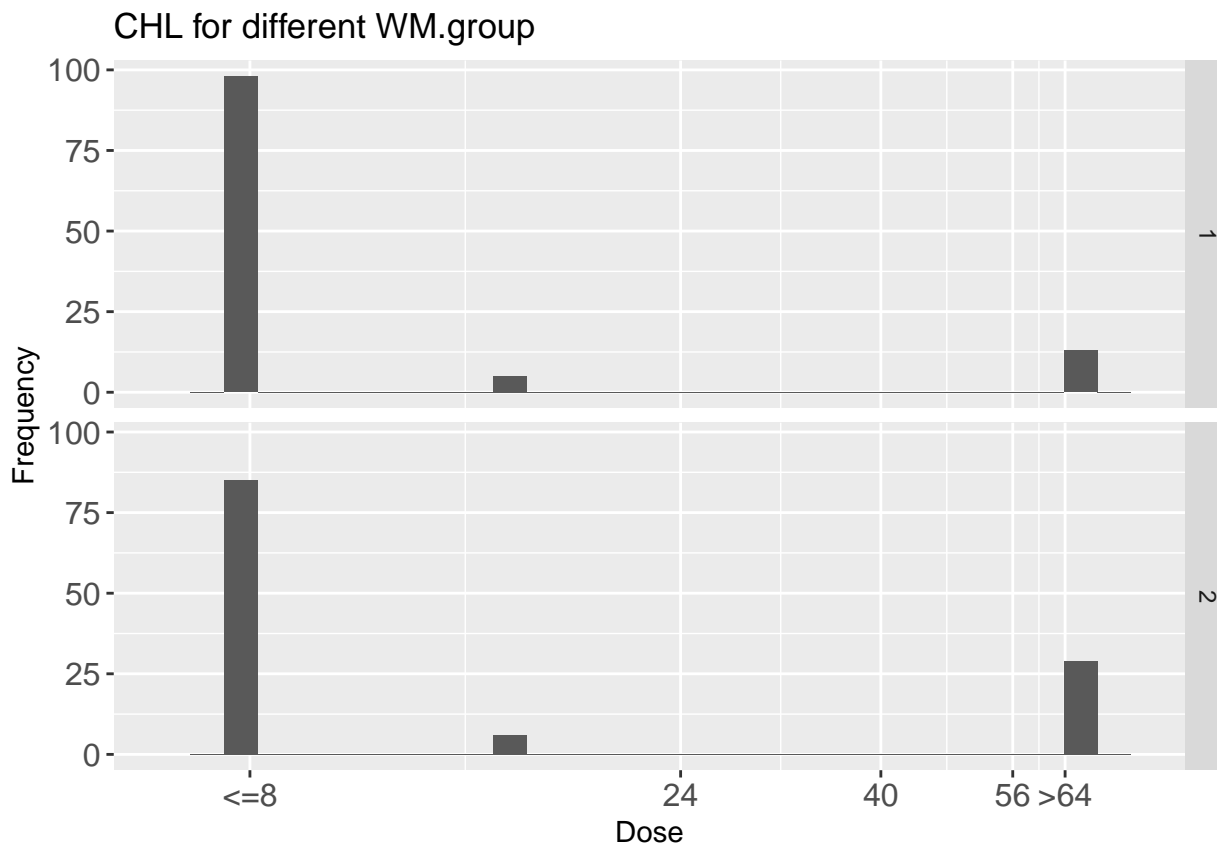
```
## [1] ""
```



Der Mittelwert ist tendenziell höher ohne WM.

```
graphisch("WM.group", "CHL", 8,64, 8,16)
```

```
## [1] "CHL - Resistance, WM      :"
## [1] "  Median      <= 8"
## [1] "  Mean   in  7.862 ... 14.621"
## [1] ""
## [1] "CHL - Resistance, no WM   :"
## [1] "  Median      <= 8"
## [1] "  Mean   in 16.267 ... 21.933"
## [1] ""
```



Der Mittelwert ist tendenziell höher ohne WM.

```
graphisch("WM.group", "NAL", 4,64, 4,16)
```

```
## [1] "NAL - Resistance, WM      :"
```

```
## [1] "  Median      <= 4"
```

```
## [1] "  Mean   in  2.276 ... 6.103"
```

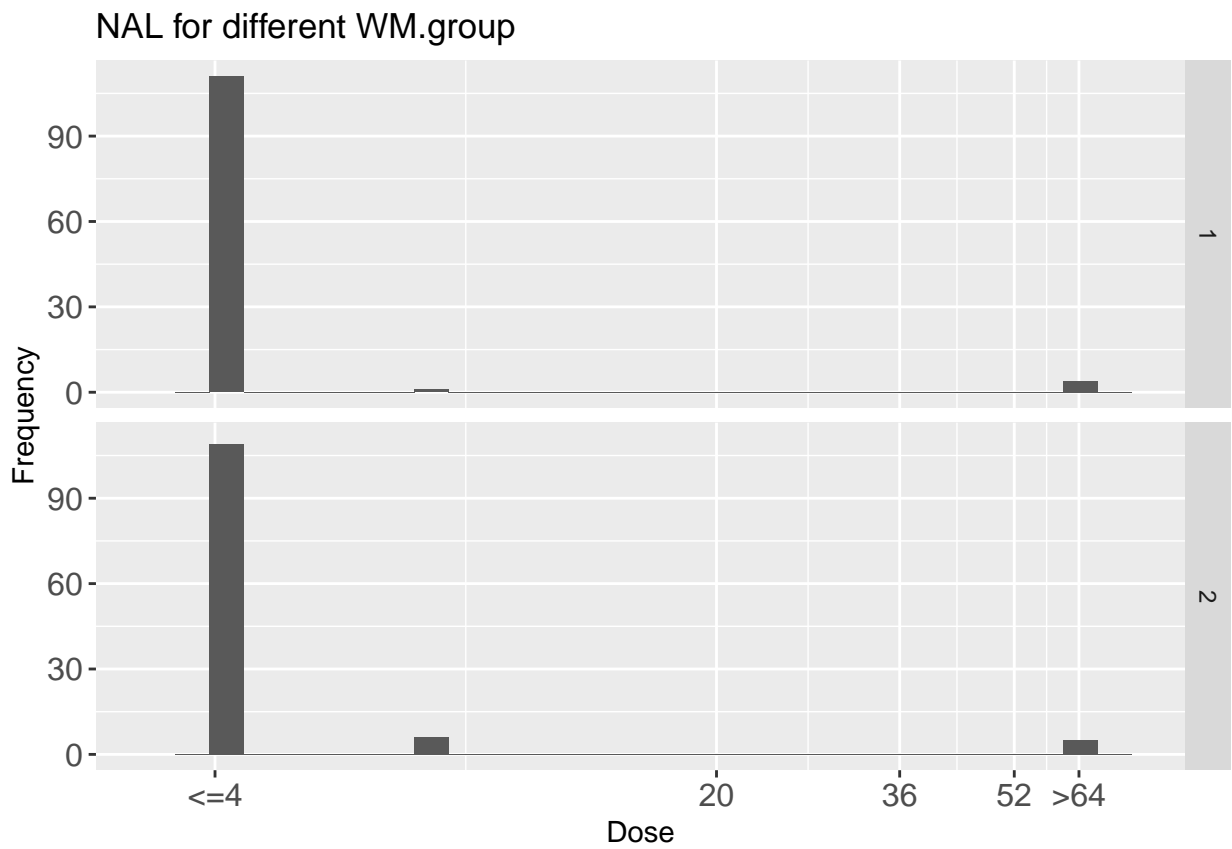
```
## [1] ""
```

```
## [1] "NAL - Resistance, no WM   :"
```

```
## [1] "  Median      <= 4"
```

```
## [1] "  Mean   in  3.067 ... 6.700"
```

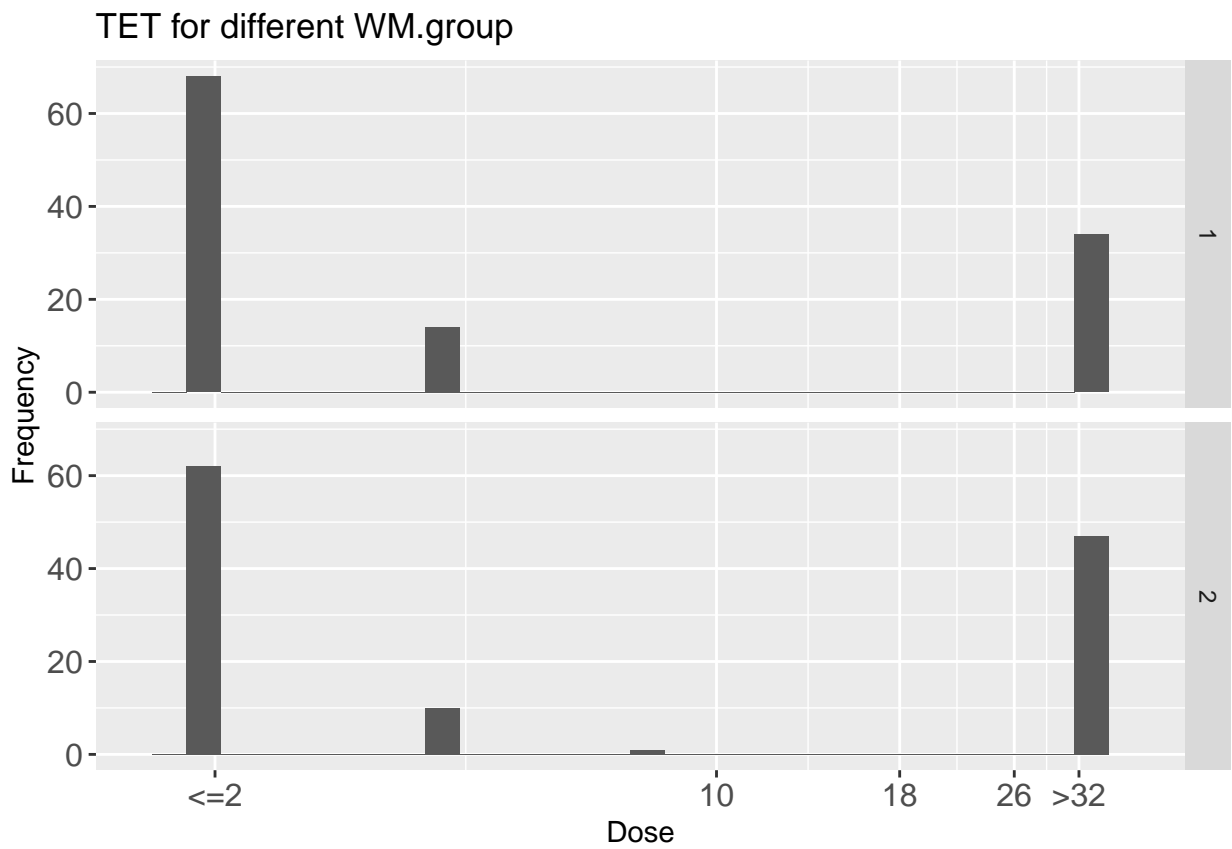
```
## [1] ""
```



Der Mittelwert ist tendenziell höher ohne WM.

```
graphisch("WM.group", "TET", 2,32, 2,8)
```

```
## [1] "TET - Resistance, WM      :"  
## [1] "  Median      <= 2"  
## [1] "  Mean   in  9.862 ... 11.034"  
## [1] ""  
## [1] "TET - Resistance, no WM   :"  
## [1] "  Median      <= 2"  
## [1] "  Mean   in 12.933 ... 13.967"  
## [1] ""
```



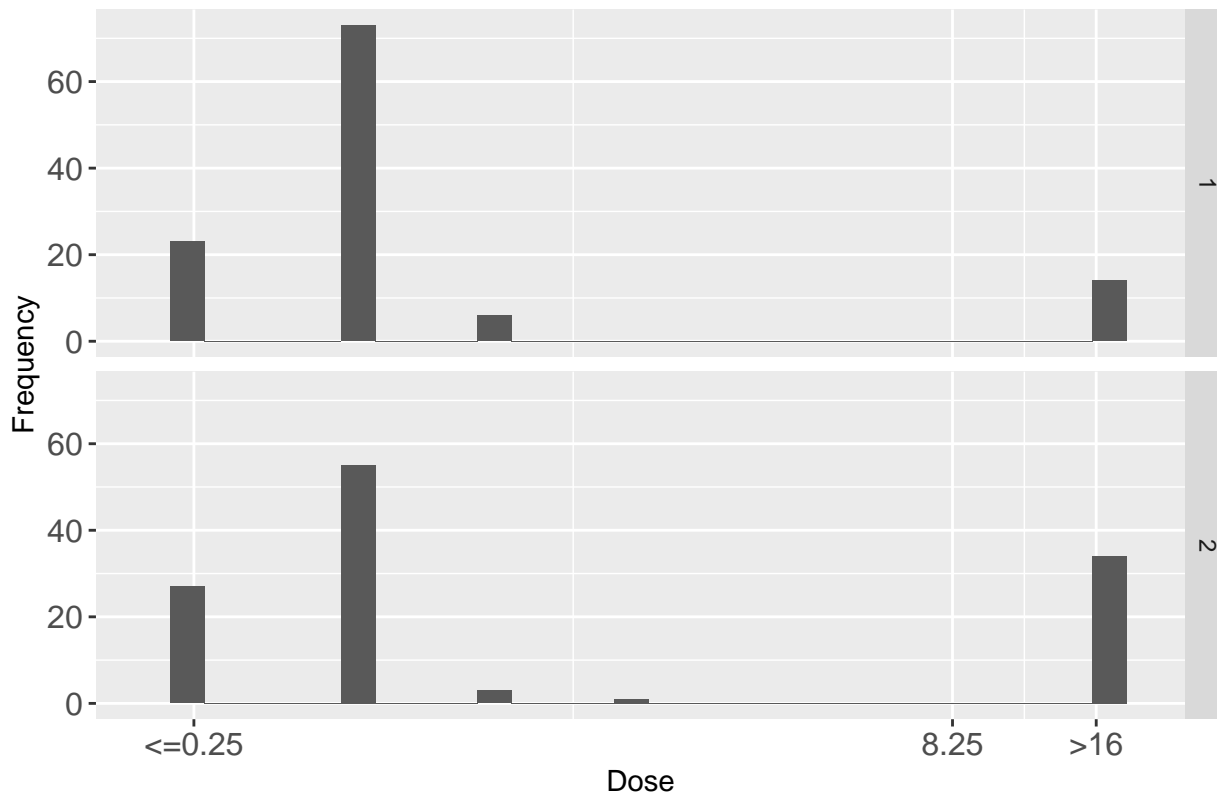
Der Mittelwert ist tendenziell höher ohne WM.

```
graphisch("WM.group", "TMP", 0.25,16, .25,8)
```

```
## [1] "TMP - Resistance, WM      :"  
## [1] "  Median      = 0.5"  
## [1] "  Mean   in  2.297 ... 2.347"  
## [1] ""  
## [1] "TMP - Resistance, no WM   :"  
## [1] "  Median      = 0.5"  
## [1] "  Mean   in  4.804 ... 4.860"  
## [1] ""
```



TMP for different WM.group

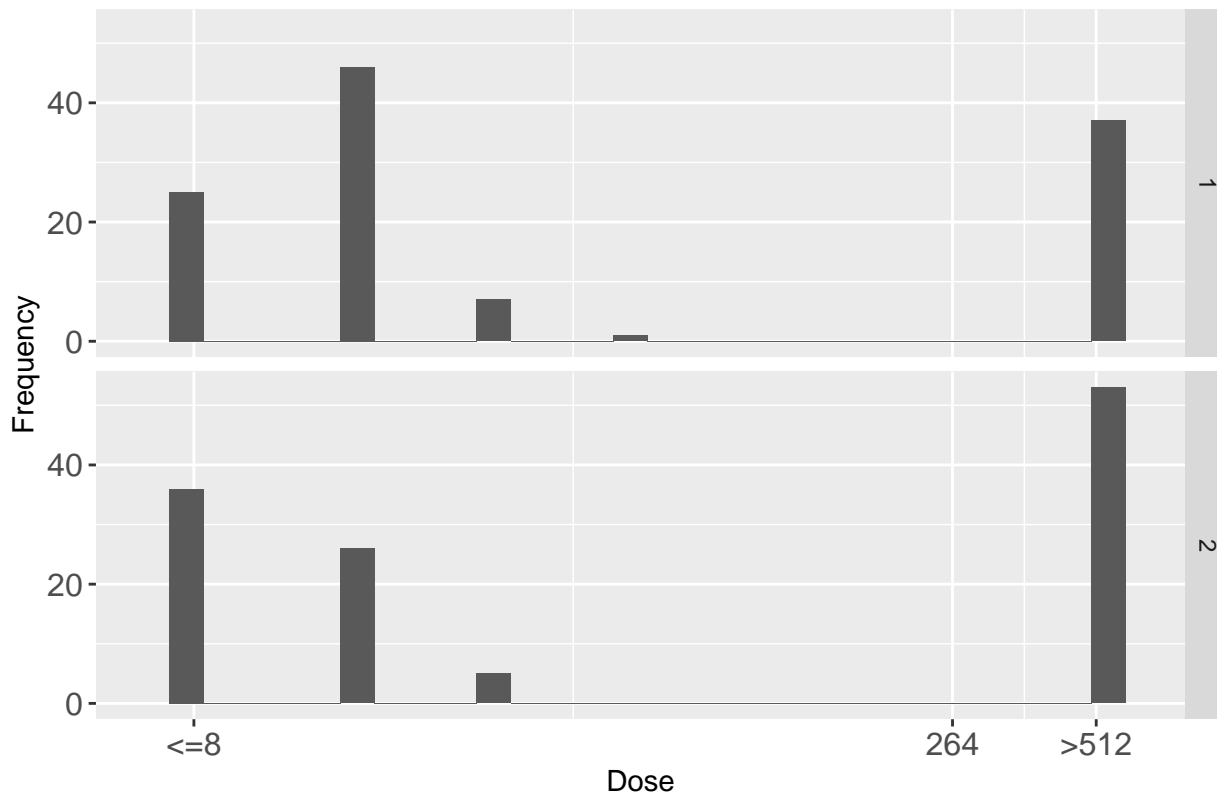


Der Mittelwert ist höher ohne WM.

```
graphisch("WM.group", "SMX", 8,512, 8,256)
```

```
## [1] "SMX - Resistance, WM      :"  
## [1] "  Median      = 16"  
## [1] "  Mean   in 172.138 ... 173.862"  
## [1] ""  
## [1] "SMX - Resistance, no WM   :"  
## [1] "  Median      = 16"  
## [1] "  Mean   in 230.933 ... 233.333"  
## [1] ""
```

## SMX for different WM.group



Der Mittelwert ist vergleichbar ohne WM.

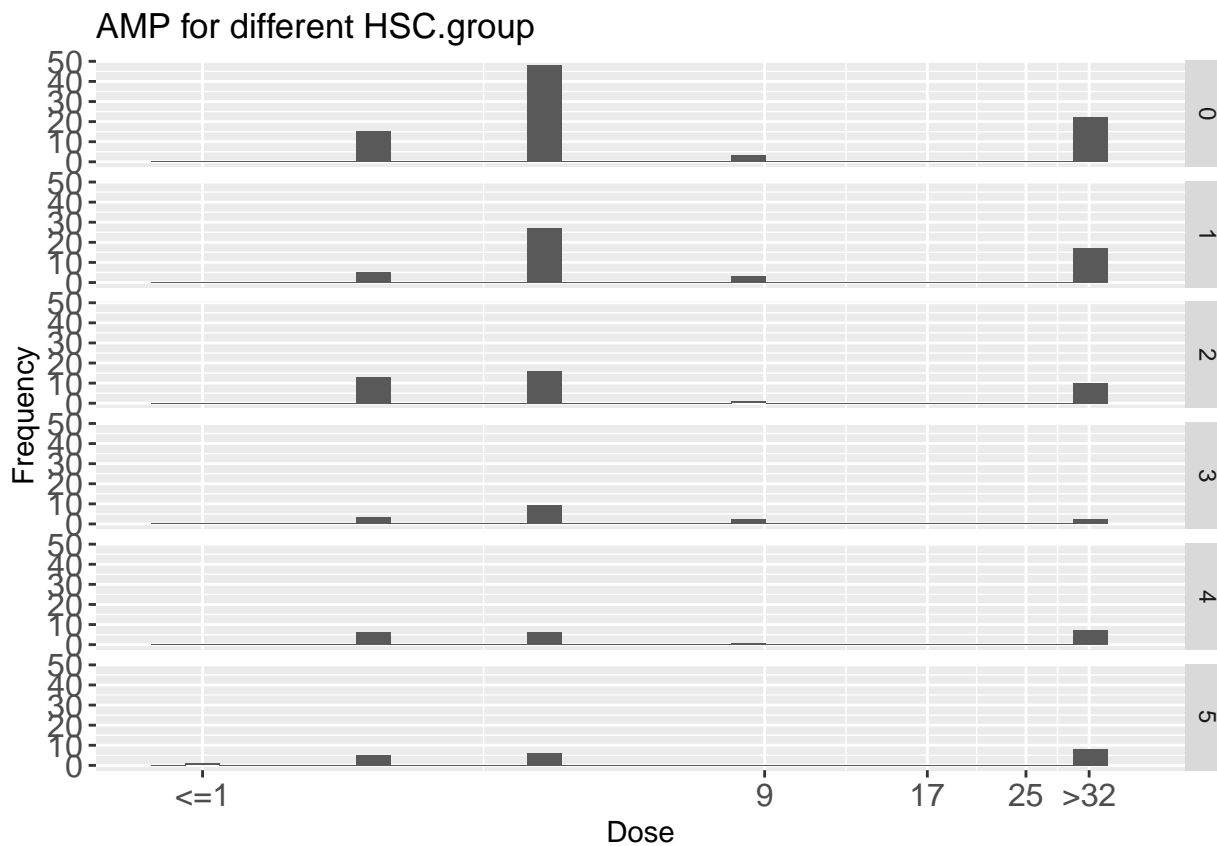
Die Mittelwerte der Resistenz sind für 5 Antibiotika vergleichbar (MERO, GEN, TGC, TAZ, SMX), für 3 Antibiotika tendenziell grösser im Fall WM (CIP, FOT, NAL) und für 5 Antibiotika definitiv grösser in diesem Fall (AMP, AZI, HCL, TET, TMP).

## Husbandry System Calves - Gruppen

Mit "HSC" abgekürzt.

```
graphisch("HSC.group", "AMP", 1,32, 1,8)
```

```
## [1] "AMP - Resistance, 0: stable w\\o outlet :"  
## [1] " Median = 4"  
## [1] " Mean = 10.795"  
## [1] ""  
## [1] "AMP - Resistance, 1: stable with outlet :"  
## [1] " Median = 4"  
## [1] " Mean = 13.192"  
## [1] ""  
## [1] "AMP - Resistance, 2: outdoors :"  
## [1] " Median = 4"  
## [1] " Mean = 10.450"  
## [1] ""  
## [1] "AMP - Resistance, 0+1 :"  
## [1] " Median = 4"  
## [1] " Mean = 7.625"  
## [1] ""  
## [1] "AMP - Resistance, 1+2 :"  
## [1] " Median = 4"  
## [1] " Mean = 13.400"  
## [1] ""  
## [1] "AMP - Resistance, 0+2 :"  
## [1] " Median = 4"  
## [1] " Mean in 14.500 ... 14.550"  
## [1] ""
```



```
graphisch("HSC.group", "MERO", 0.03 , -0.06, 0.015,0.015)
```

```
## [1] "MERO - Resistance, 0: stable w\\o outlet :"
```

```
## [1] "  Median          <= 0.03"
```

```
## [1] "  Mean   in 0.000 ... 0.030"
```

```
## [1] ""
```

```
## [1] "MERO - Resistance, 1: stable with outlet :"
```

```
## [1] "  Median          <= 0.03"
```

```
## [1] "  Mean   in 0.000 ... 0.030"
```

```
## [1] ""
```

```
## [1] "MERO - Resistance, 2: outdoors          :"
```

```
## [1] "  Median          <= 0.03"
```

```
## [1] "  Mean   in 0.000 ... 0.030"
```

```
## [1] ""
```

```
## [1] "MERO - Resistance, 0+1                    :"
```

```
## [1] "  Median          <= 0.03"
```

```
## [1] "  Mean   in 0.000 ... 0.030"
```

```
## [1] ""
```

```
## [1] "MERO - Resistance, 1+2                    :"
```

```
## [1] "  Median          <= 0.03"
```

```
## [1] "  Mean   in 0.000 ... 0.030"
```

```
## [1] ""
```

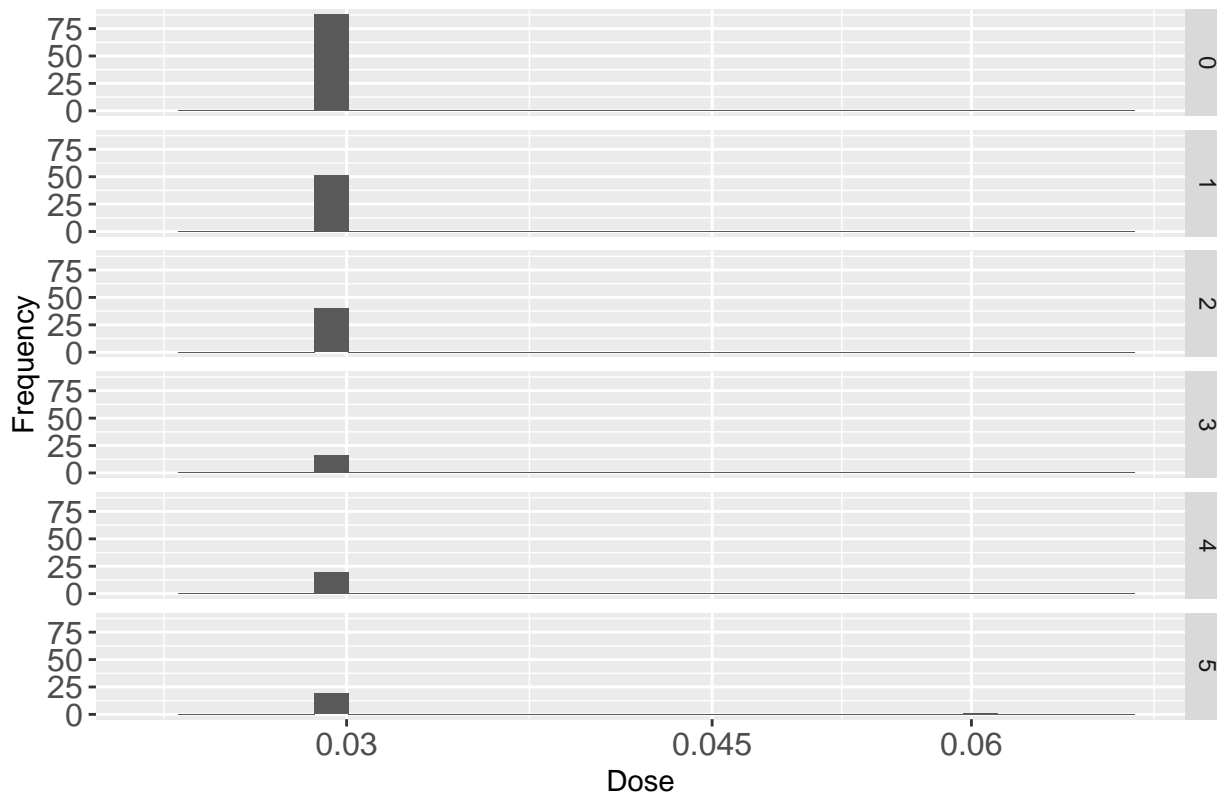
```
## [1] "MERO - Resistance, 0+2                    :"
```

```
## [1] "  Median          <= 0.03"
```

```
## [1] "  Mean   in 0.003 ... 0.032"
```

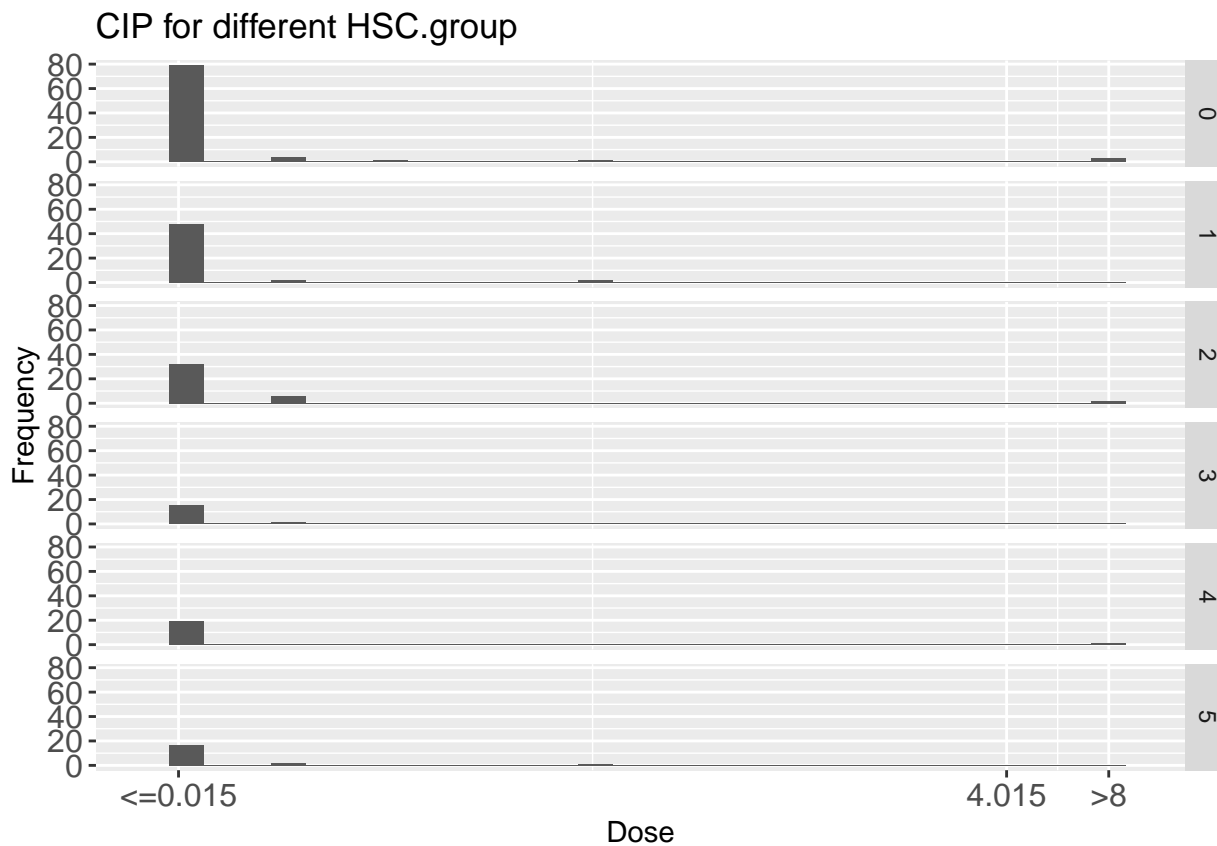
```
## [1] ""
```

MERO for different HSC.group



```
graphisch("HSC.group", "CIP" , 0.015, 8 , 0.015, 4 )
```

```
## [1] "CIP - Resistance, 0: stable w\\o outlet :"  
## [1] " Median          <= 0.015"  
## [1] " Mean   in  0.278 ... 0.291"  
## [1] ""  
## [1] "CIP - Resistance, 1: stable with outlet :"  
## [1] " Median          <= 0.015"  
## [1] " Mean   in  0.011 ... 0.025"  
## [1] ""  
## [1] "CIP - Resistance, 2: outdoors           :"  
## [1] " Median          <= 0.015"  
## [1] " Mean   in  0.405 ... 0.416"  
## [1] ""  
## [1] "CIP - Resistance, 0+1                   :"  
## [1] " Median          <= 0.015"  
## [1] " Mean   in  0.002 ... 0.016"  
## [1] ""  
## [1] "CIP - Resistance, 1+2                   :"  
## [1] " Median          <= 0.015"  
## [1] " Mean   in  0.400 ... 0.414"  
## [1] ""  
## [1] "CIP - Resistance, 0+2                   :"  
## [1] " Median          <= 0.015"  
## [1] " Mean   in  0.015 ... 0.028"  
## [1] ""
```



```
graphisch("HSC.group", "AZI" , 2 , 64 , 1 , 10 )
```

```
## [1] "AZI - Resistance, 0: stable w\\o outlet :"
```

```
## [1] "  Median          = 8"
```

```
## [1] "  Mean   in  7.636 ... 7.659"
```

```
## [1] ""
```

```
## [1] "AZI - Resistance, 1: stable with outlet :"
```

```
## [1] "  Median          = 8"
```

```
## [1] "  Mean   in  6.462 ... 6.538"
```

```
## [1] ""
```

```
## [1] "AZI - Resistance, 2: outdoors           :"
```

```
## [1] "  Median          = 8"
```

```
## [1] "  Mean   in  6.600 ... 6.700"
```

```
## [1] ""
```

```
## [1] "AZI - Resistance, 0+1                   :"
```

```
## [1] "  Median          = 8"
```

```
## [1] "  Mean   =  6.500"
```

```
## [1] ""
```

```
## [1] "AZI - Resistance, 1+2                   :"
```

```
## [1] "  Median          = 8"
```

```
## [1] "  Mean   in  8.200 ... 8.300"
```

```
## [1] ""
```

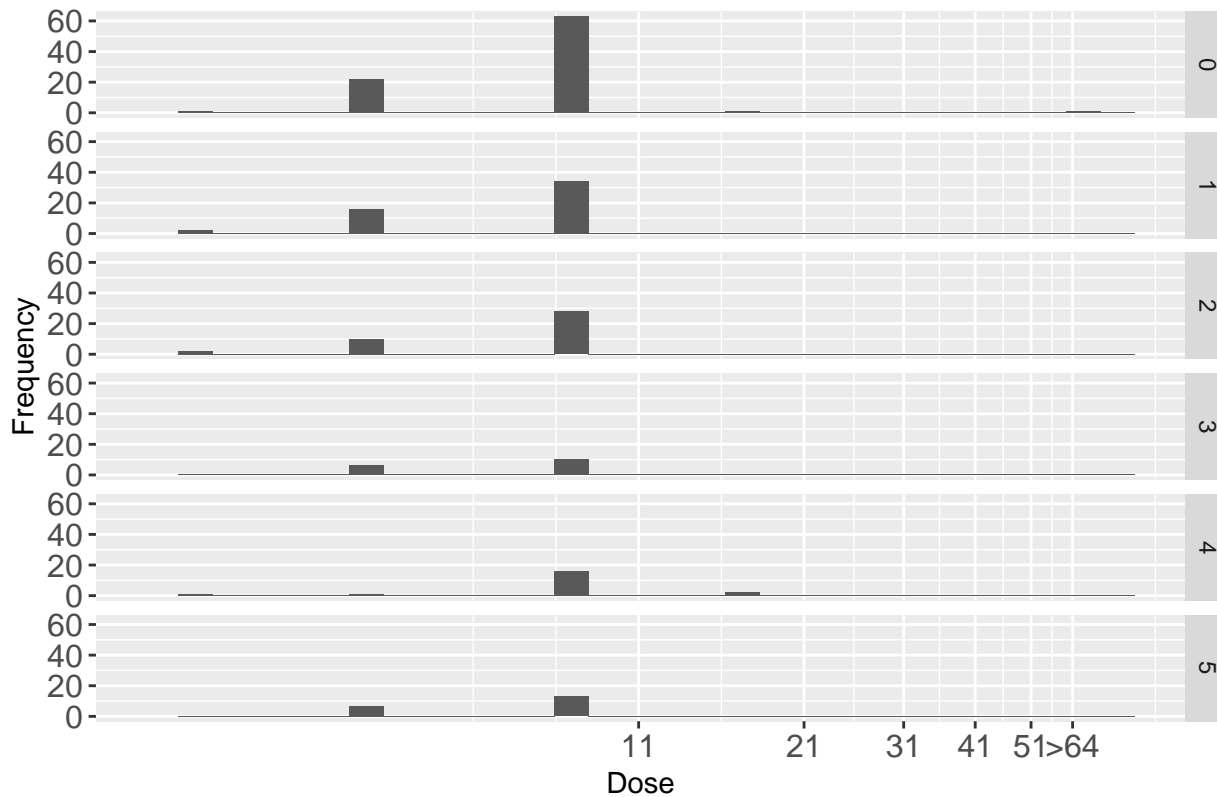
```
## [1] "AZI - Resistance, 0+2                   :"
```

```
## [1] "  Median          = 8"
```

```
## [1] "  Mean   =  6.600"
```

```
## [1] ""
```

AZI for different HSC.group



```
graphisch("HSC.group", "GEN" , 0.5 , 16 , 0.5 , 4 )
```

```
## [1] "GEN - Resistance, 0: stable w\\o outlet :"
```

```
## [1] "  Median          <= 0.5"
```

```
## [1] "  Mean   in  0.557 ... 0.989"
```

```
## [1] ""
```

```
## [1] "GEN - Resistance, 1: stable with outlet :"
```

```
## [1] "  Median          <= 0.5"
```

```
## [1] "  Mean   in  1.481 ... 1.875"
```

```
## [1] ""
```

```
## [1] "GEN - Resistance, 2: outdoors          :"
```

```
## [1] "  Median          <= 0.5"
```

```
## [1] "  Mean   in  2.575 ... 2.925"
```

```
## [1] ""
```

```
## [1] "GEN - Resistance, 0+1                    :"
```

```
## [1] "  Median          <= 0.5"
```

```
## [1] "  Mean   in  0.062 ... 0.531"
```

```
## [1] ""
```

```
## [1] "GEN - Resistance, 1+2                    :"
```

```
## [1] "  Median          <= 0.5"
```

```
## [1] "  Mean   in  0.050 ... 0.525"
```

```
## [1] ""
```

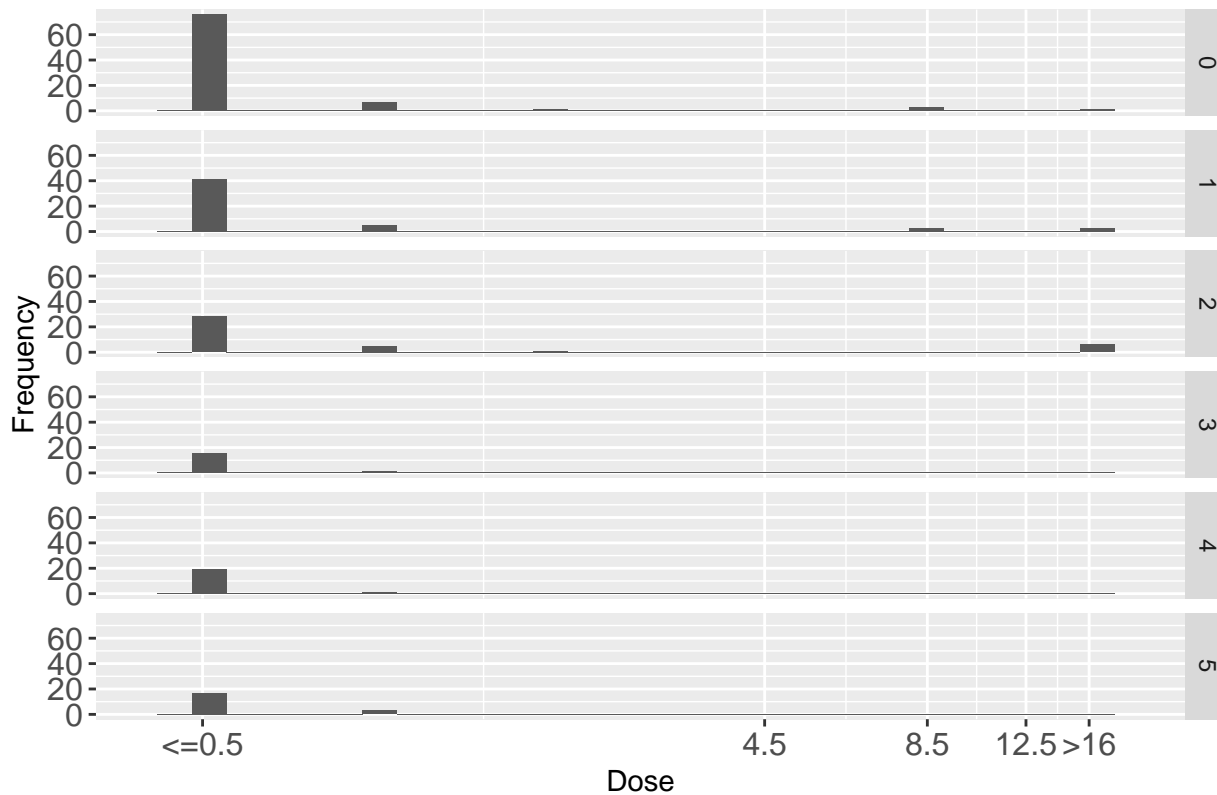
```
## [1] "GEN - Resistance, 0+2                    :"
```

```
## [1] "  Median          <= 0.5"
```

```
## [1] "  Mean   in  0.150 ... 0.575"
```

```
## [1] ""
```

## GEN for different HSC.group



```
graphisch("HSC.group", "TGC" , 0.25 , -0.5 , 0.25 , 0.25 )
```

```
## [1] "TGC - Resistance, 0: stable w\\o outlet :"
```

```
## [1] "  Median          <= 0.25"
```

```
## [1] "  Mean   in  0.040 ... 0.270"
```

```
## [1] ""
```

```
## [1] "TGC - Resistance, 1: stable with outlet :"
```

```
## [1] "  Median          <= 0.25"
```

```
## [1] "  Mean   in  0.096 ... 0.298"
```

```
## [1] ""
```

```
## [1] "TGC - Resistance, 2: outdoors          :"
```

```
## [1] "  Median          <= 0.25"
```

```
## [1] "  Mean   in  0.013 ... 0.256"
```

```
## [1] ""
```

```
## [1] "TGC - Resistance, 0+1                    :"
```

```
## [1] "  Median          <= 0.25"
```

```
## [1] "  Mean   in  0.062 ... 0.281"
```

```
## [1] ""
```

```
## [1] "TGC - Resistance, 1+2                    :"
```

```
## [1] "  Median          <= 0.25"
```

```
## [1] "  Mean   in  0.075 ... 0.287"
```

```
## [1] ""
```

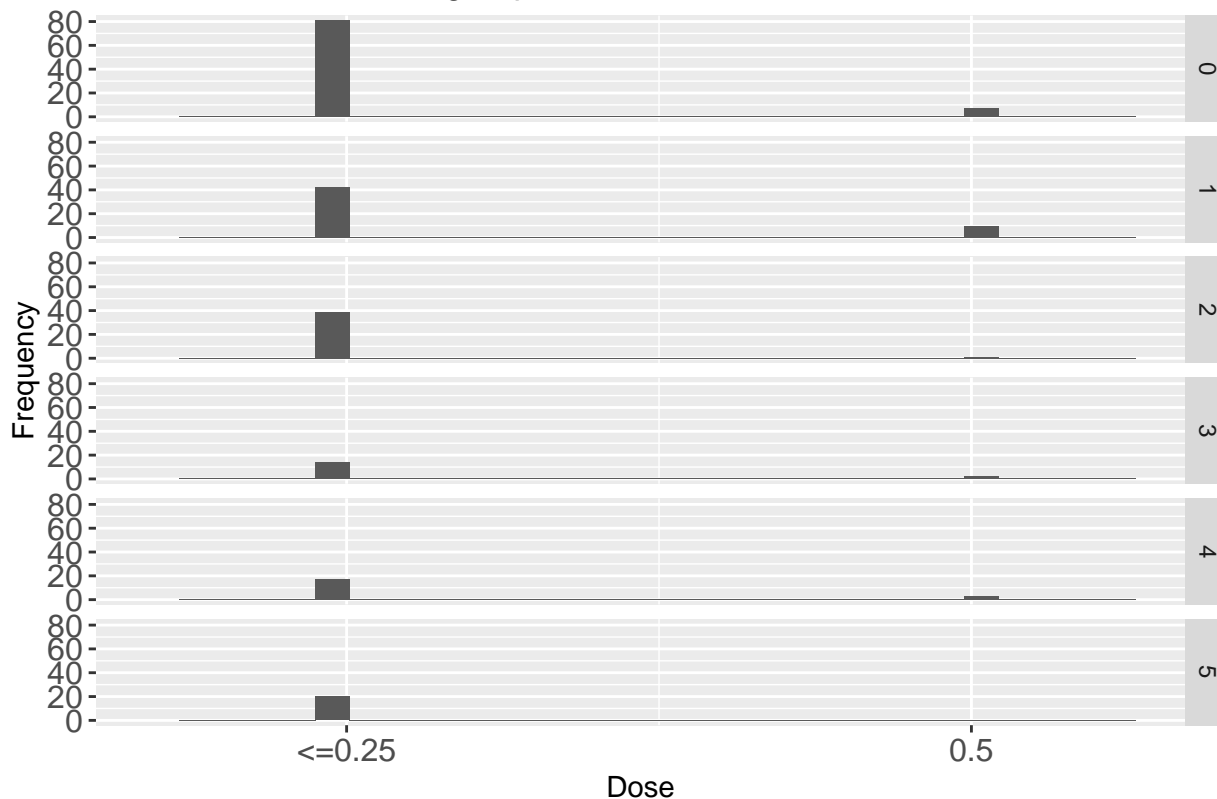
```
## [1] "TGC - Resistance, 0+2                    :"
```

```
## [1] "  Median          <= 0.25"
```

```
## [1] "  Mean   in  0.000 ... 0.250"
```

```
## [1] ""
```

TGC for different HSC.group



```
graphisch("HSC.group", "TAZ" , 0.25 , -1 , 0.25 , 0.25 )
```

```
## [1] "TAZ - Resistance, 0: stable w\\o outlet :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.034 ... 0.276"
```

```
## [1] ""
```

```
## [1] "TAZ - Resistance, 1: stable with outlet :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.000 ... 0.250"
```

```
## [1] ""
```

```
## [1] "TAZ - Resistance, 2: outdoors          :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.025 ... 0.263"
```

```
## [1] ""
```

```
## [1] "TAZ - Resistance, 0+1                  :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.031 ... 0.266"
```

```
## [1] ""
```

```
## [1] "TAZ - Resistance, 1+2                  :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.025 ... 0.263"
```

```
## [1] ""
```

```
## [1] "TAZ - Resistance, 0+2                  :"
```

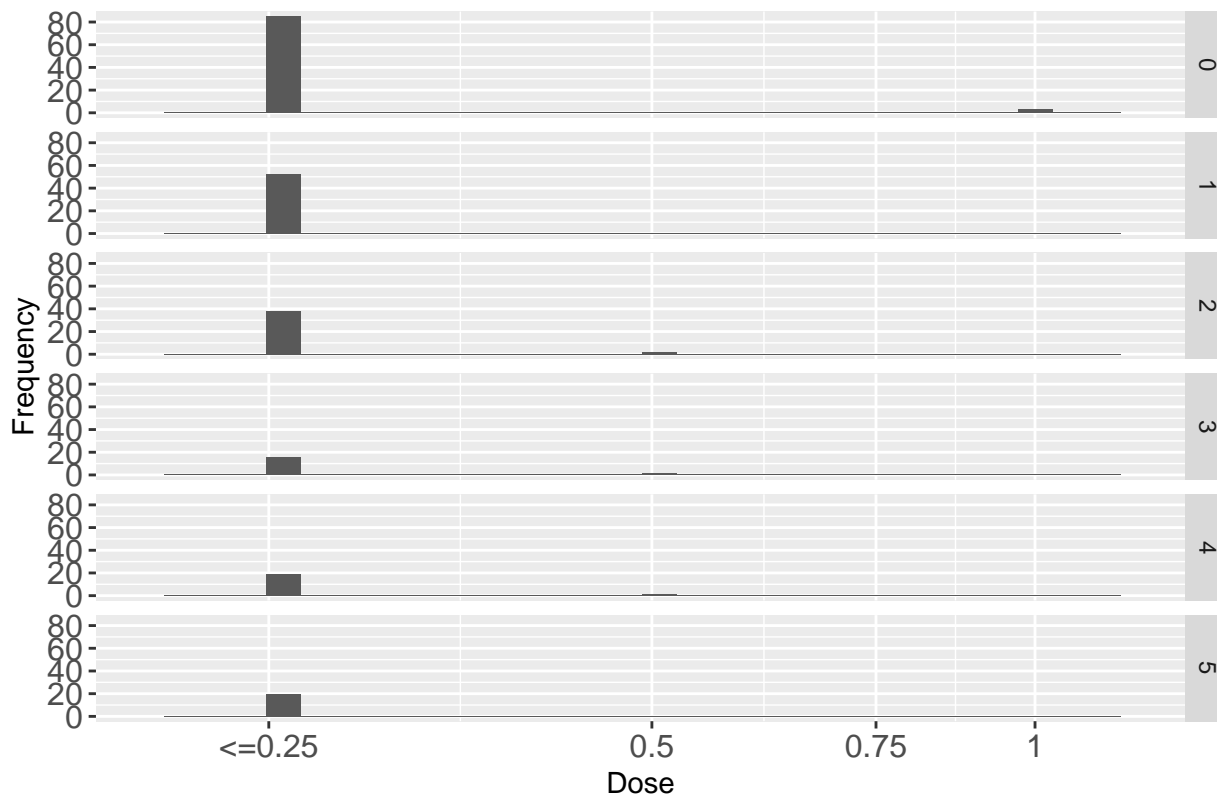
```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.000 ... 0.250"
```

```
## [1] ""
```



TAZ for different HSC.group



```
graphisch("HSC.group", "FOT" , 0.25 , 4 , 0.25 , 1 )
```

```
## [1] "FOT - Resistance, 0: stable w\\o outlet :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.136 ... 0.378"
```

```
## [1] ""
```

```
## [1] "FOT - Resistance, 1: stable with outlet :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.010 ... 0.255"
```

```
## [1] ""
```

```
## [1] "FOT - Resistance, 2: outdoors          :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.000 ... 0.250"
```

```
## [1] ""
```

```
## [1] "FOT - Resistance, 0+1                    :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.000 ... 0.250"
```

```
## [1] ""
```

```
## [1] "FOT - Resistance, 1+2                    :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.000 ... 0.250"
```

```
## [1] ""
```

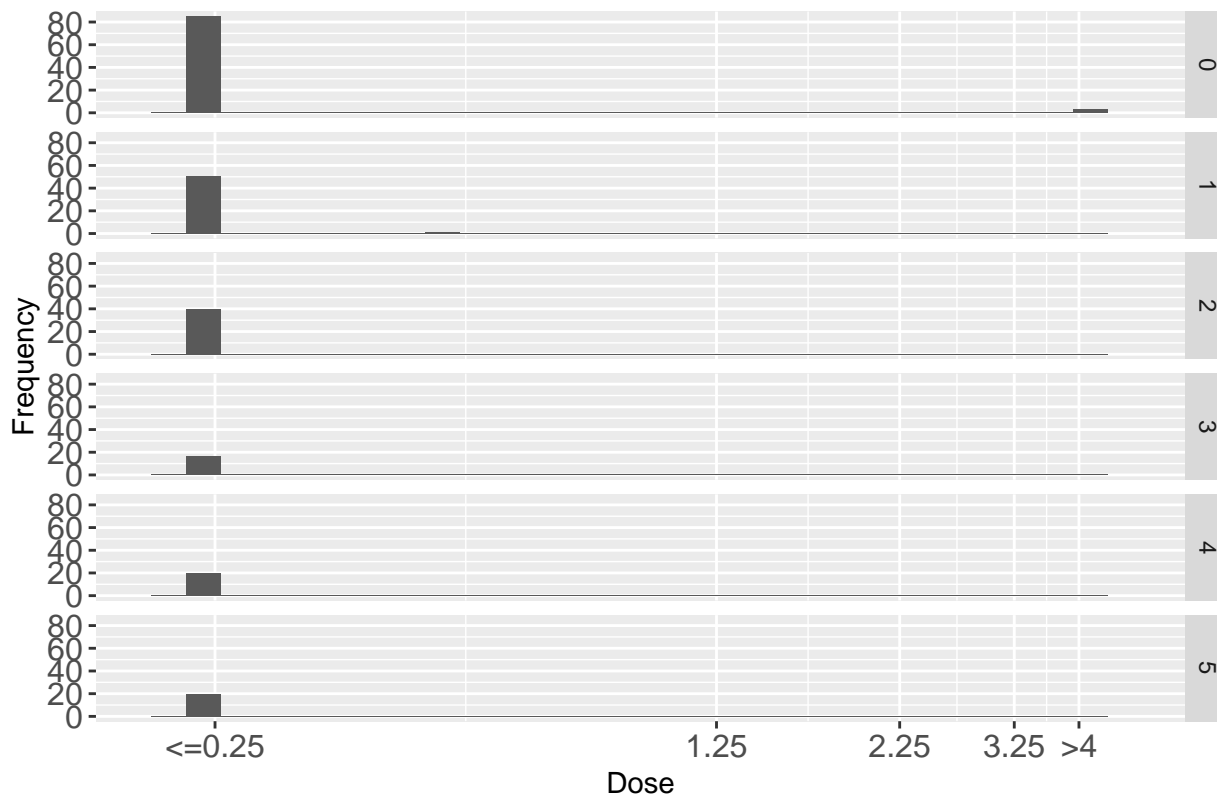
```
## [1] "FOT - Resistance, 0+2                    :"
```

```
## [1] "  Median      <= 0.25"
```

```
## [1] "  Mean   in  0.000 ... 0.250"
```

```
## [1] ""
```

FOT for different HSC.group



```
graphisch("HSC.group", "CHL" , 8 , 64 , 8,16 )
```

```
## [1] "CHL - Resistance, 0: stable w\\o outlet :"
```

```
## [1] "  Median          <= 8"
```

```
## [1] "  Mean   in 13.455 ... 19.636"
```

```
## [1] ""
```

```
## [1] "CHL - Resistance, 1: stable with outlet :"
```

```
## [1] "  Median          <= 8"
```

```
## [1] "  Mean   in 16.000 ... 21.538"
```

```
## [1] ""
```

```
## [1] "CHL - Resistance, 2: outdoors          :"
```

```
## [1] "  Median          <= 8"
```

```
## [1] "  Mean   in  8.800 ... 15.400"
```

```
## [1] ""
```

```
## [1] "CHL - Resistance, 0+1                    :"
```

```
## [1] "  Median          <= 8"
```

```
## [1] "  Mean   in  2.000 ...  9.000"
```

```
## [1] ""
```

```
## [1] "CHL - Resistance, 1+2                    :"
```

```
## [1] "  Median          <= 8"
```

```
## [1] "  Mean   in  6.400 ... 13.600"
```

```
## [1] ""
```

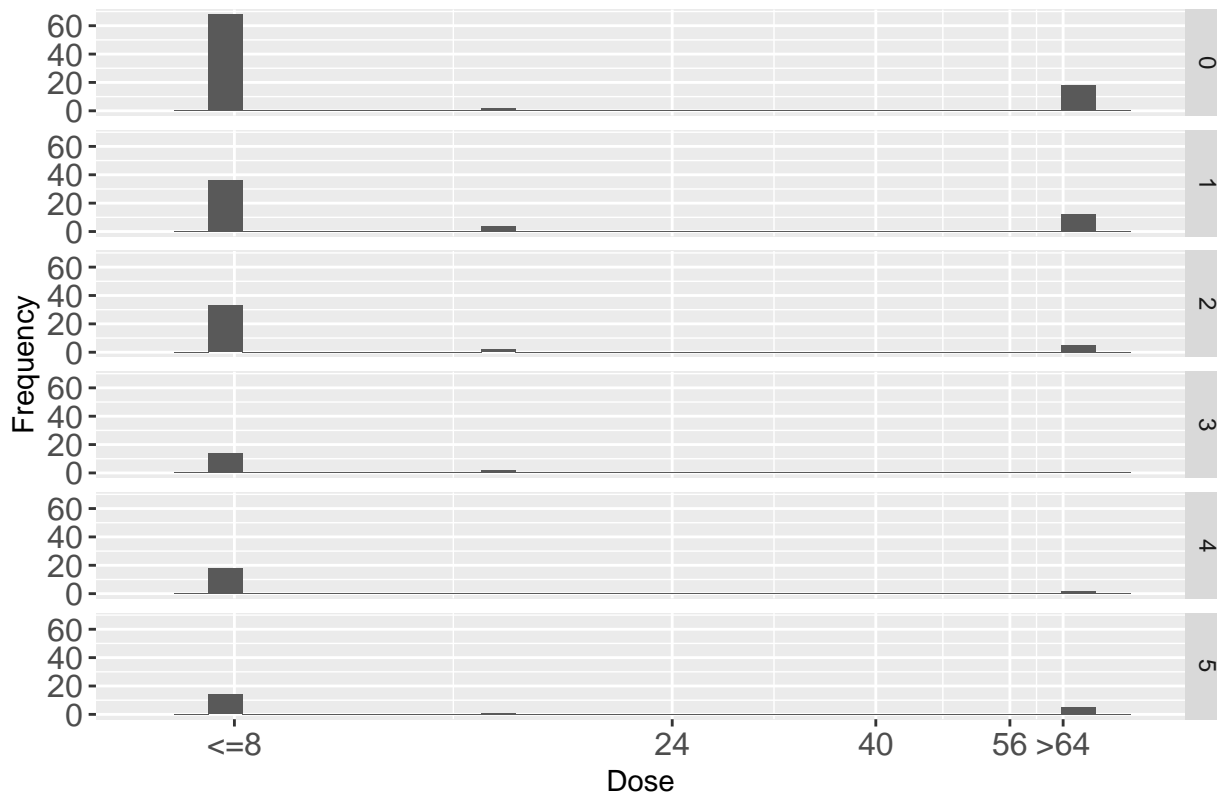
```
## [1] "CHL - Resistance, 0+2                    :"
```

```
## [1] "  Median          <= 8"
```

```
## [1] "  Mean   in 16.800 ... 22.400"
```

```
## [1] ""
```

CHL for different HSC.group



```
graphisch("HSC.group", "NAL" , 4 , 64 , 4,16 )
```

```
## [1] "NAL - Resistance, 0: stable w\\o outlet :"
```

```
## [1] "  Median      <= 4"
```

```
## [1] "  Mean   in  2.364 ... 6.136"
```

```
## [1] ""
```

```
## [1] "NAL - Resistance, 1: stable with outlet :"
```

```
## [1] "  Median      <= 4"
```

```
## [1] "  Mean   in  2.462 ... 6.308"
```

```
## [1] ""
```

```
## [1] "NAL - Resistance, 2: outdoors          :"
```

```
## [1] "  Median      <= 4"
```

```
## [1] "  Mean   in  3.800 ... 7.300"
```

```
## [1] ""
```

```
## [1] "NAL - Resistance, 0+1                  :"
```

```
## [1] "  Median      <= 4"
```

```
## [1] "  Mean   in  0.000 ... 4.000"
```

```
## [1] ""
```

```
## [1] "NAL - Resistance, 1+2                  :"
```

```
## [1] "  Median      <= 4"
```

```
## [1] "  Mean   in  3.200 ... 7.000"
```

```
## [1] ""
```

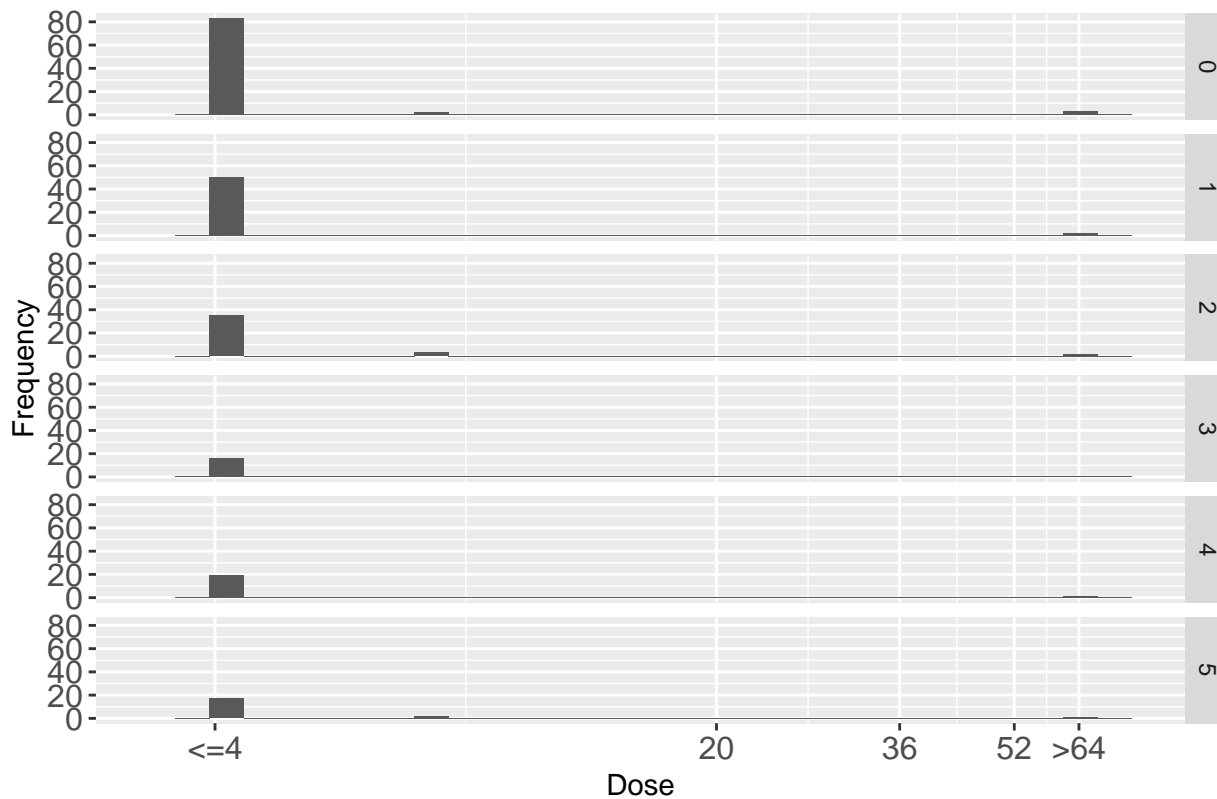
```
## [1] "NAL - Resistance, 0+2                  :"
```

```
## [1] "  Median      <= 4"
```

```
## [1] "  Mean   in  4.000 ... 7.400"
```

```
## [1] ""
```

NAL for different HSC.group



```
graphisch("HSC.group", "TET" , 2 , 32 , 2,8 )
```

```
## [1] "TET - Resistance, 0: stable w\\o outlet :"
```

```
## [1] "  Median      <= 2"
```

```
## [1] "  Mean   in 10.136 ... 11.364"
```

```
## [1] ""
```

```
## [1] "TET - Resistance, 1: stable with outlet :"
```

```
## [1] "  Median      = 4"
```

```
## [1] "  Mean   in 12.538 ... 13.385"
```

```
## [1] ""
```

```
## [1] "TET - Resistance, 2: outdoors          :"
```

```
## [1] "  Median      <= 2"
```

```
## [1] "  Mean   in 10.100 ... 11.300"
```

```
## [1] ""
```

```
## [1] "TET - Resistance, 0+1                  :"
```

```
## [1] "  Median      <= 2"
```

```
## [1] "  Mean   in 12.000 ... 13.250"
```

```
## [1] ""
```

```
## [1] "TET - Resistance, 1+2                  :"
```

```
## [1] "  Median      <= 2"
```

```
## [1] "  Mean   in 10.000 ... 11.200"
```

```
## [1] ""
```

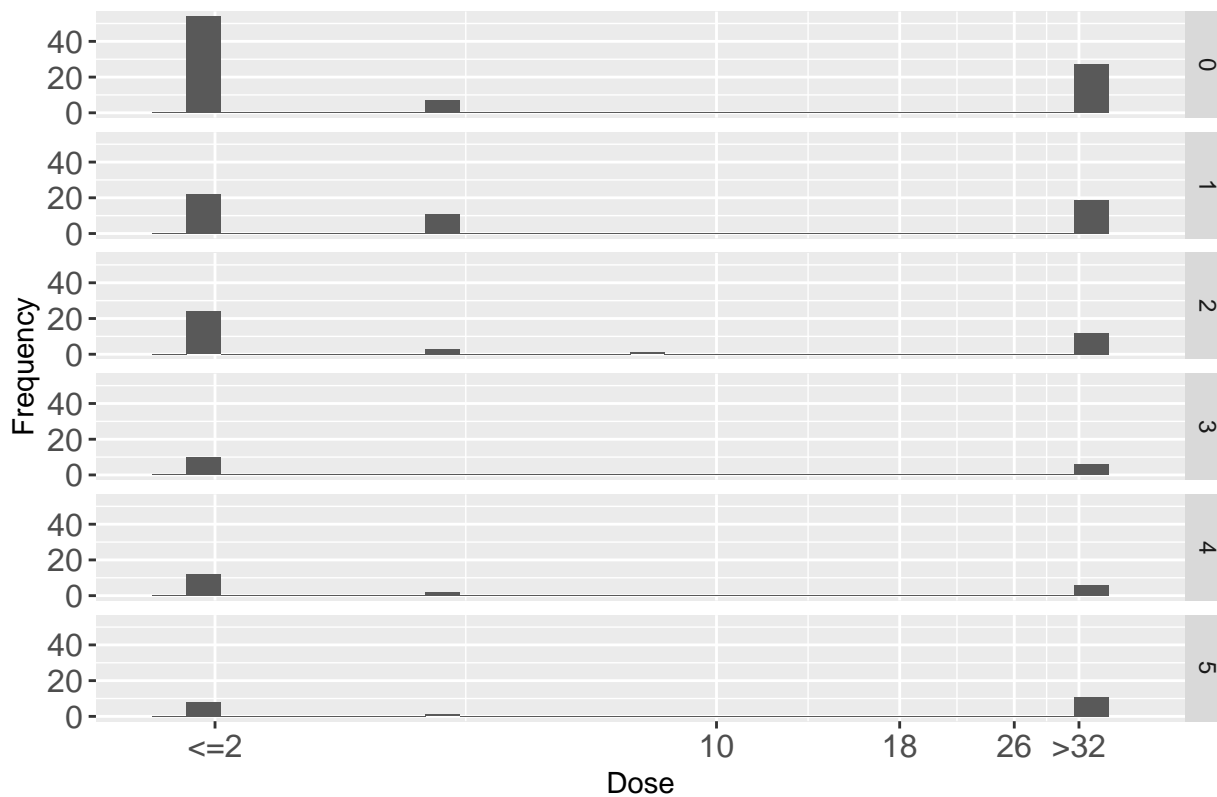
```
## [1] "TET - Resistance, 0+2                  :"
```

```
## [1] "  Median      > 32"
```

```
## [1] "  Mean   in 17.800 ... 18.600"
```

```
## [1] ""
```

TET for different HSC.group



```
graphisch("HSC.group", "TMP" , 0.25 , 16 , 0.25,8 )
```

```
## [1] "TMP - Resistance, 0: stable w\\o outlet :"
```

```
## [1] "  Median          = 0.5"
```

```
## [1] "  Mean   in  2.915 ... 2.963"
```

```
## [1] ""
```

```
## [1] "TMP - Resistance, 1: stable with outlet :"
```

```
## [1] "  Median          = 0.5"
```

```
## [1] "  Mean   in  4.279 ... 4.332"
```

```
## [1] ""
```

```
## [1] "TMP - Resistance, 2: outdoors           :"
```

```
## [1] "  Median          = 0.5"
```

```
## [1] "  Mean   in  3.875 ... 3.931"
```

```
## [1] ""
```

```
## [1] "TMP - Resistance, 0+1                   :"
```

```
## [1] "  Median          = 0.5"
```

```
## [1] "  Mean   in  1.438 ... 1.469"
```

```
## [1] ""
```

```
## [1] "TMP - Resistance, 1+2                   :"
```

```
## [1] "  Median          = 0.5"
```

```
## [1] "  Mean   in  5.900 ... 5.938"
```

```
## [1] ""
```

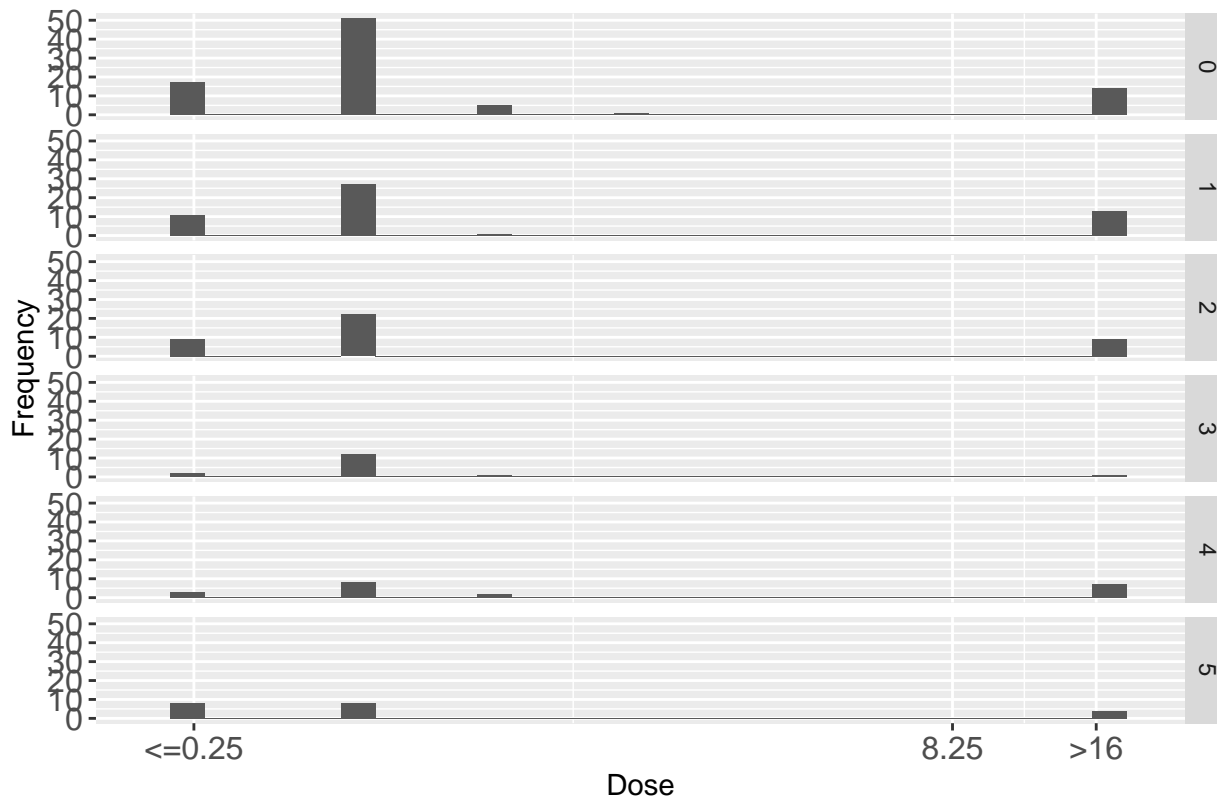
```
## [1] "TMP - Resistance, 0+2                   :"
```

```
## [1] "  Median          = 0.5"
```

```
## [1] "  Mean   in  3.400 ... 3.500"
```

```
## [1] ""
```

TMP for different HSC.group



```
graphisch("HSC.group", "SMX" , 8 , 512 , 8,256 )
```

```
## [1] "SMX - Resistance, 0: stable w\\o outlet :"
```

```
## [1] "  Median          = 16"
```

```
## [1] "  Mean   in 199.455 ... 201.455"
```

```
## [1] ""
```

```
## [1] "SMX - Resistance, 1: stable with outlet :"
```

```
## [1] "  Median          = 16"
```

```
## [1] "  Mean   in 212.615 ... 214.769"
```

```
## [1] ""
```

```
## [1] "SMX - Resistance, 2: outdoors           :"
```

```
## [1] "  Median          = 16"
```

```
## [1] "  Mean   in 160.400 ... 163.000"
```

```
## [1] ""
```

```
## [1] "SMX - Resistance, 0+1                   :"
```

```
## [1] "  Median          = 16"
```

```
## [1] "  Mean   in 199.000 ... 200.500"
```

```
## [1] ""
```

```
## [1] "SMX - Resistance, 1+2                   :"
```

```
## [1] "  Median          = 32"
```

```
## [1] "  Mean   in 214.400 ... 215.600"
```

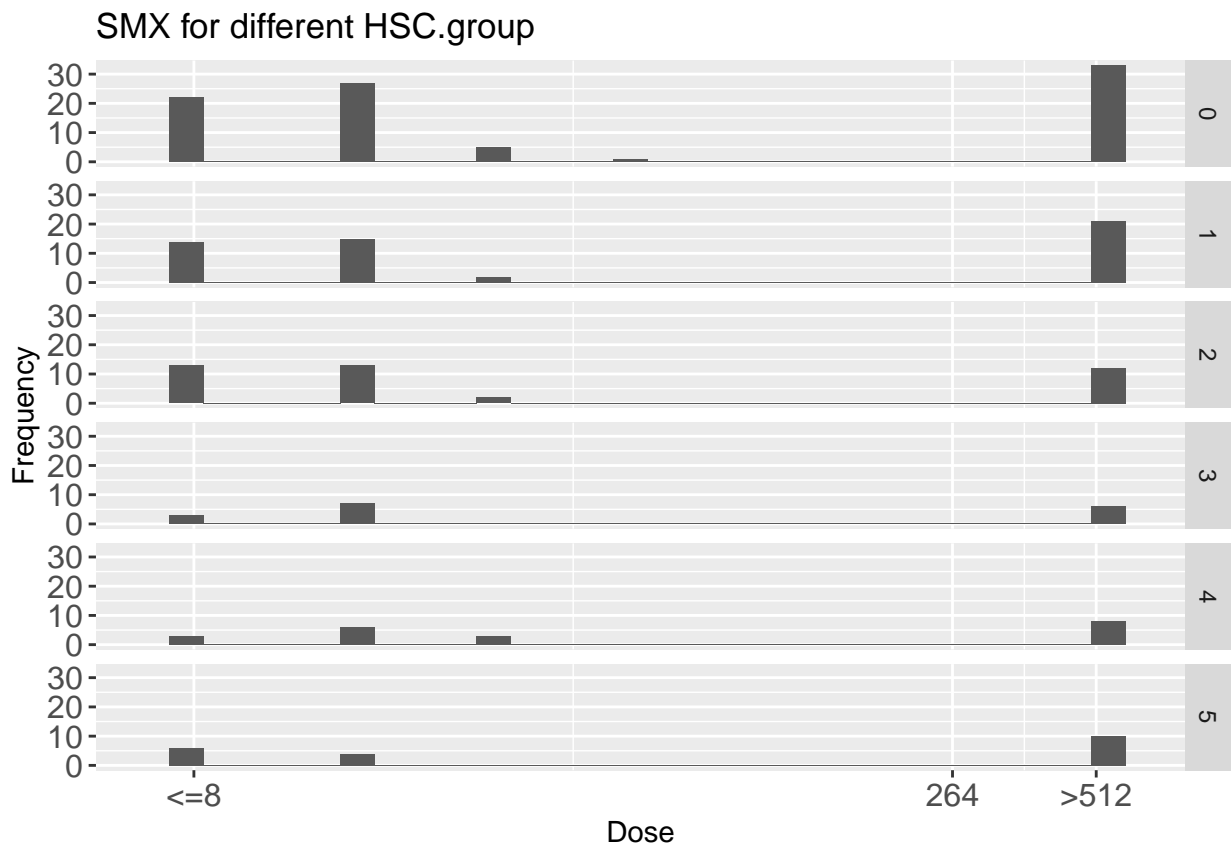
```
## [1] ""
```

```
## [1] "SMX - Resistance, 0+2                   :"
```

```
## [1] "  Median          = 264"
```

```
## [1] "  Mean   in 259.200 ... 261.600"
```

```
## [1] ""
```



Es ist kein sehr ausgeprägtes Muster für grösste/kleinste Resistenzen zu erkennen. Tendenziell ergeben 1 und 1+2 die grössten Resistenzen, 2 und vor allem 0+1 die kleinsten.

## Vollständigkeit

Jetzt sind alle Verteilungen geplottet und deskriptiv analysiert, ausser:

- AMI: alle Proben sensitiv <=4
- COL: alle Proben sensitiv <=1

## Weitere Schritte

### Technischer Natur

- ??

### Fundamentaler Natur

Kausalitäten studieren mittels Regressionen :

- Kausalitätsgraph
- Lineare Regressionen?
- multivariable logistische Regression ... mixed effects?

- vs Assoziation:
  - Vorlesung Christian: “Kausalität nur wenn immer der Fall”-!?
  - Buch Scutari: ??