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 raussschreiben 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);Vie
```

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) {
```

```r
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 "<=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("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("")
    }
  }
}

DF2 <- Resistenzen

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)) +
```

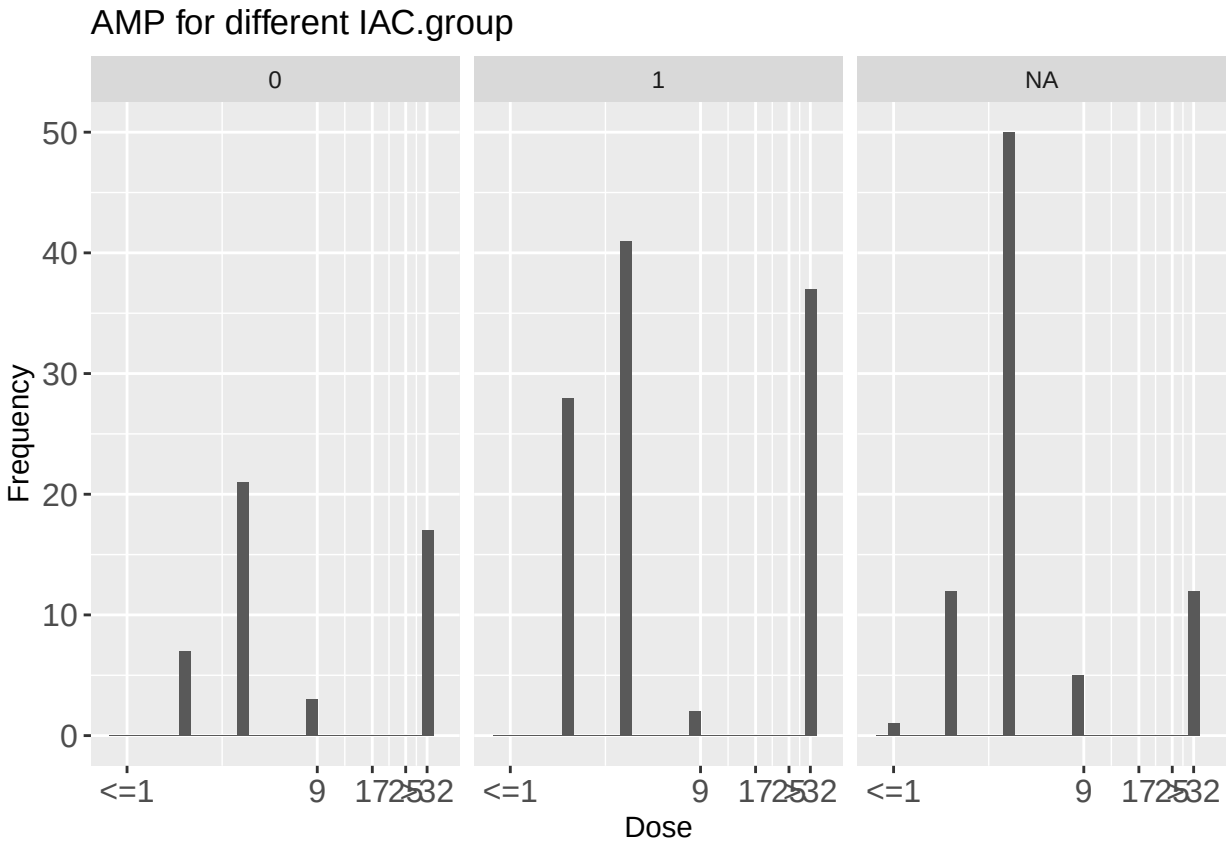
```
    theme(axis.text.y = element_text(size=12)) +
    xlab(Xlab) + ylab(Ylab)                    +

    #facet_grid(reformulate(".",groups))    +     # vertical stack  : reformulate gibt Formel (IAC.group ~ .)  etc
    facet_grid(reformulate(groups,"."))    +      # horizontal stack: reformulate gibt Formel (. ~ IAC.group)  etc

    ggtitle(paste(antib,"for different",groups))
  print(plot)
}
```

Ill Animals in Calving Box - Gruppen

Mit “IAC” abgekürzt.

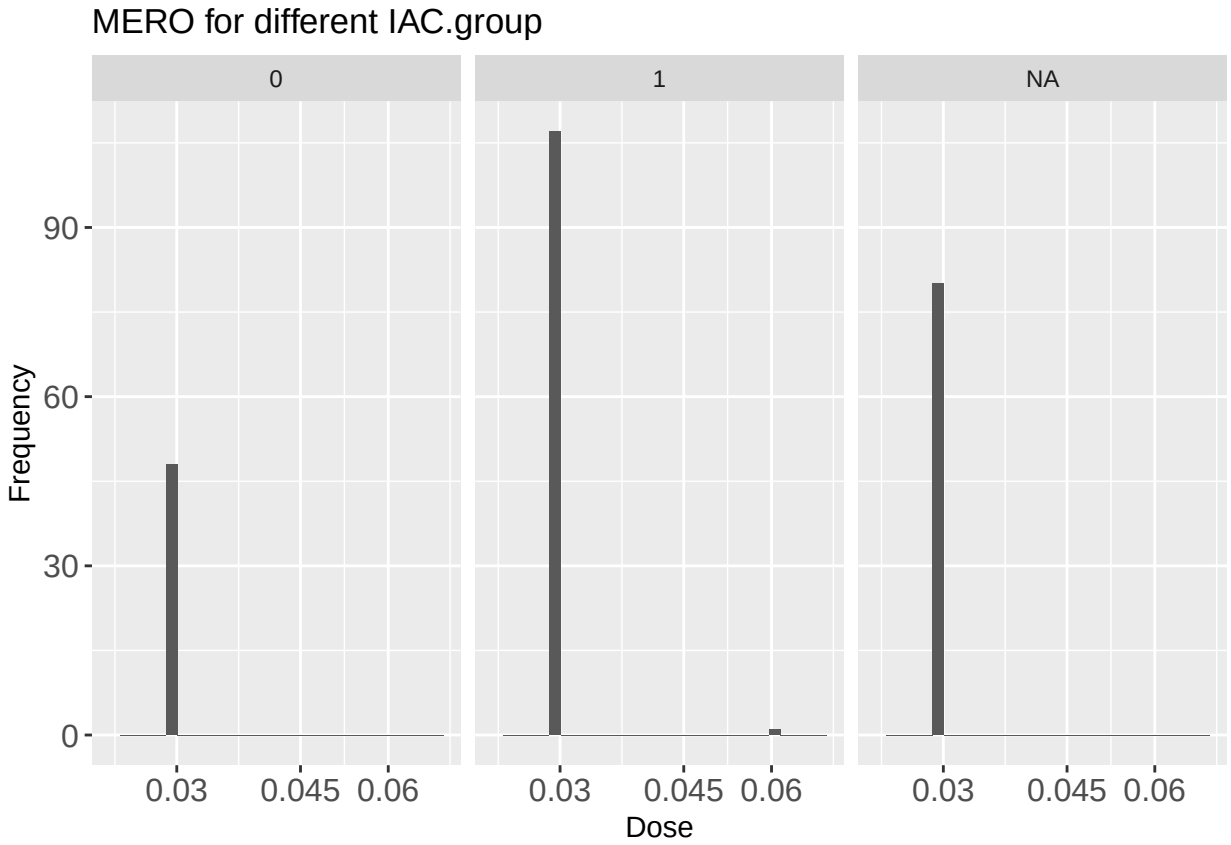
```
  graphisch("IAC.group", "AMP", 1,32, 1,8)
```

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



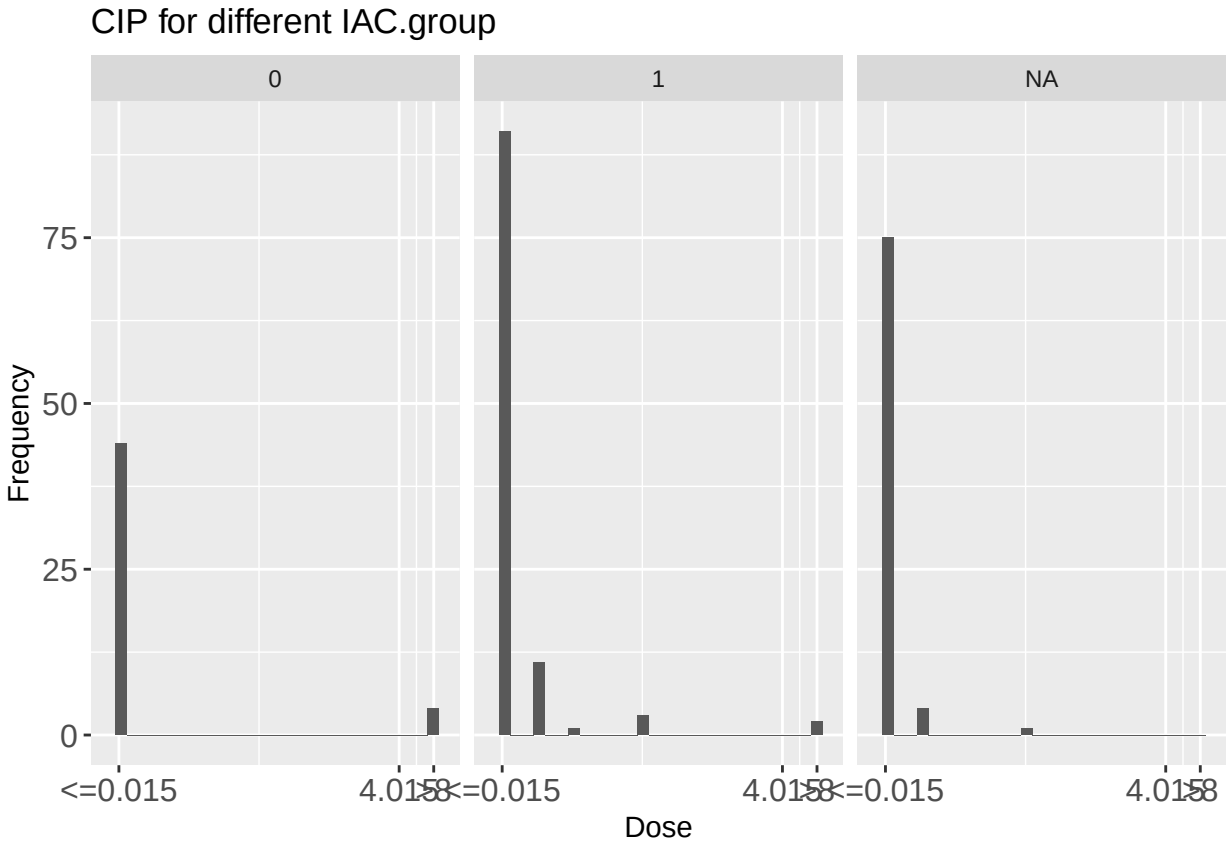

```
  graphisch("IAC.group", "MERO", 0.03,-0.06,   0.015,0.015 )
```

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



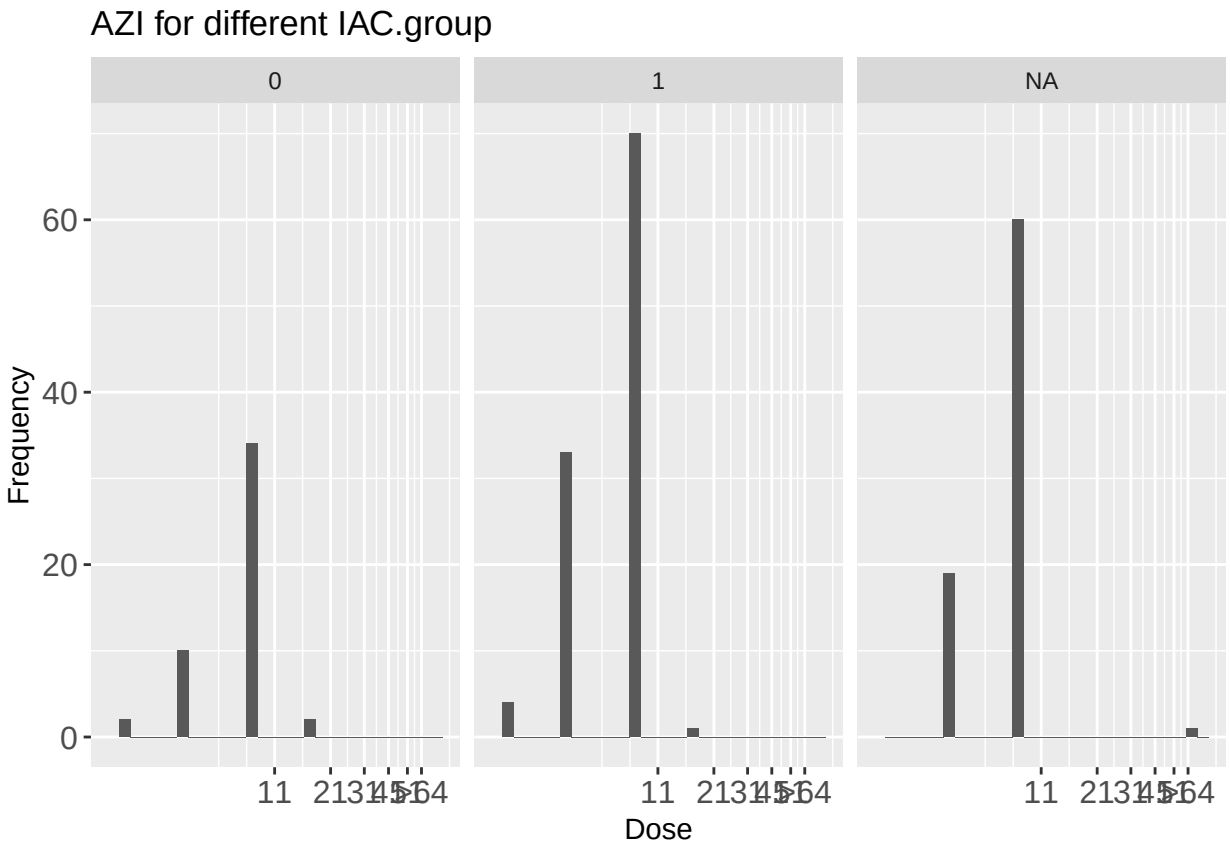

```
graphisch("IAC.group", "CIP" , 0.015,   8   ,   0.015,   4     )
```

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



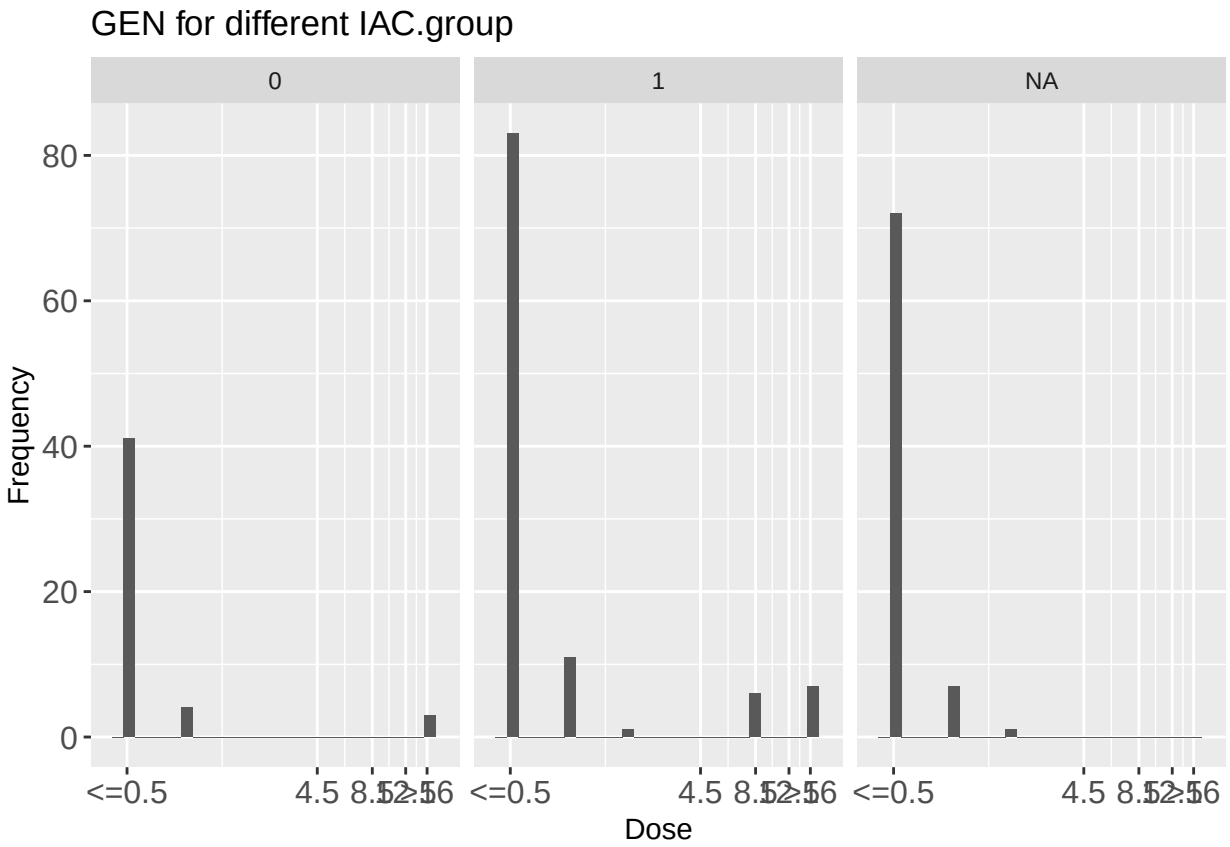

```
graphisch("IAC.group","AZI" , 2,64,   1,10)
```

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



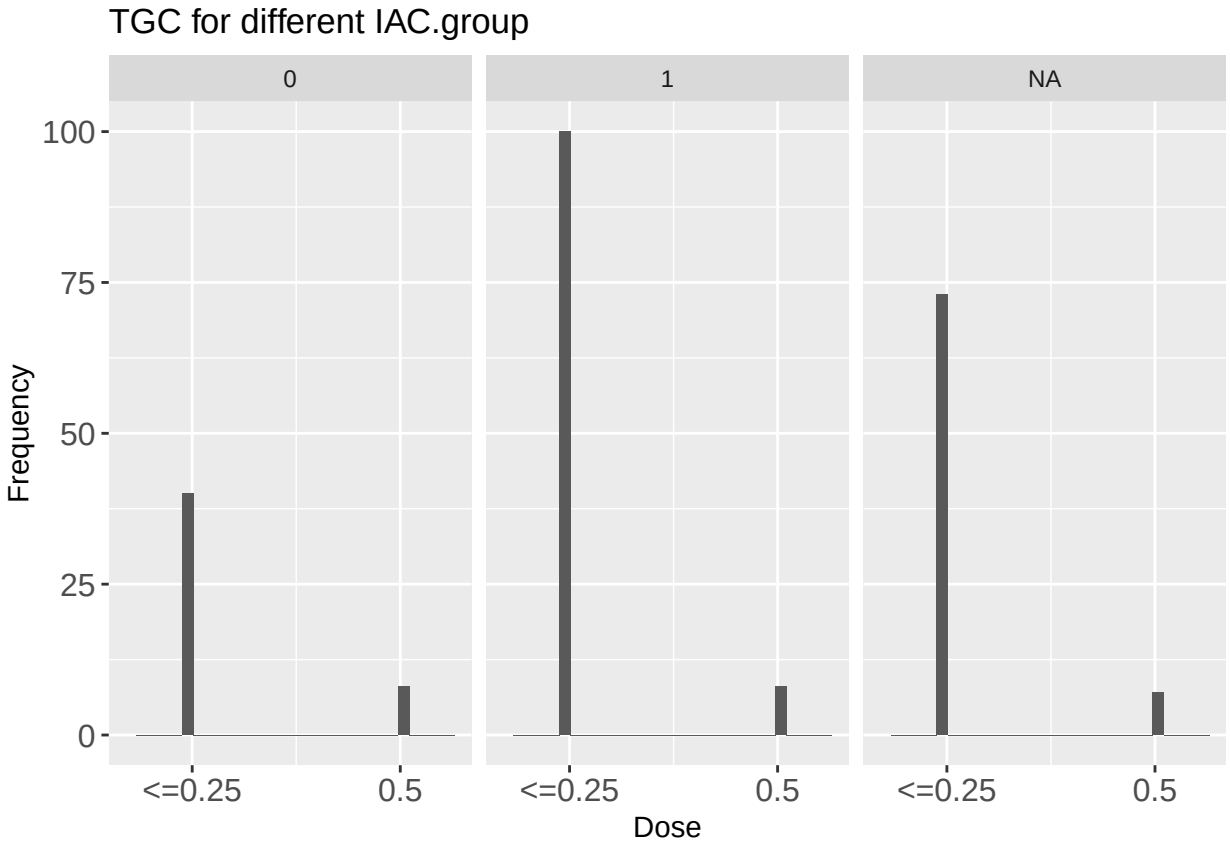

```
graphisch("IAC.group", "GEN" , 0.5  ,  16   ,   0.5  ,   4    )
```

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



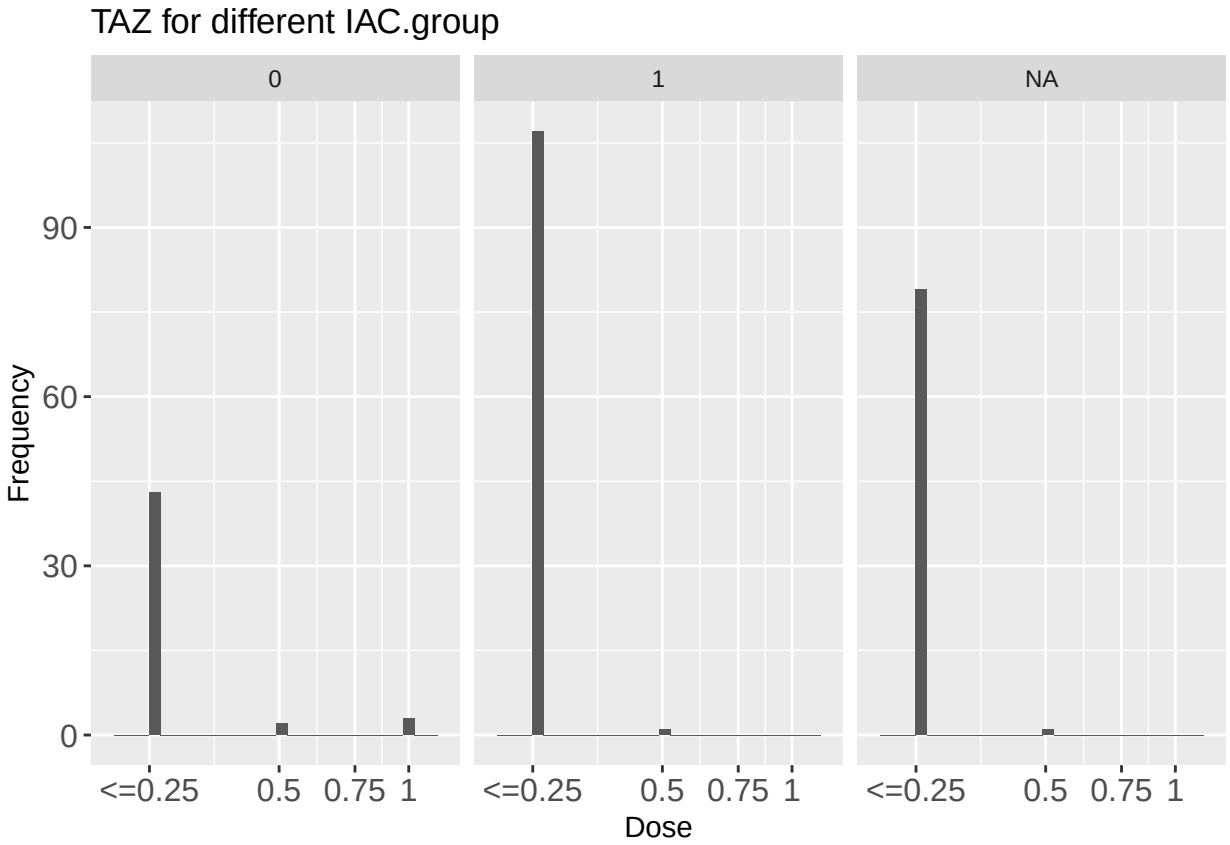

```
graphisch("IAC.group", "TGC" , 0.25 ,  -0.5 ,   0.25 ,   0.25 )
```

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



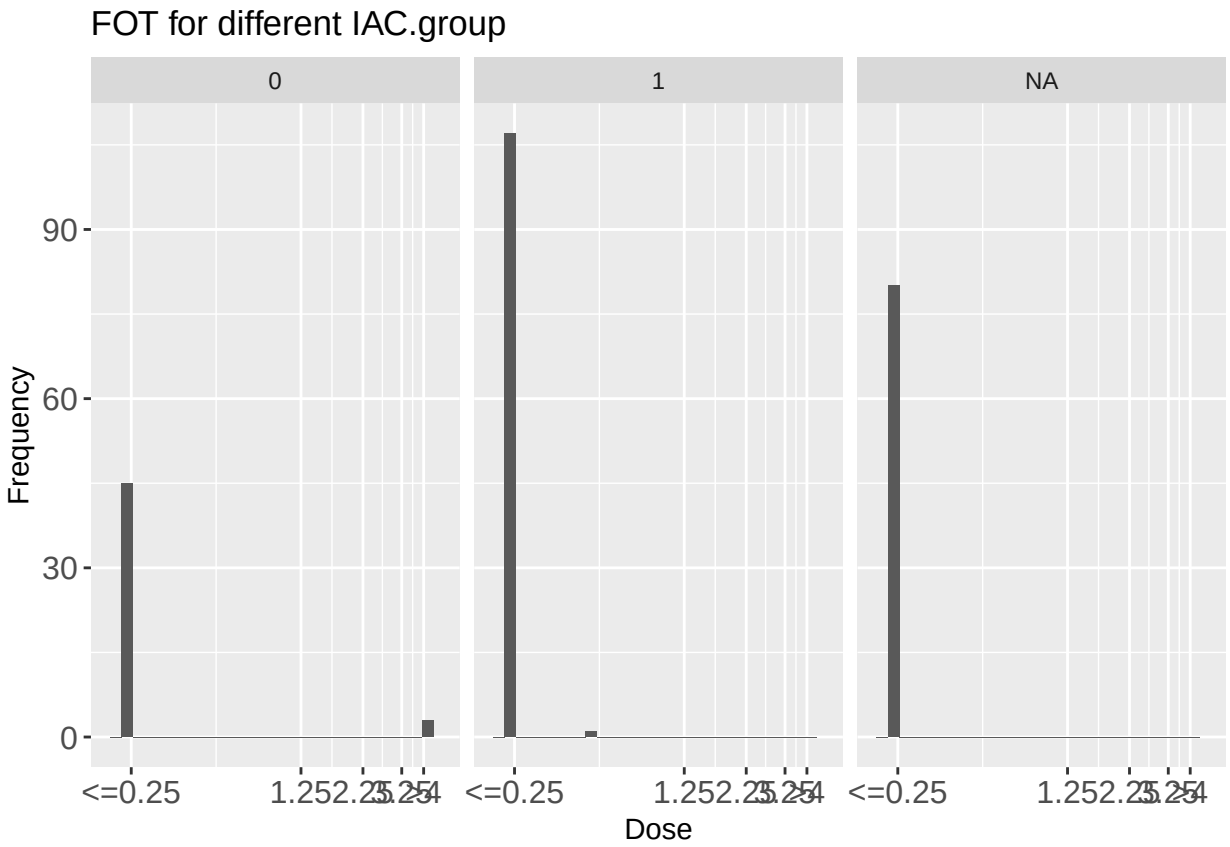

```
graphisch("IAC.group", "TAZ" , 0.25,-1,   0.25,0.25 )
```

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



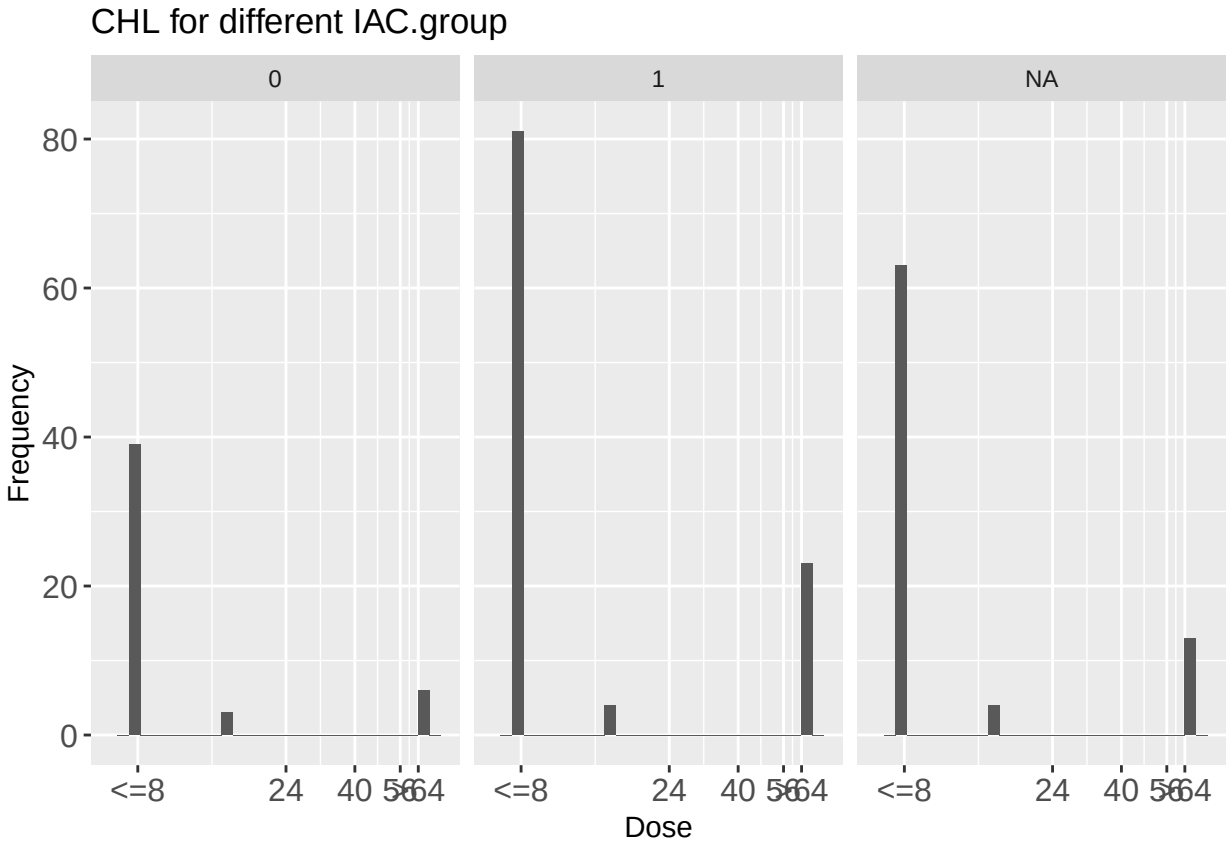

```
  graphisch("IAC.group", "FOT" , 0.25,4   ,   0.25,1     )
```

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



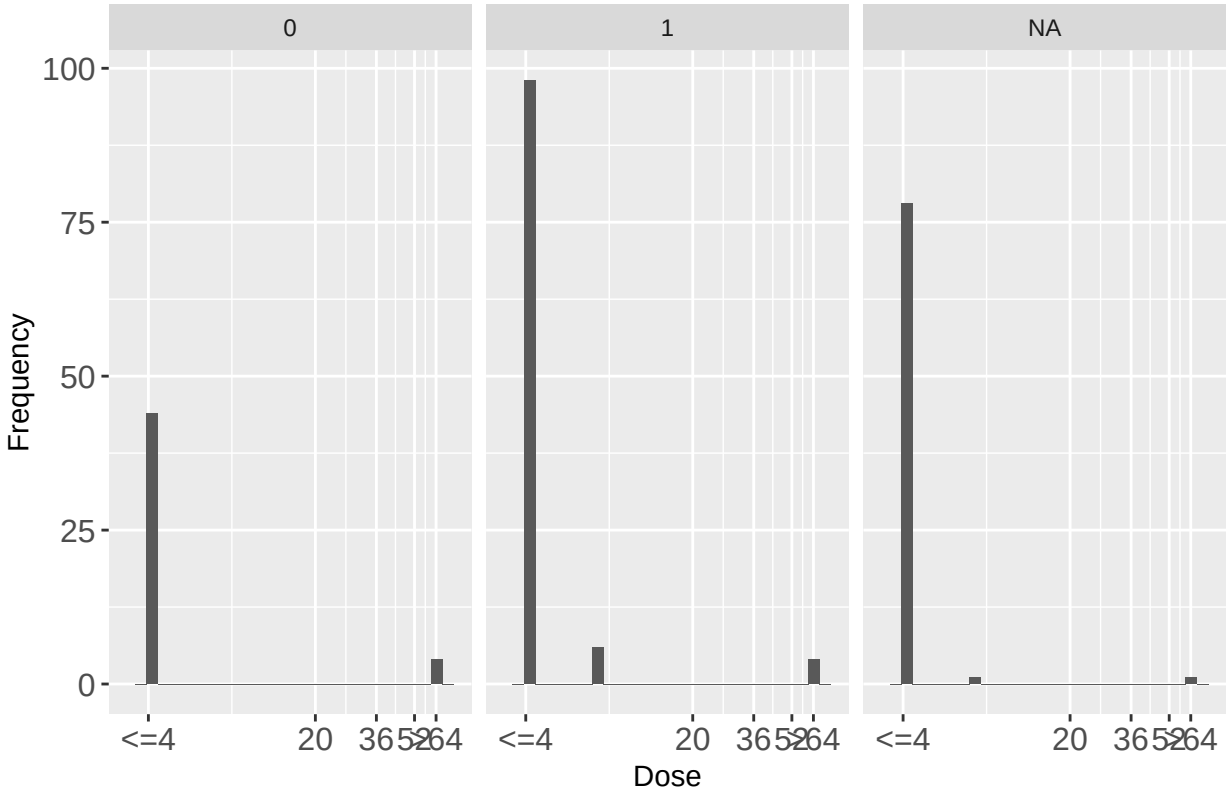

```
   graphisch("IAC.group", "CHL" , 8    ,  64   ,   8,16   )
```

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



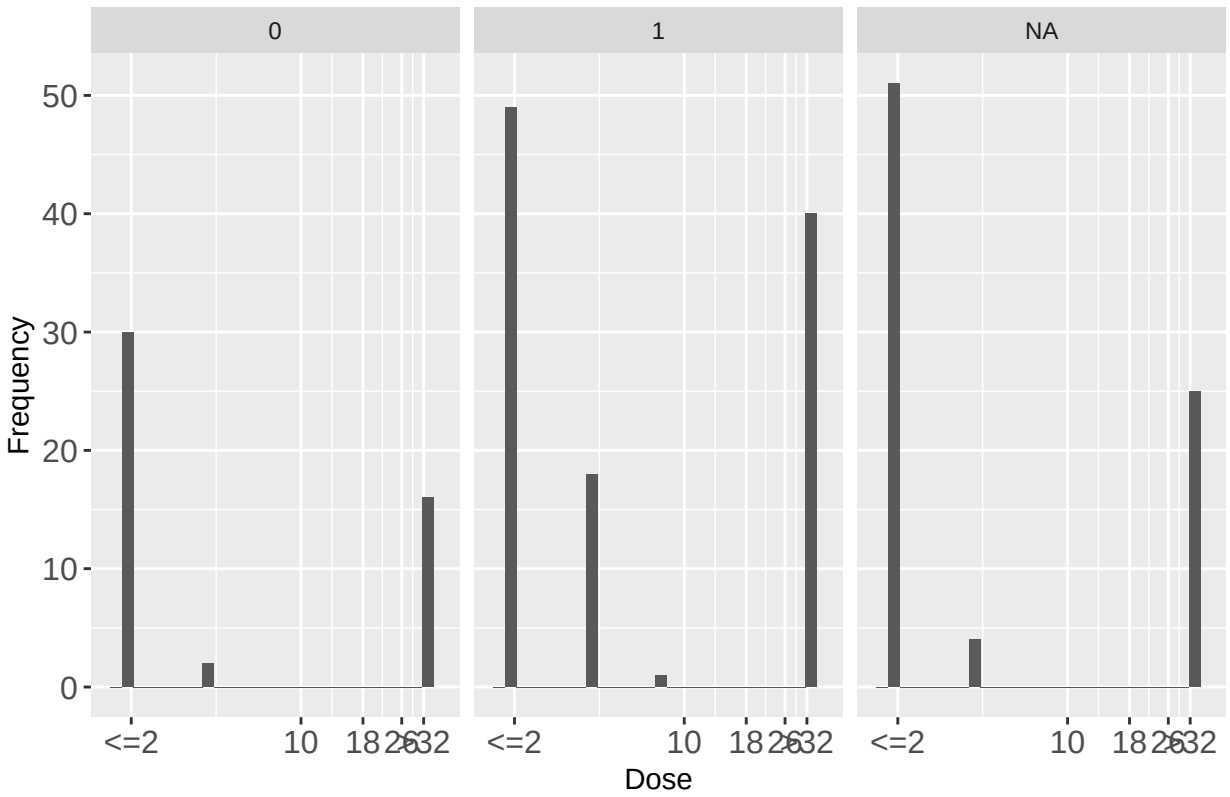

```
   graphisch("IAC.group", "NAL" , 4,64,   4,16    )
```

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



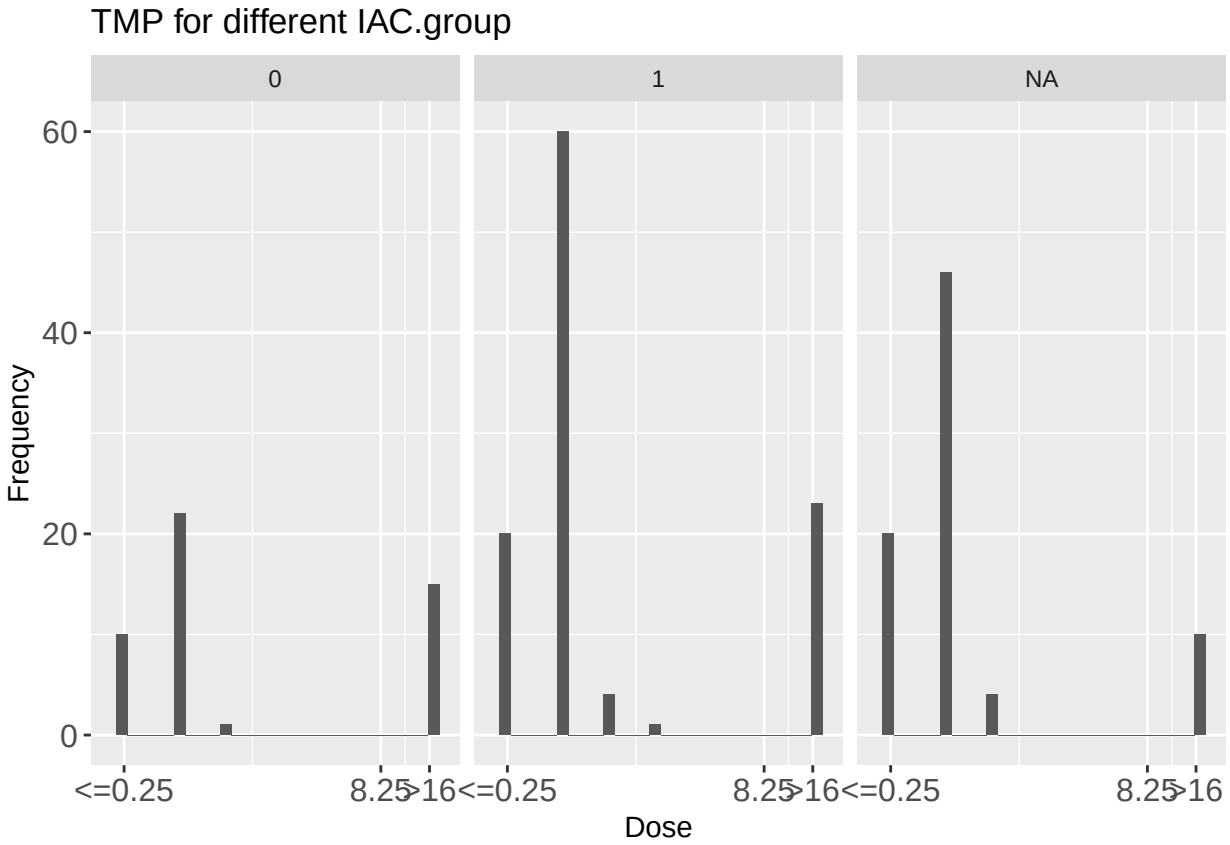

```
graphisch("IAC.group", "TET" , 2,32,   2,8    )
```

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



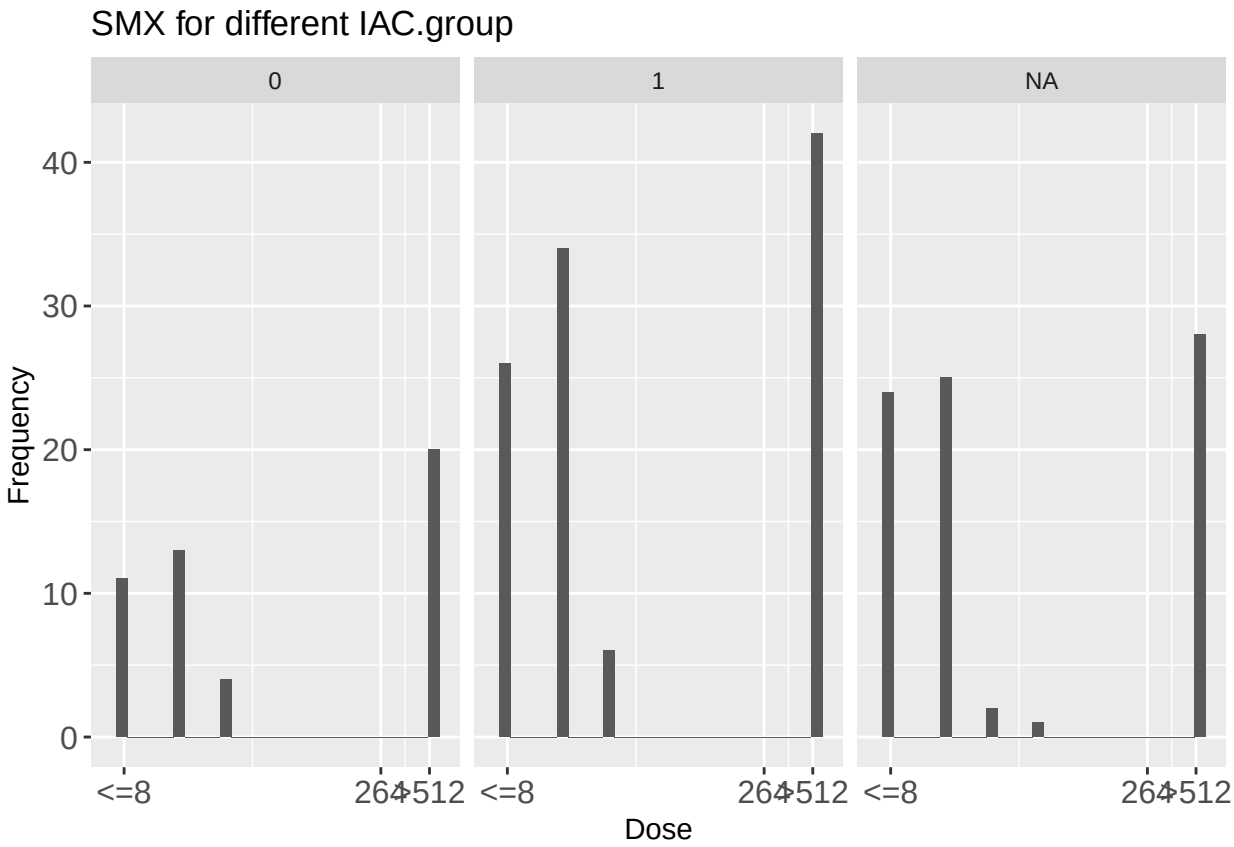

```
graphisch("IAC.group", "TMP" , 0.25 ,  16   ,   0.25,8    )
```

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




```
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 definitv 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.

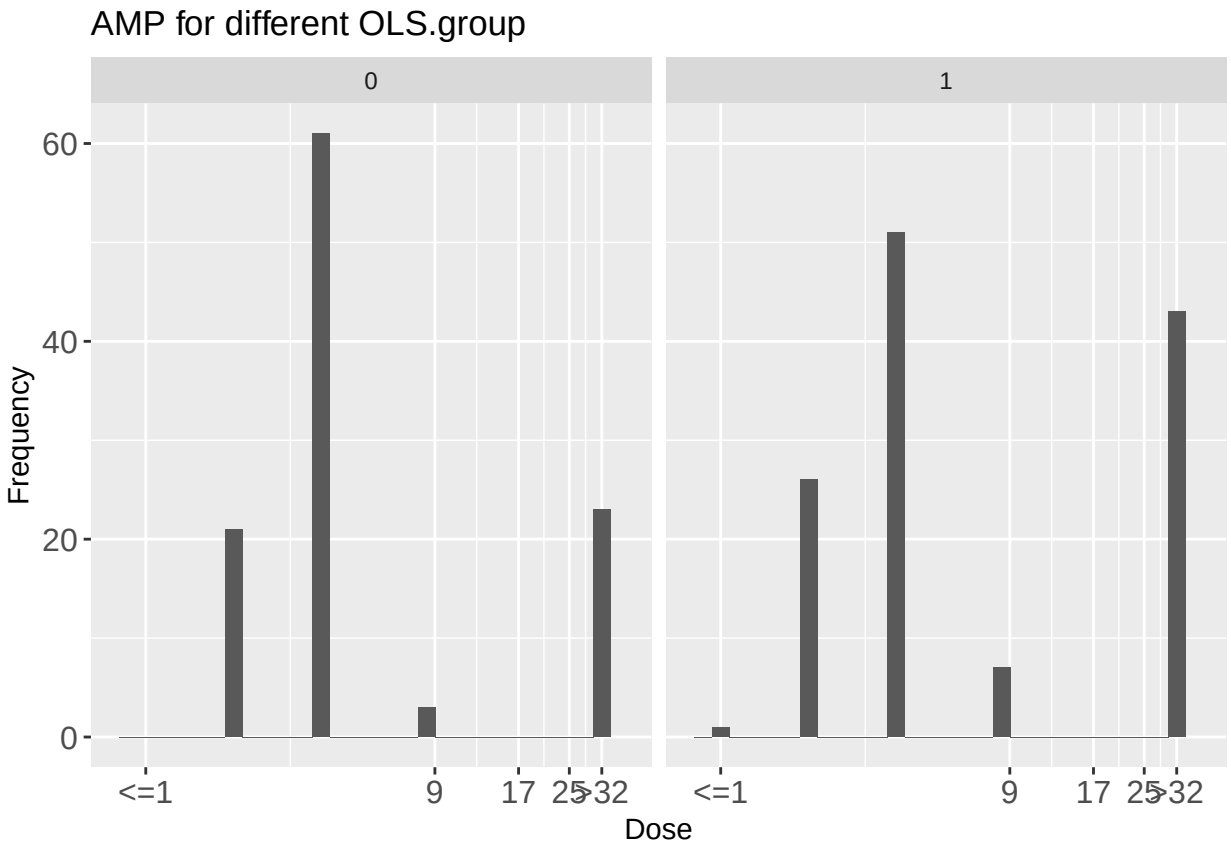
Der Vergleich des Medians der 2 Gruppen zeigt Unterschiede nur für TET und SMX, in der gleichen Richtung wie der Mittelwert. Deshalb diskutiere ich den Median nicht weiter.

Other Live Stock - Gruppen

Mit “OLS” abgekürzt.

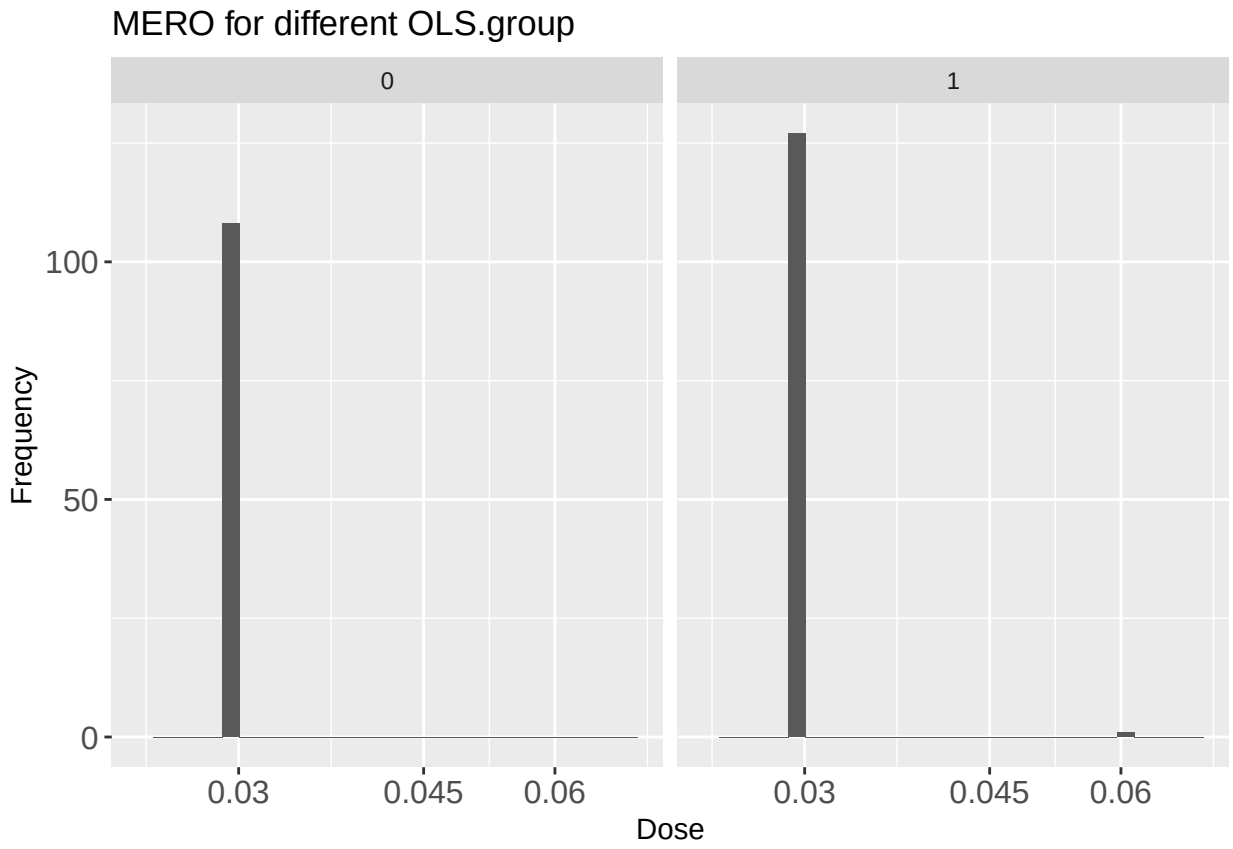
```
  graphisch("OLS.group", "AMP", 1,32, 1,8)
```

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



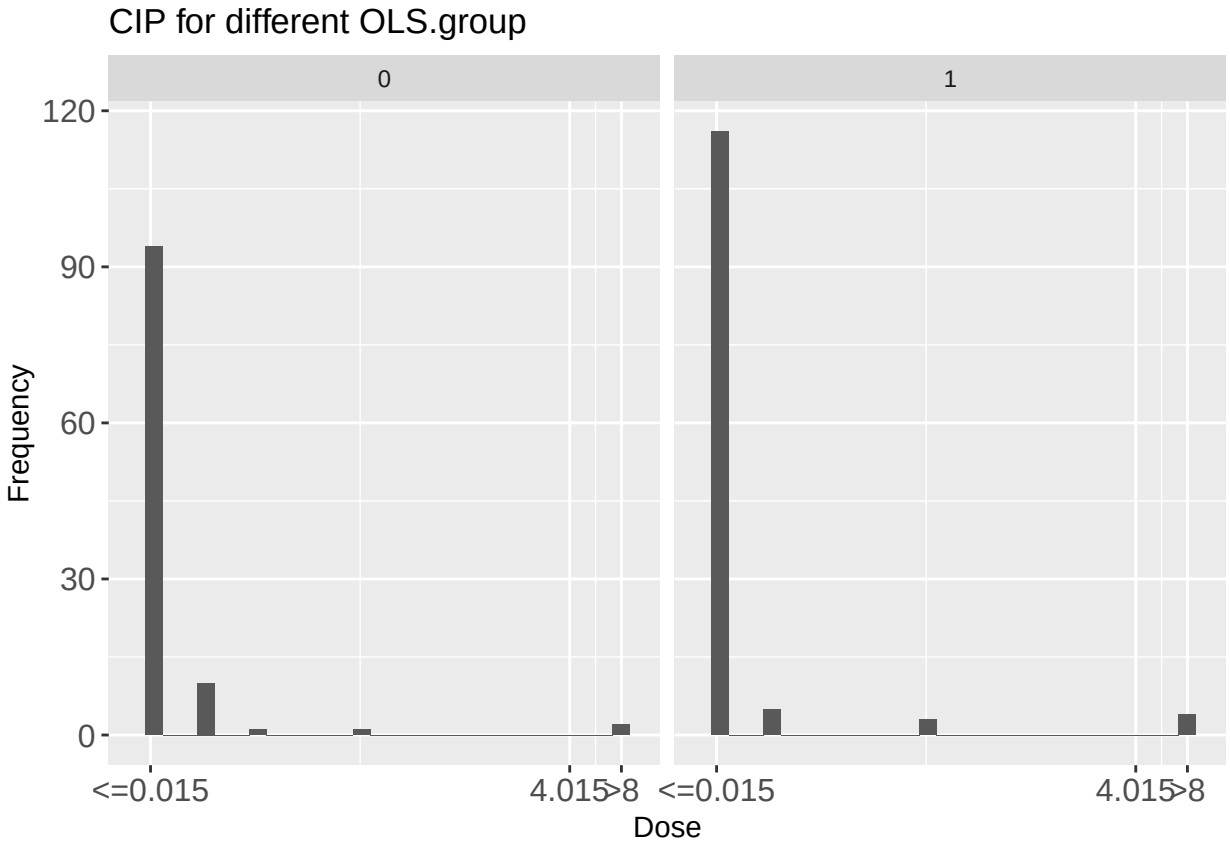

```
graphisch("OLS.group", "MERO", 0.03 ,  -0.06,   0.015,   0.015 )
```

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



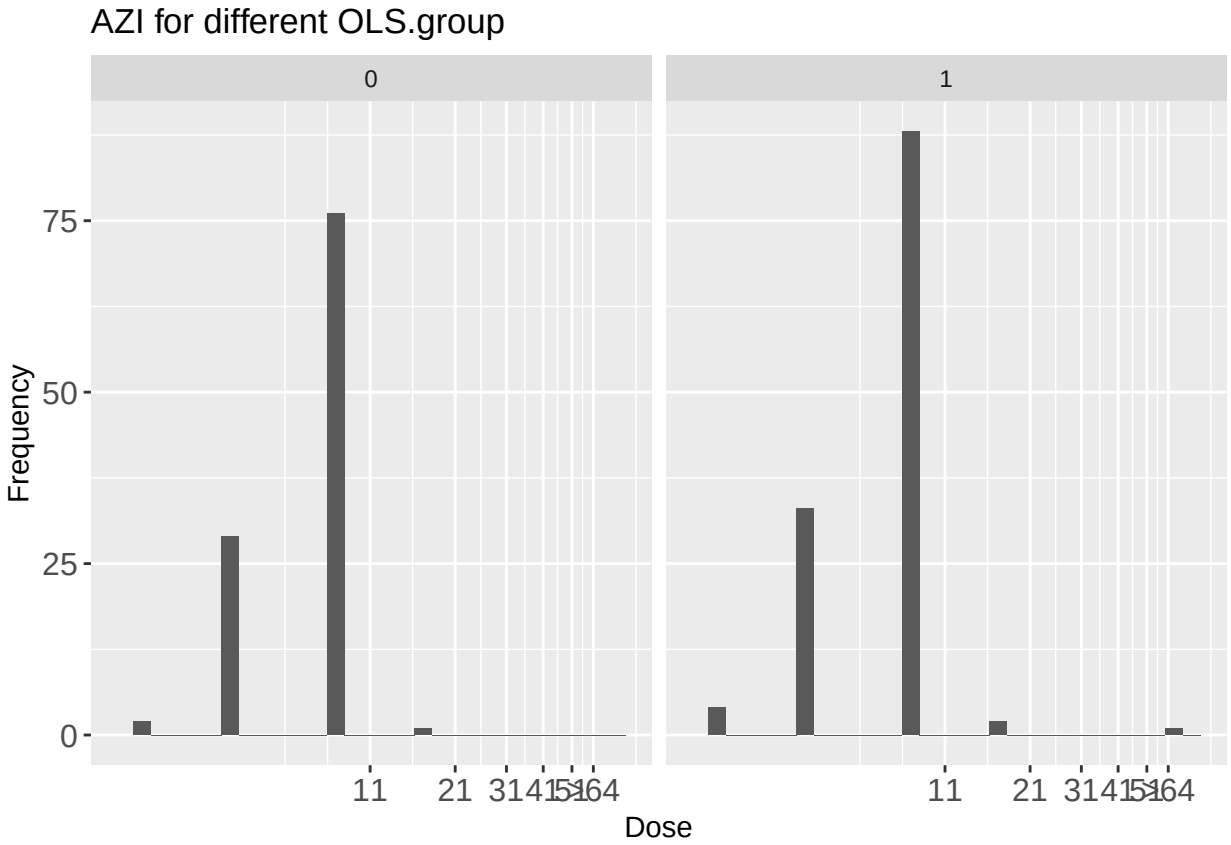

```
graphisch("OLS.group", "CIP" , 0.015,   8   ,   0.015,   4     )
```

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



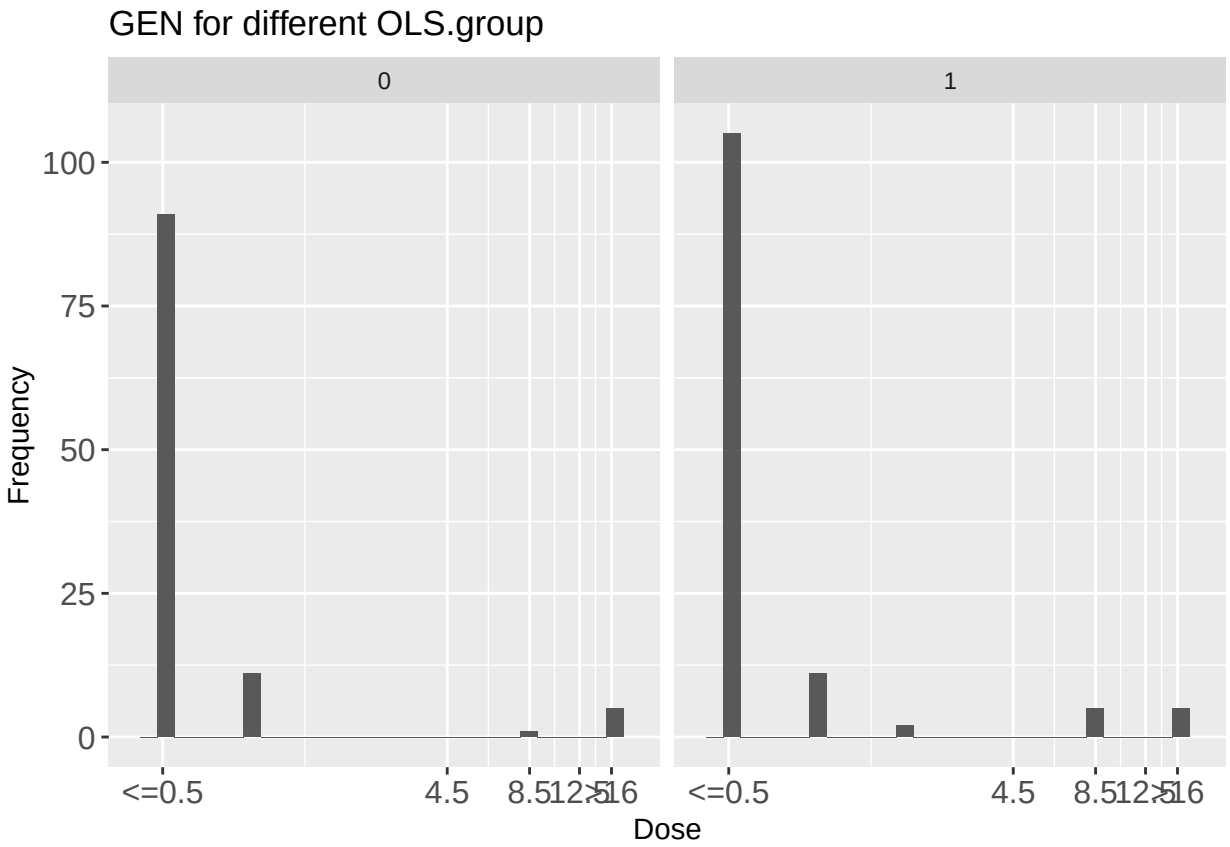

```
  graphisch("OLS.group","AZI", 2,64, 1,10    )
```

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



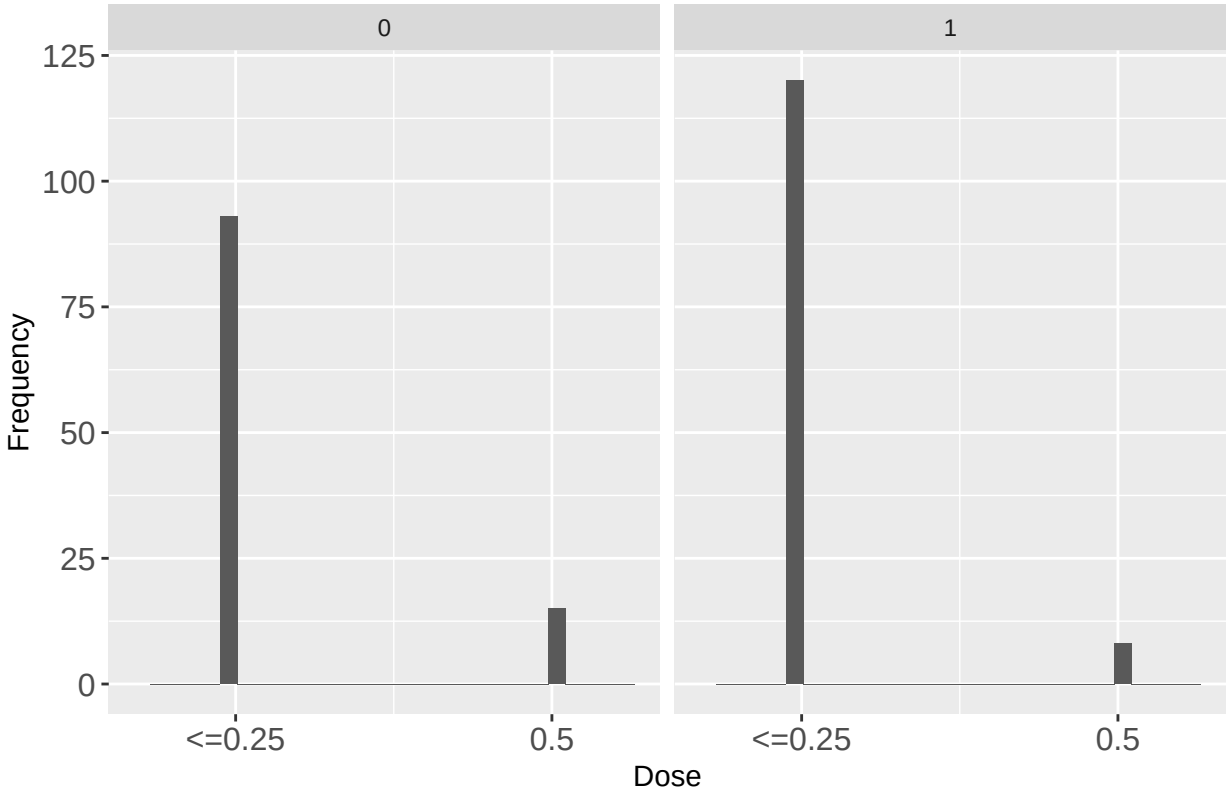

```
graphisch("OLS.group", "GEN" , 0.5  ,  16   ,   0.5  ,   4    )
```

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



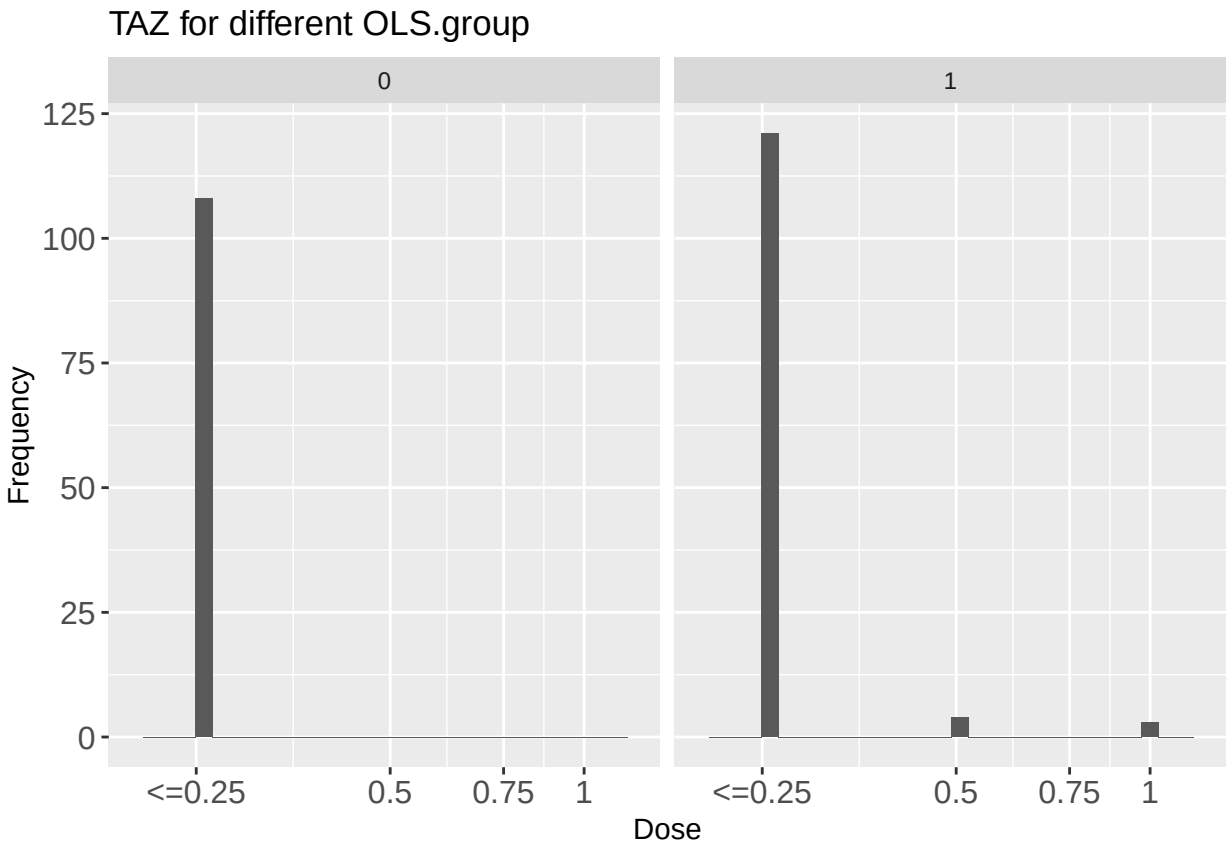

```
graphisch("OLS.group", "TGC" , 0.25 ,  -0.5 ,   0.25 ,   0.25 )
```

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



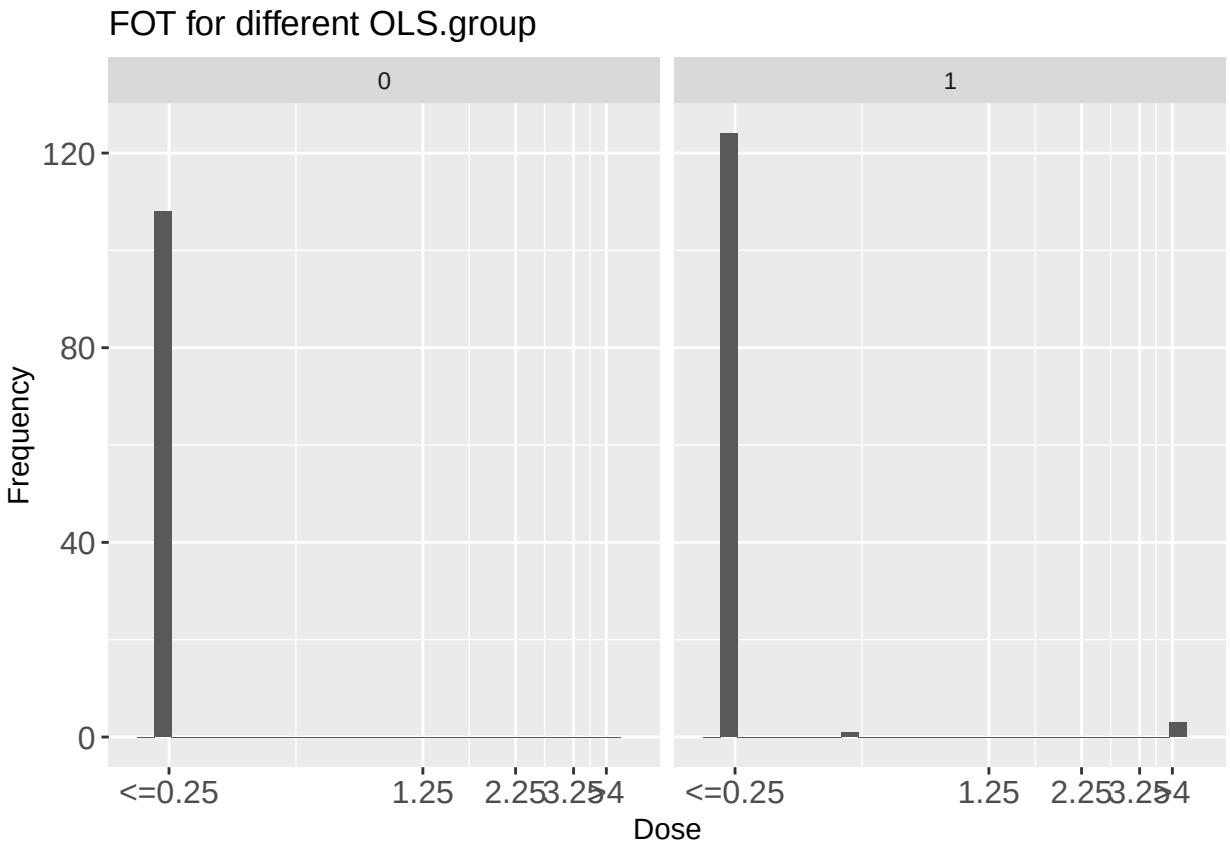

```
  graphisch("OLS.group", "TAZ" , 0.25,-1    ,    0.25,0.25 )
```

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



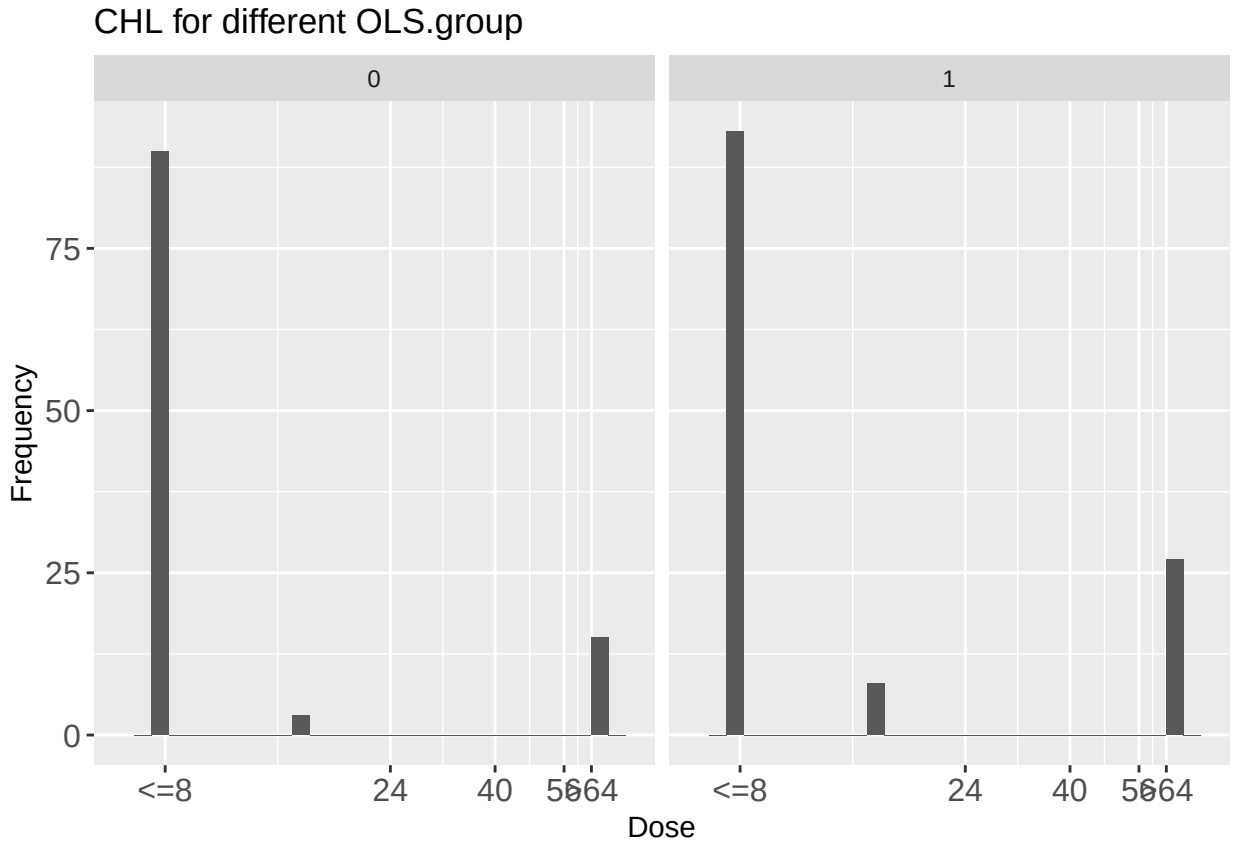

```
  graphisch("OLS.group", "FOT" , 0.25 ,   4    ,   0.25 ,   1     )
```

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



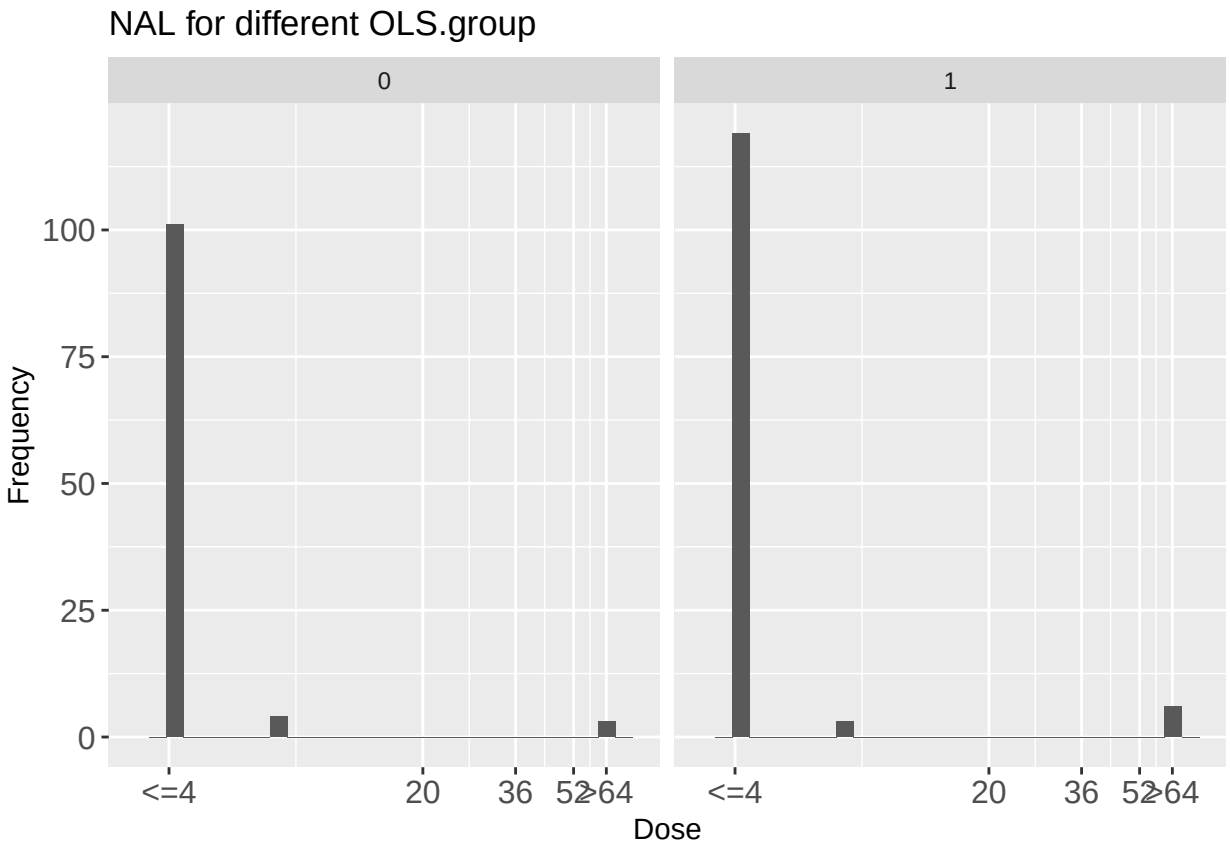

```
graphisch("OLS.group", "CHL" , 8    ,  64   ,   8,16    )
```

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



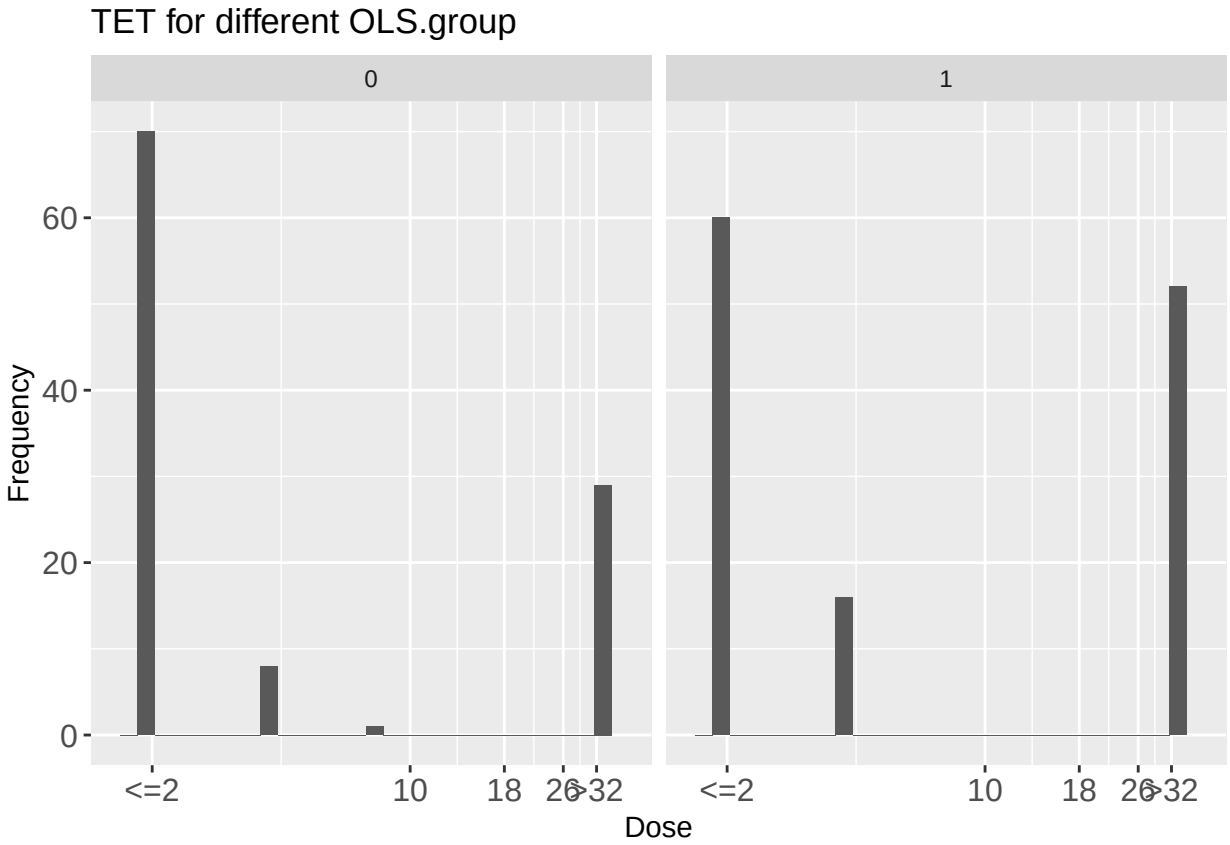

```
graphisch("OLS.group", "NAL" , 4    ,  64   ,   4,16    )
```

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



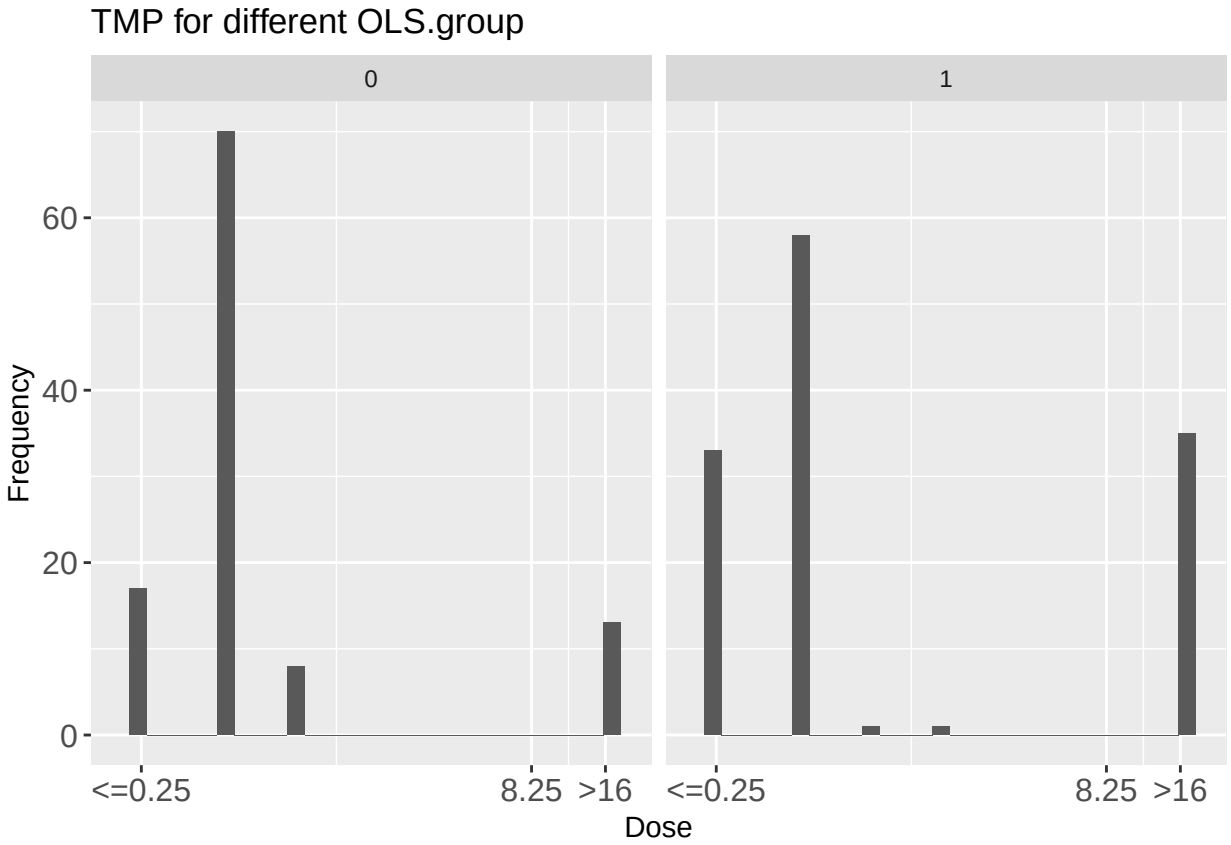

```
graphisch("OLS.group", "TET" , 2    ,  32   ,   2,8    )
```

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



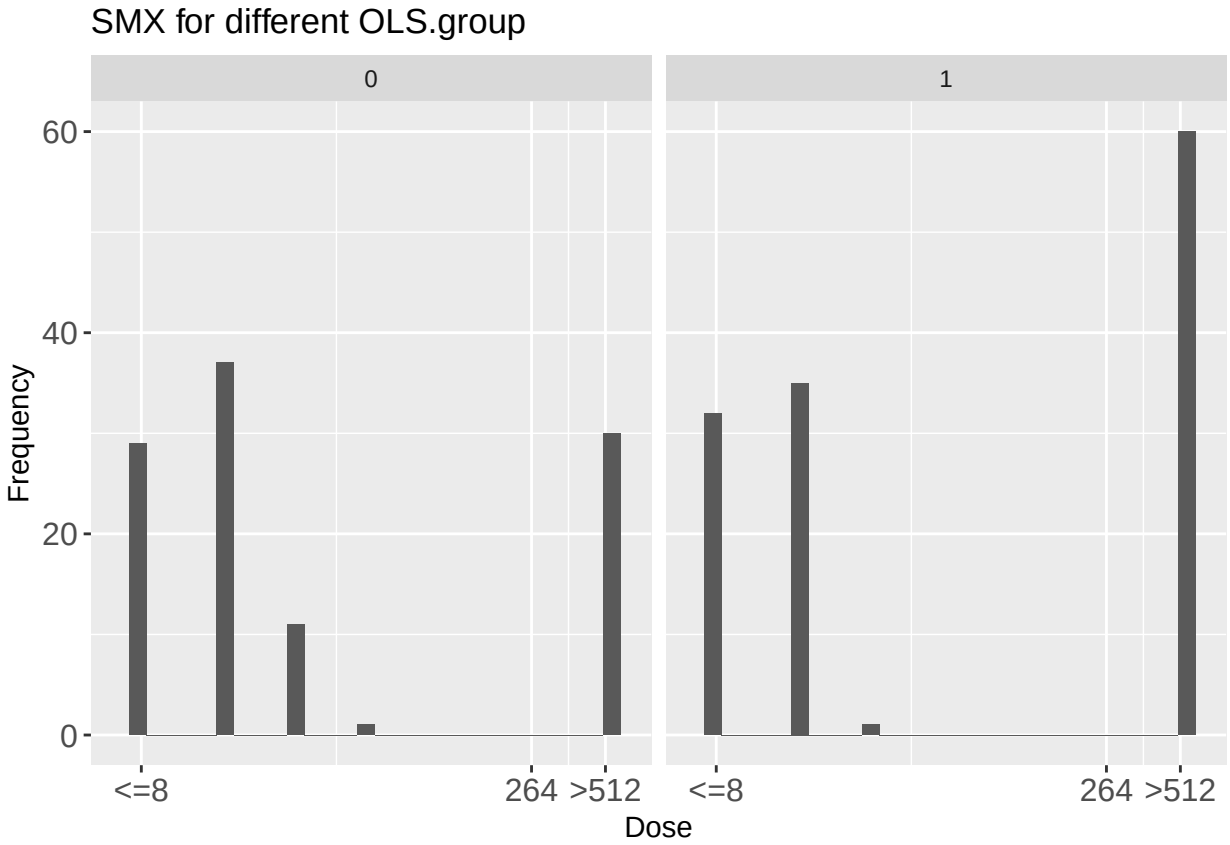

```
  graphisch("OLS.group", "TMP" , 0.25 ,  16   ,   0.25,8    )
```

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




```
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] ""
```



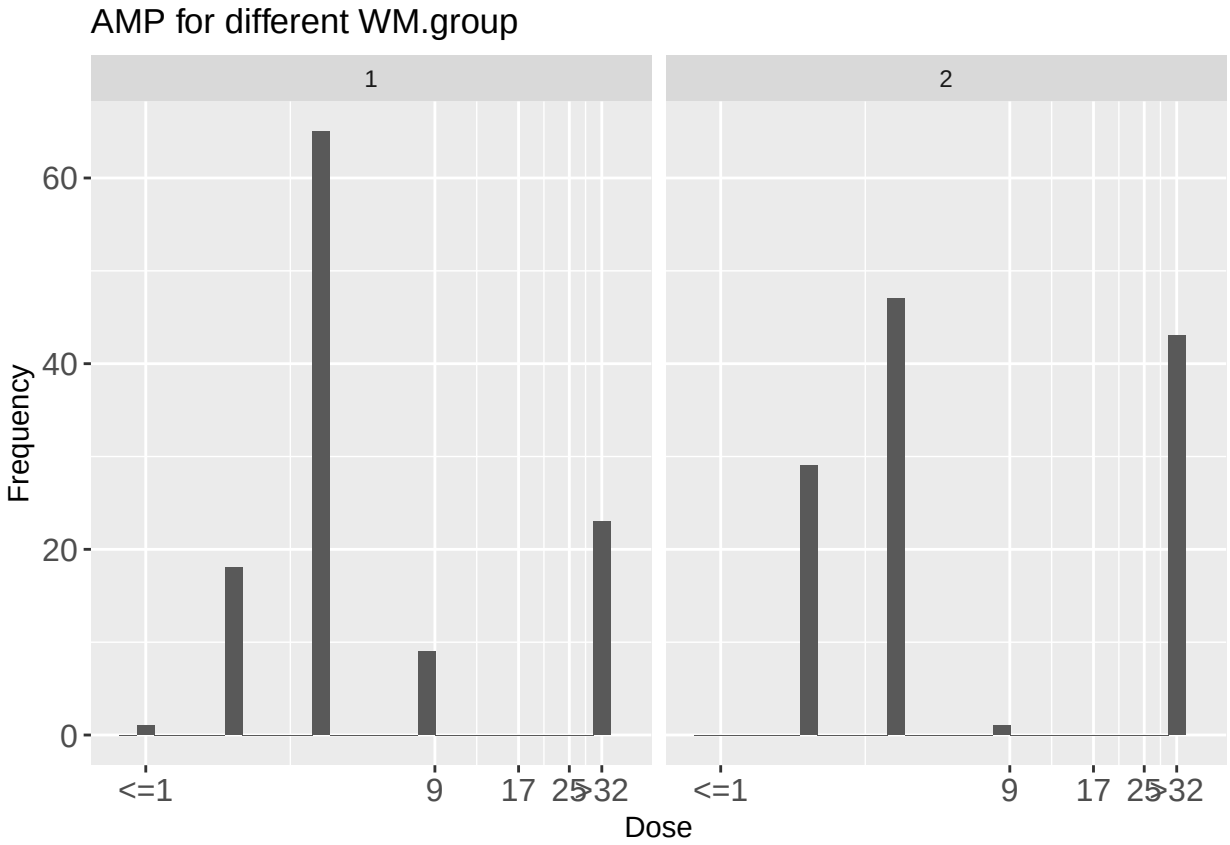

```
#stop the script
```

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)
```

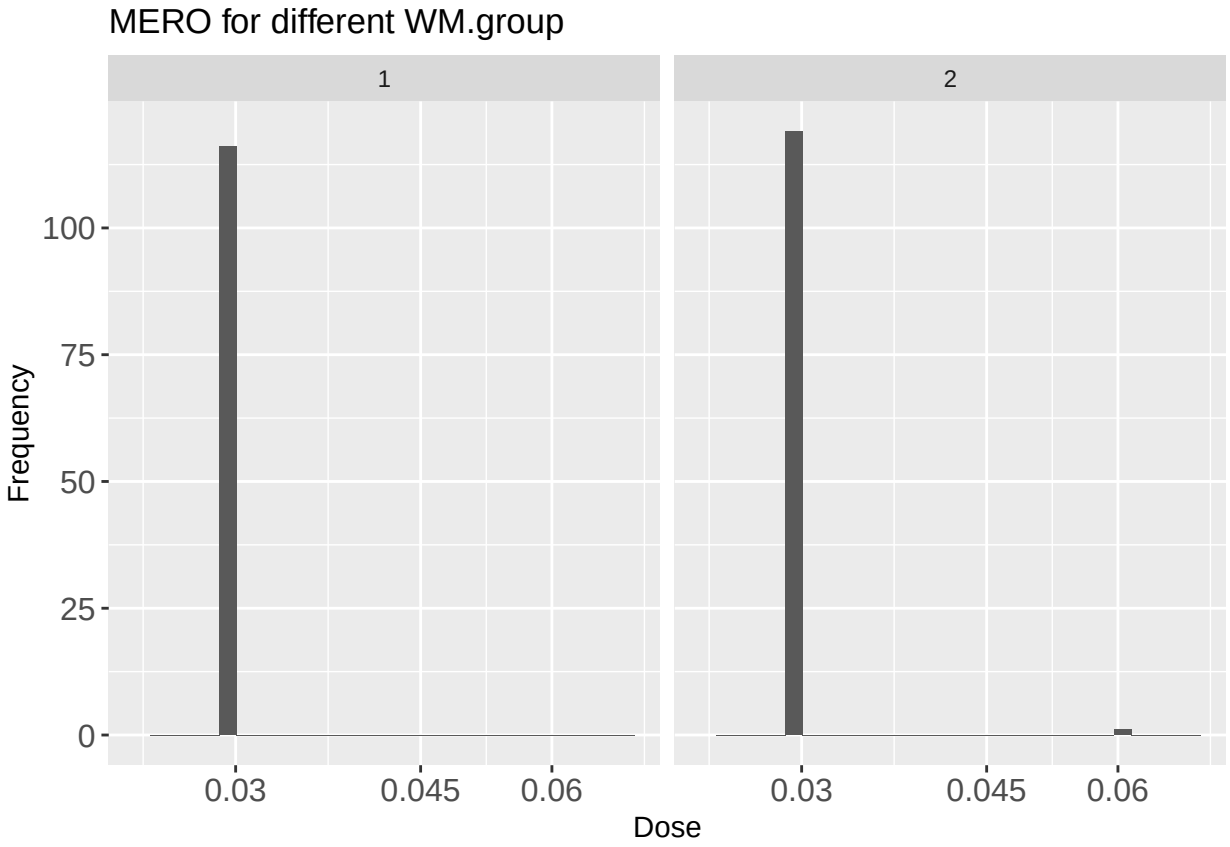
```
## [1] "AMP - Resistance, WM            :"
## [1] "  Median             = 4"
## [1] "  Mean   in  9.517 ... 9.526"
## [1] ""
## [1] "AMP - Resistance, no WM      :"
## [1] "  Median             = 4"
## [1] "  Mean   =  13.583"
## [1] ""
```



Der Mittelwert ist höher ohne WM.

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

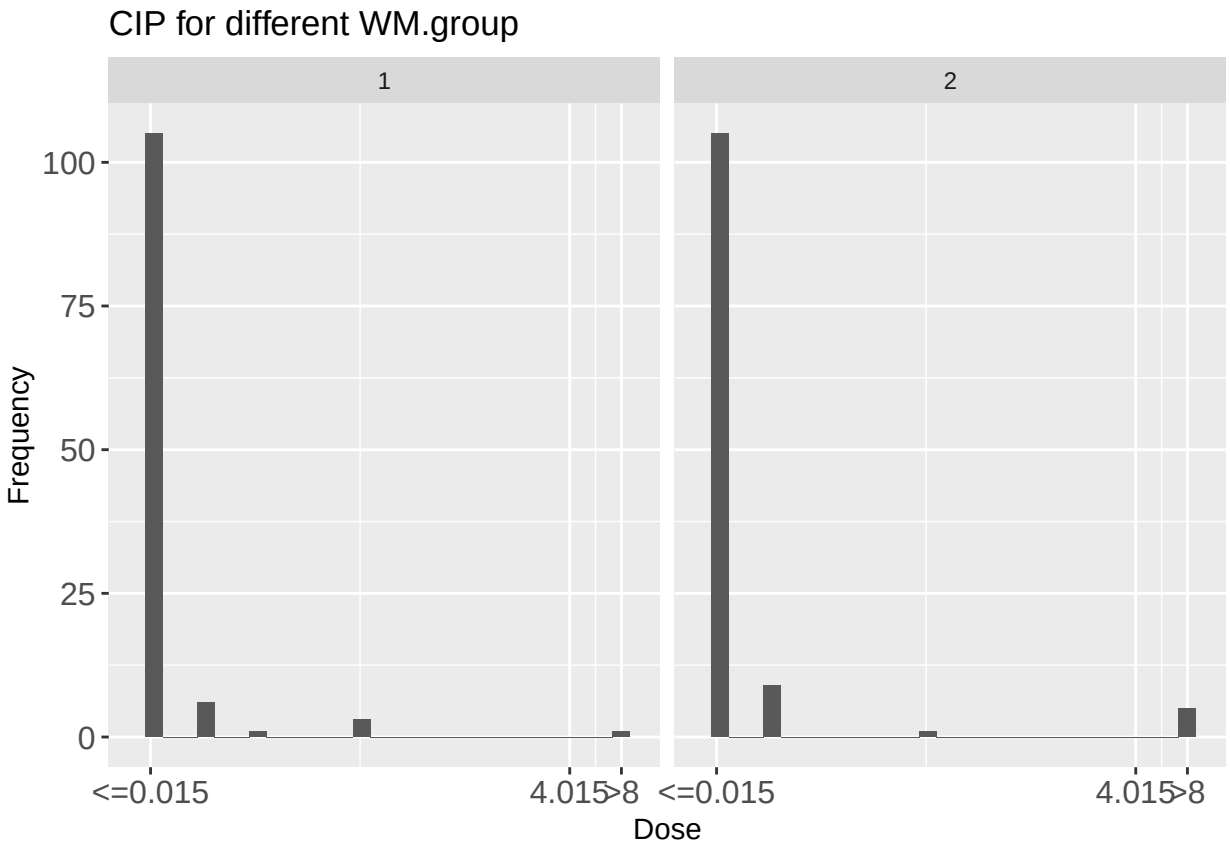
```
## [1] "MERO - Resistance, WM            :"
## [1] "  Median             <= 0.03"
## [1] "  Mean   in  0.000 ... 0.030"
## [1] ""
## [1] "MERO - Resistance, no WM      :"
## [1] "  Median             <= 0.03"
## [1] "  Mean   in  0.001 ... 0.030"
## [1] ""
```



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

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

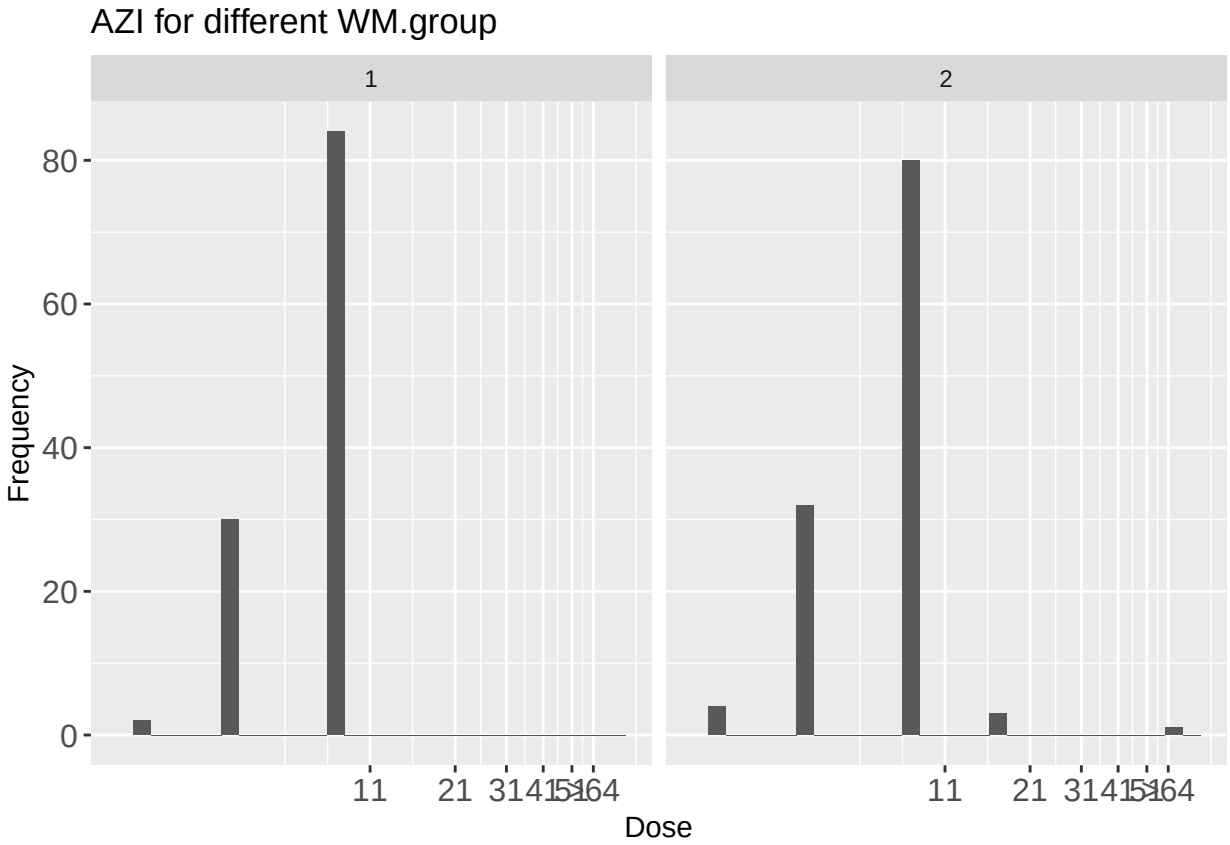
```
## [1] "CIP - Resistance, WM            :"
## [1] "  Median             <= 0.015"
## [1] "  Mean   in  0.077 ... 0.091"
## [1] ""
## [1] "CIP - Resistance, no WM      :"
## [1] "  Median             <= 0.015"
## [1] "  Mean   in  0.338 ... 0.351"
## [1] ""
```



Der Mittelwert ist tendenziell höher ohne WM.

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

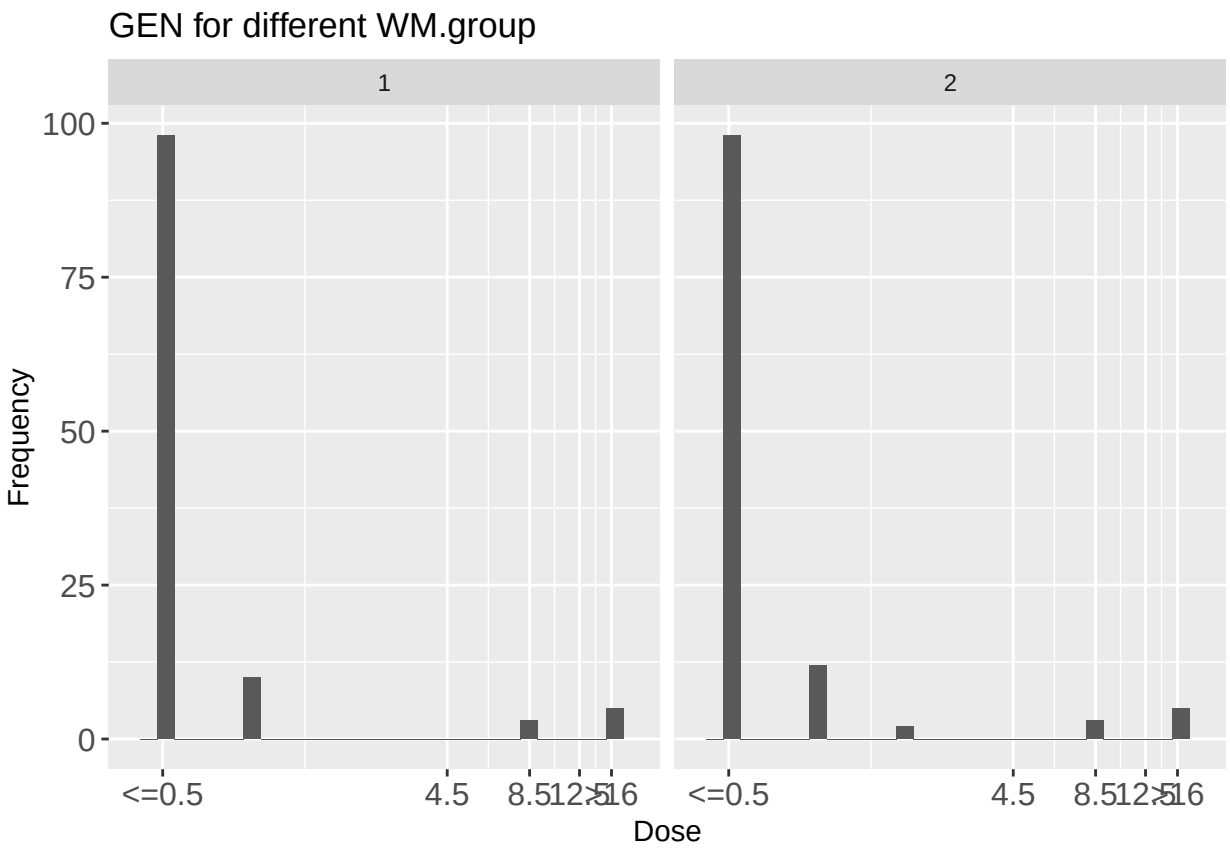
```
## [1] "AZI - Resistance, WM            :"
## [1] "  Median              = 8"
## [1] "  Mean   in  6.828 ... 6.862"
## [1] ""
## [1] "AZI - Resistance, no WM      :"
## [1] "  Median              = 8"
## [1] "  Mean   in  7.333 ... 7.400"
## [1] ""
```



Der Mittelwert ist höher ohne WM.

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

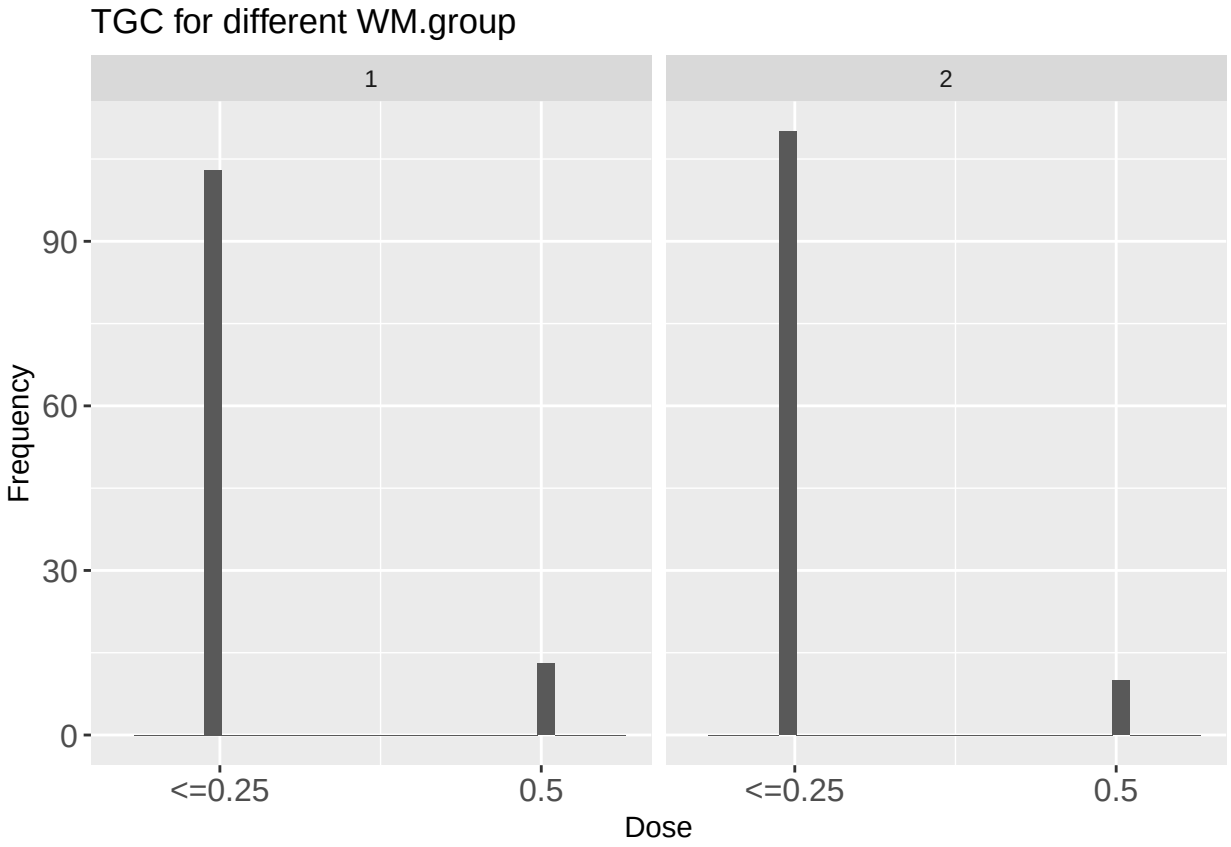
```
## [1] "GEN - Resistance, WM            :"
## [1] "  Median             <= 0.5"
## [1] "  Mean   in  0.983 ... 1.405"
## [1] ""
## [1] "GEN - Resistance, no WM      :"
## [1] "  Median             <= 0.5"
## [1] "  Mean   in  1.000 ... 1.408"
## [1] ""
```



Der Mittelwert ist vergleichbar ohne WM.

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

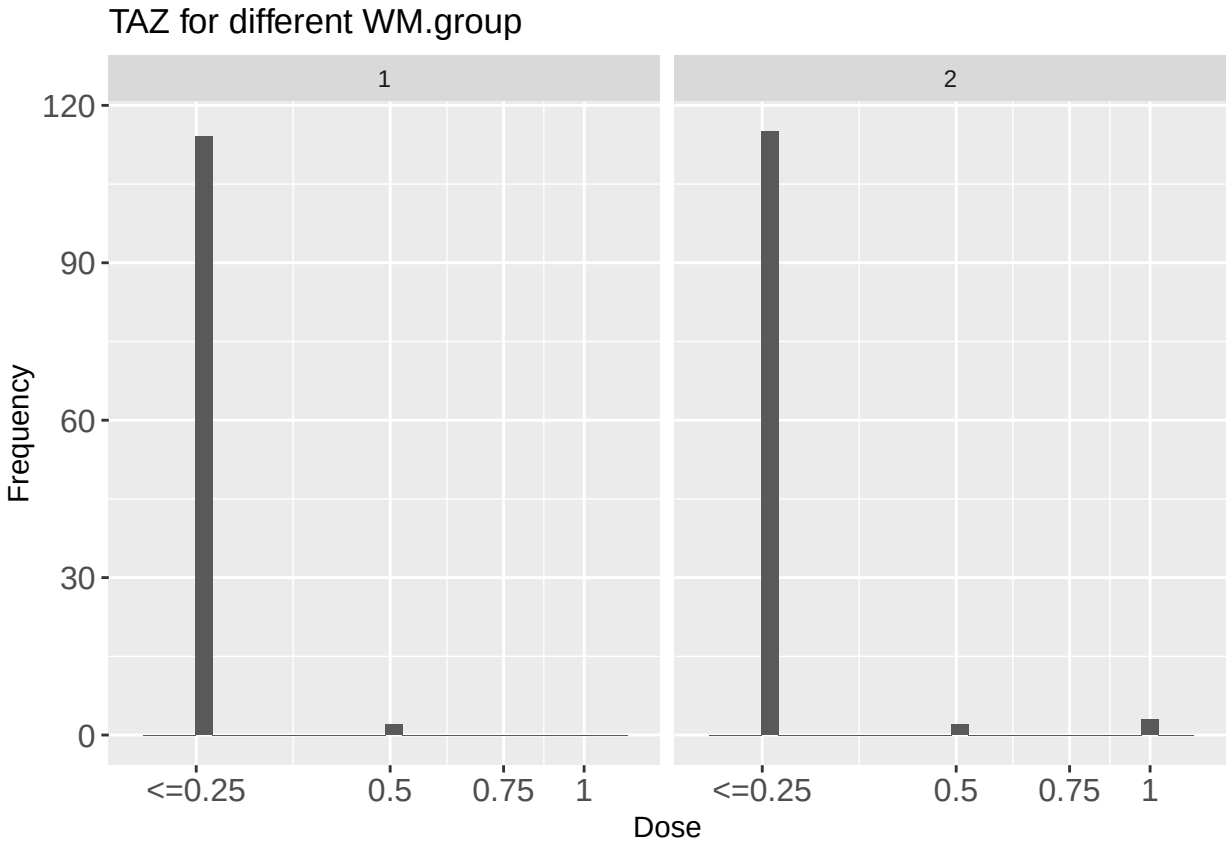
```
## [1] "TGC - Resistance, WM            :"
## [1] "  Median             <= 0.25"
## [1] "  Mean   in  0.056 ... 0.278"
## [1] ""
## [1] "TGC - Resistance, no WM      :"
## [1] "  Median             <= 0.25"
## [1] "  Mean   in  0.042 ... 0.271"
## [1] ""
```



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 <= 0.25 ausser für:

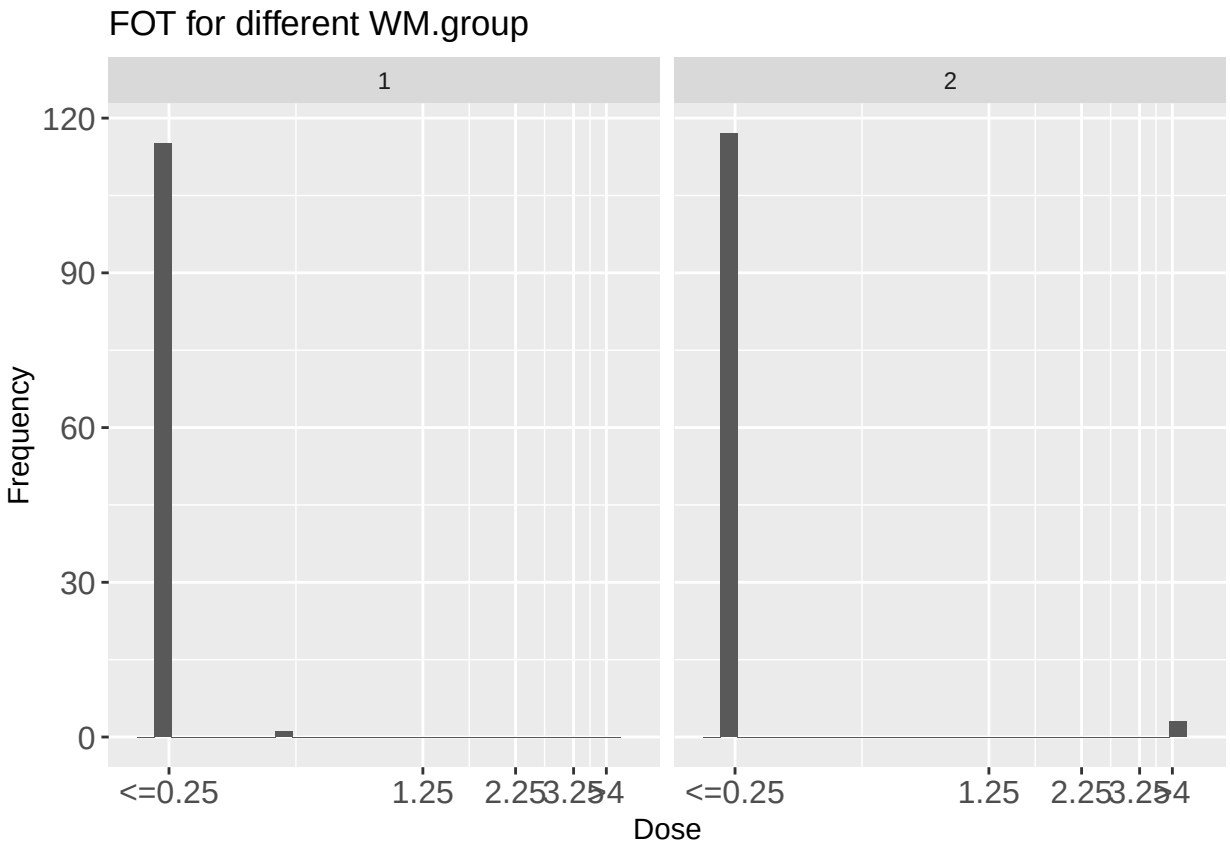
- Waste Milk: 0.5 für Betriebe 11 und 15
- Keine Waste Milk: 0.5 für Betriebe 12, 59 und 3*1 für Betrieb 52

(Betrieb 30 wurde ganz am Anfang schon gelöscht)

Die Werte 0.5 balanzieren 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)
```

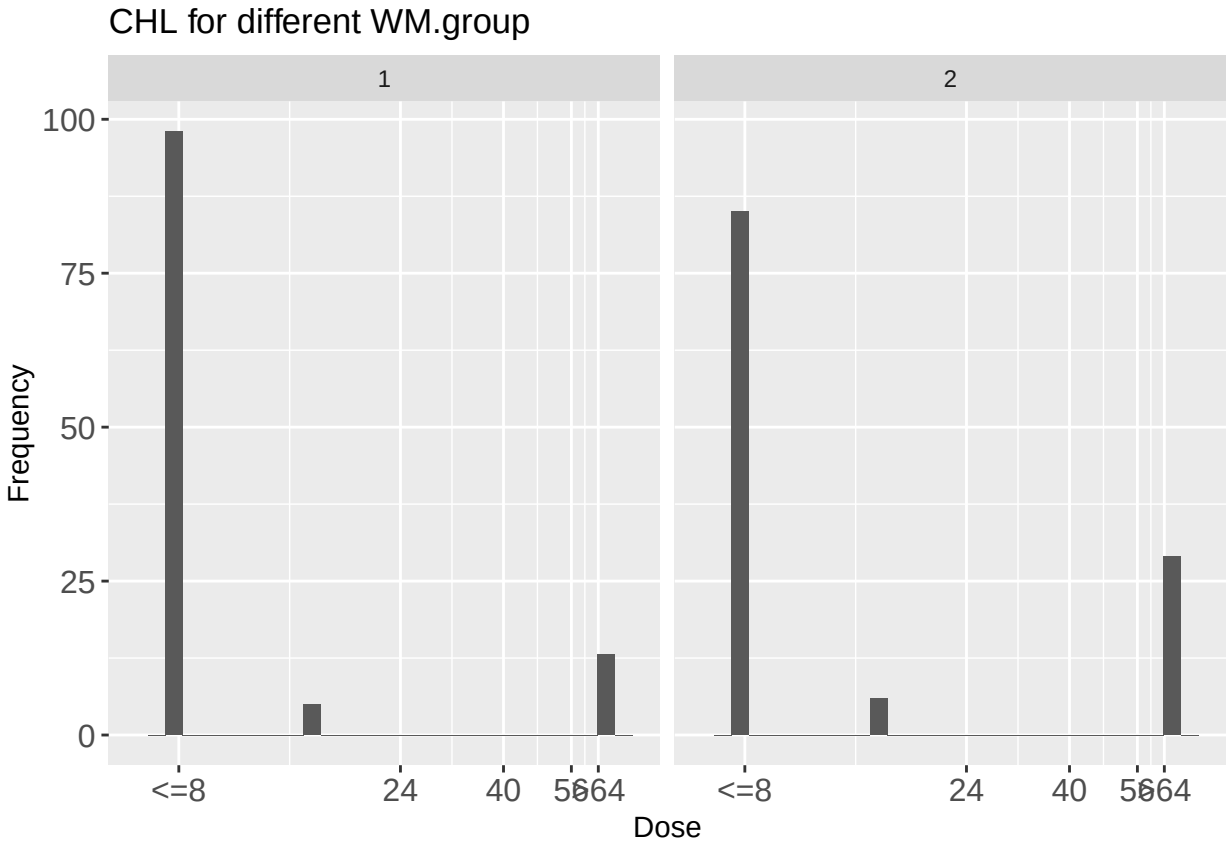
```
## [1] "FOT - Resistance, WM           :"
## [1] "  Median             <= 0.25"
## [1] "  Mean   in  0.004 ... 0.252"
## [1] ""
## [1] "FOT - Resistance, no WM      :"
## [1] "  Median             <= 0.25"
## [1] "  Mean   in  0.100 ... 0.344"
## [1] ""
```



Der Mittelwert ist tendenziell höher ohne WM.

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

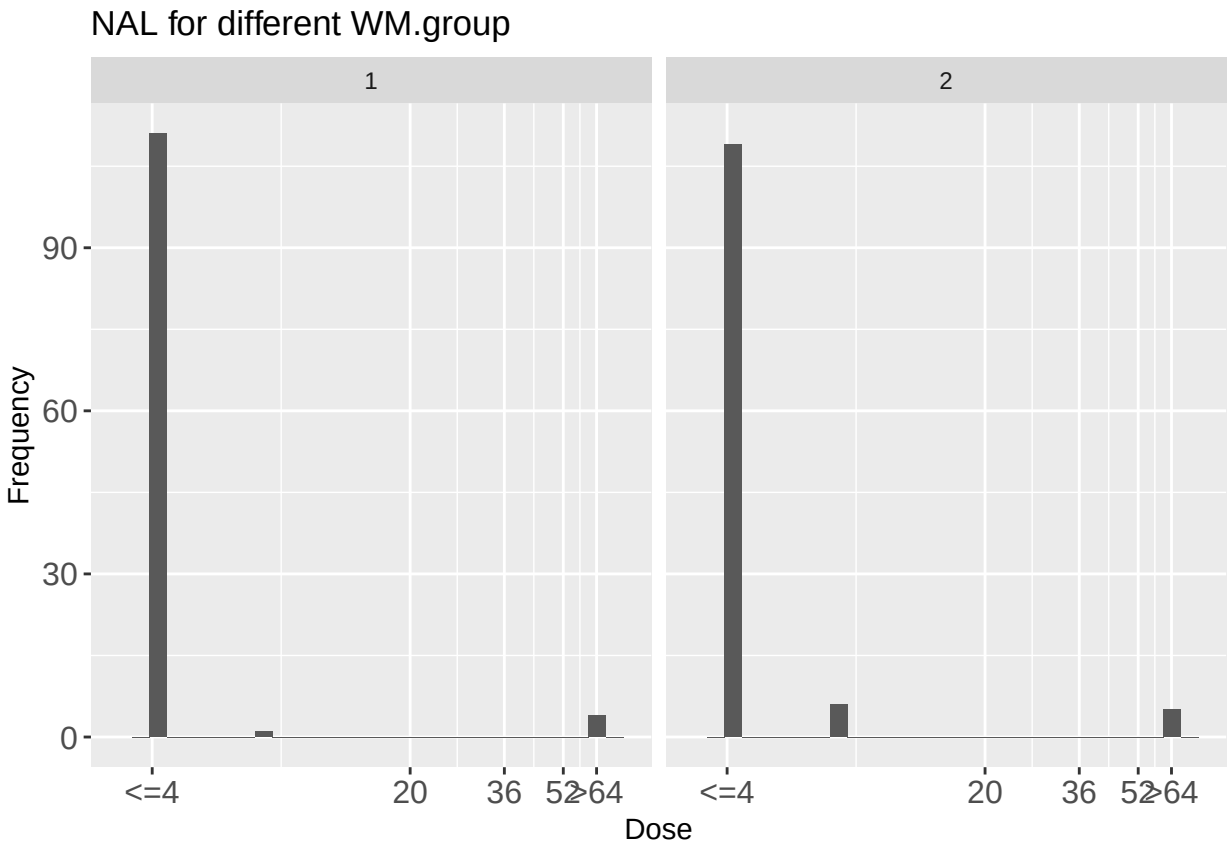
```
## [1] "CHL - Resistance, WM            :"
## [1] "  Median             <= 8"
## [1] "  Mean   in  7.862 ... 14.621"
## [1] ""
## [1] "CHL - Resistance, no WM      :"
## [1] "  Median             <= 8"
## [1] "  Mean   in  16.267 ... 21.933"
## [1] ""
```



Der Mittelwert ist tendenziell höher ohne WM.

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

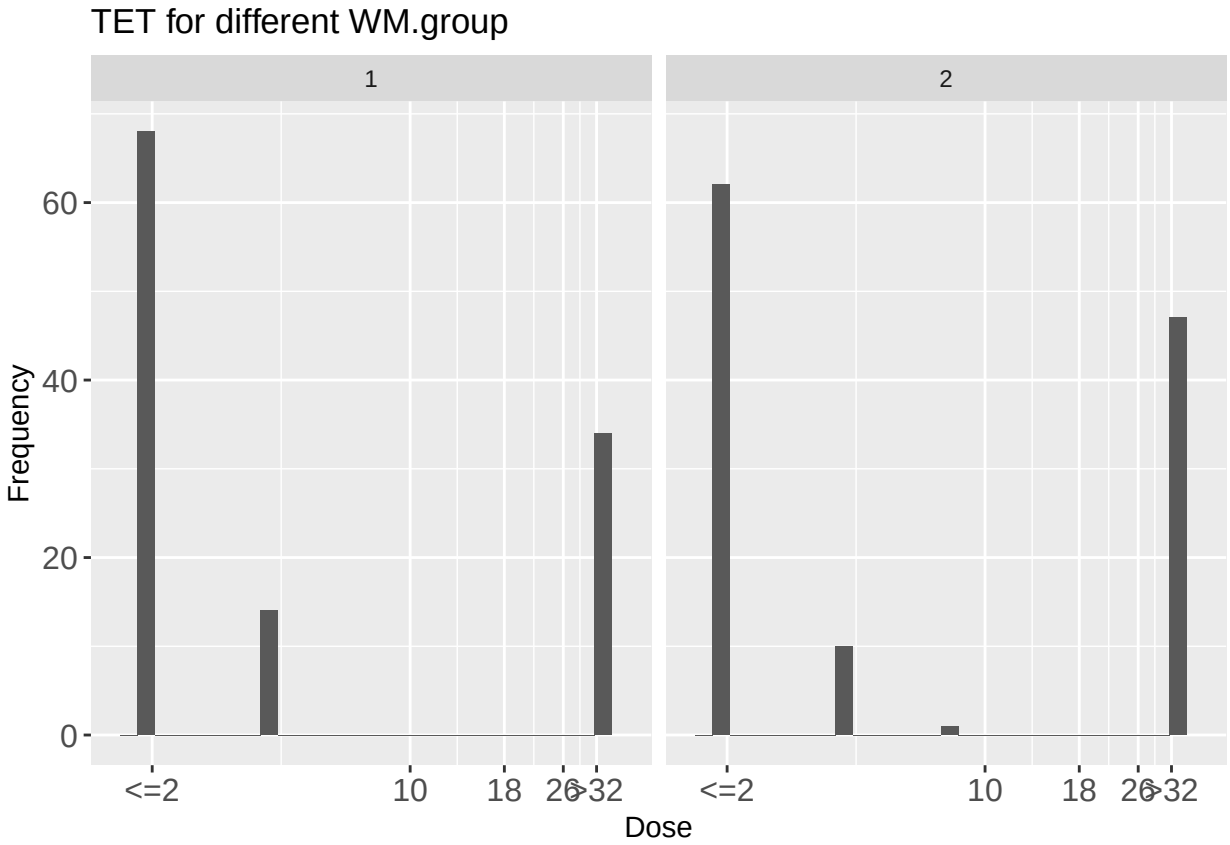
```
## [1] "NAL - Resistance, WM            :"
## [1] "  Median             <= 4"
## [1] "  Mean   in  2.276 ... 6.103"
## [1] ""
## [1] "NAL - Resistance, no WM      :"
## [1] "  Median             <= 4"
## [1] "  Mean   in  3.067 ... 6.700"
## [1] ""
```



Der Mittelwert ist tendenziell höher ohne WM.

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

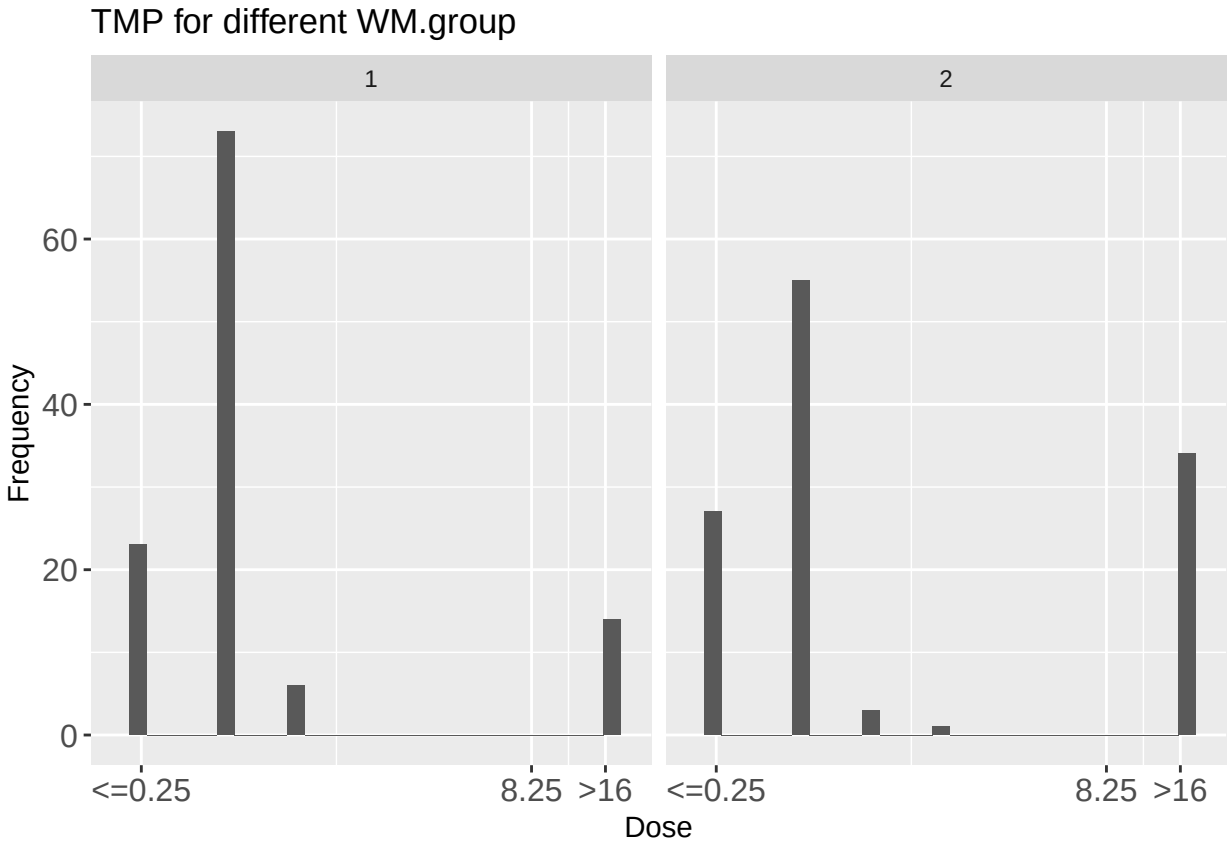
```
## [1] "TET - Resistance, WM            :"
## [1] "  Median             <= 2"
## [1] "  Mean   in  9.862 ... 11.034"
## [1] ""
## [1] "TET - Resistance, no WM      :"
## [1] "  Median             <= 2"
## [1] "  Mean   in  12.933 ... 13.967"
## [1] ""
```



Der Mittelwert ist tendenziell höher ohne WM.

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

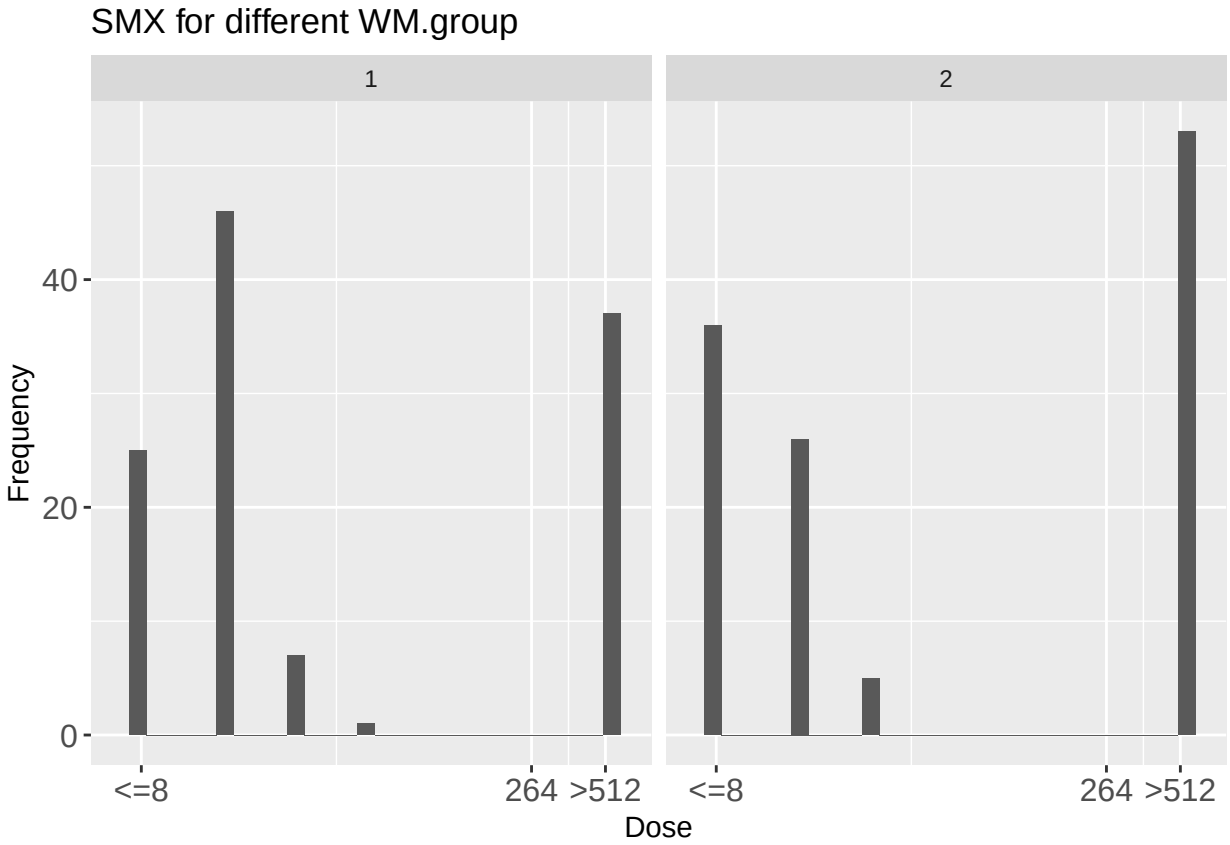
```
## [1] "TMP - Resistance, WM            :"
## [1] "  Median             = 0.5"
## [1] "  Mean   in  2.297 ... 2.347"
## [1] ""
## [1] "TMP - Resistance, no WM      :"
## [1] "  Median             = 0.5"
## [1] "  Mean   in  4.804 ... 4.860"
## [1] ""
```



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] ""
```



Der Mittelwert ist vergleichbar ohne WM.

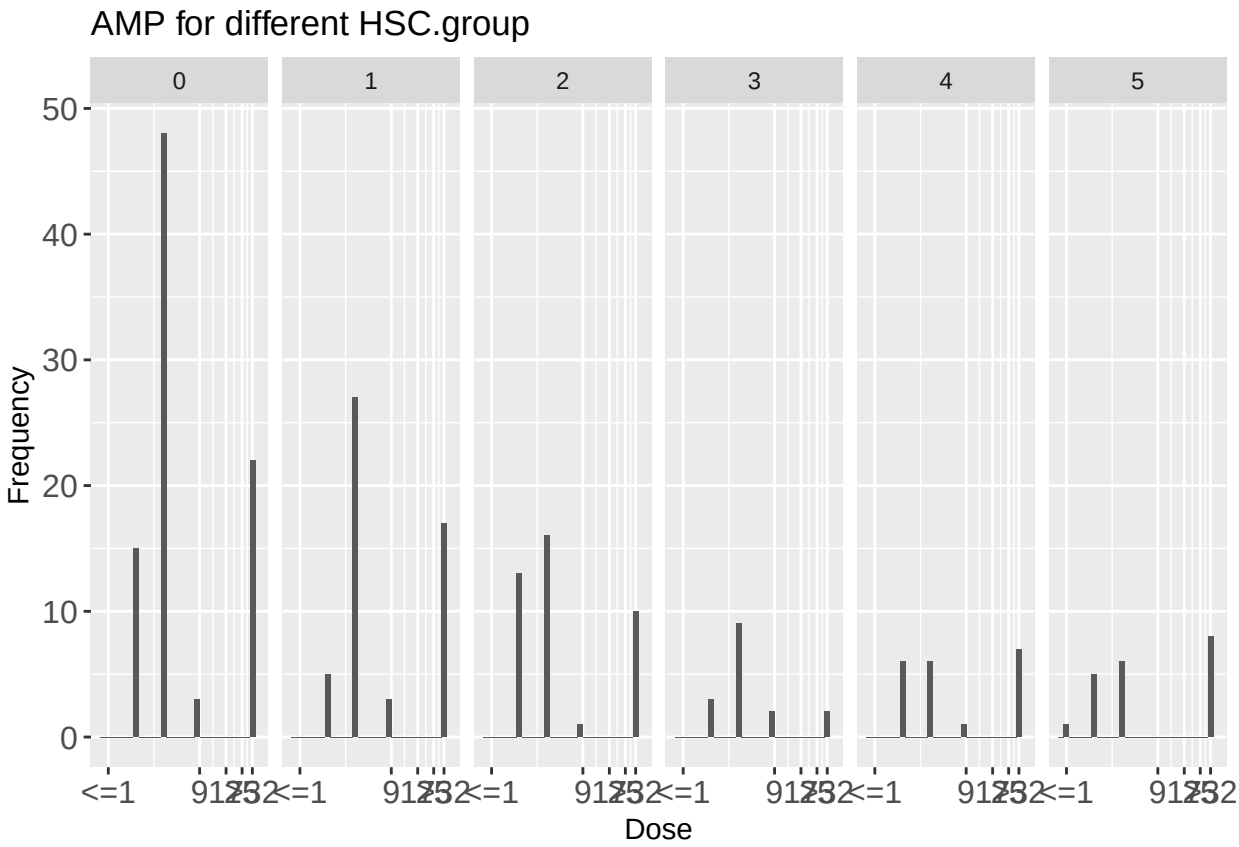
Die Mittelwerte der Resistenz sind für 5 Antibiotika vergleichbar (MERO, GEN, TGC, TAZ, SMX), für 3 Antibiotika tendenziell grösser im Fall *WM* (CIP, FOT, NAL) und für 5 Antibiotika definitiv grösser in diesem Fall (AMP, AZI, HCL, TET, TMP).

Husbandry System Calves - Gruppen

Mit “HSC” abgekürzt.

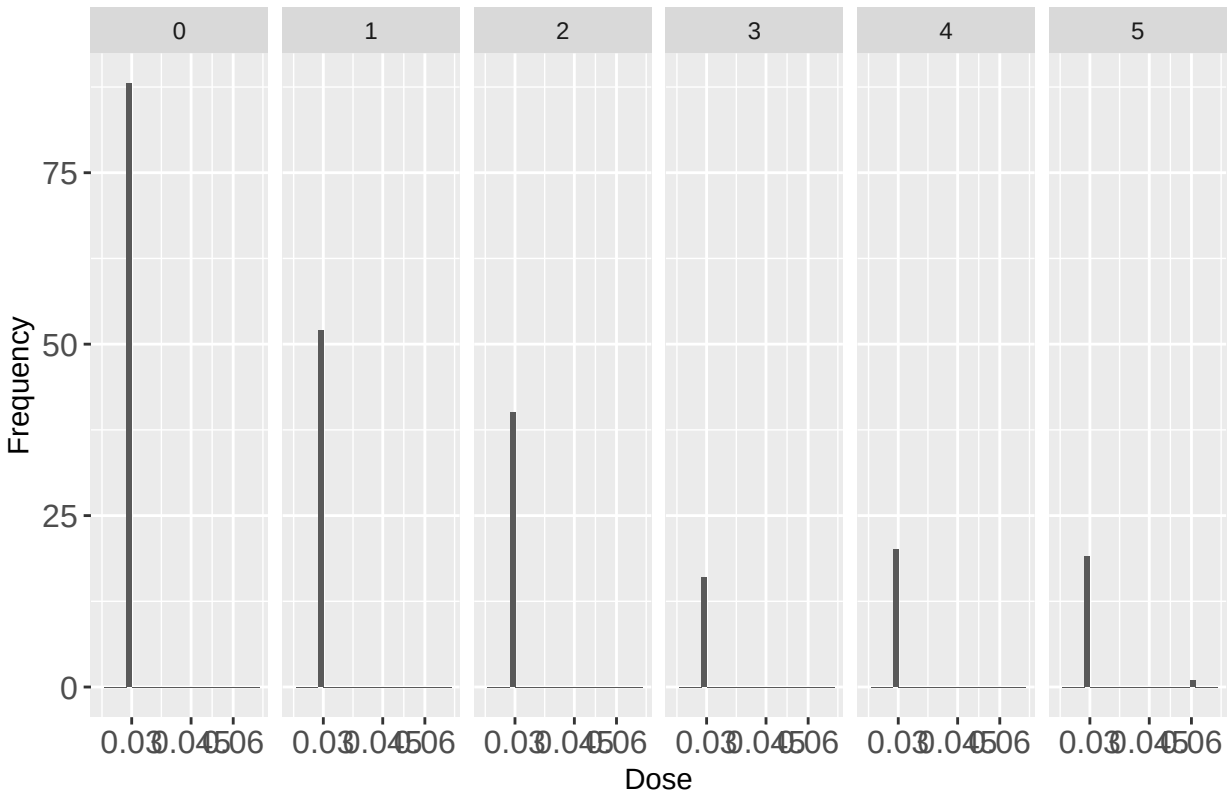
```
  graphisch("HSC.group", "AMP", 1,32, 1,8)
```

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



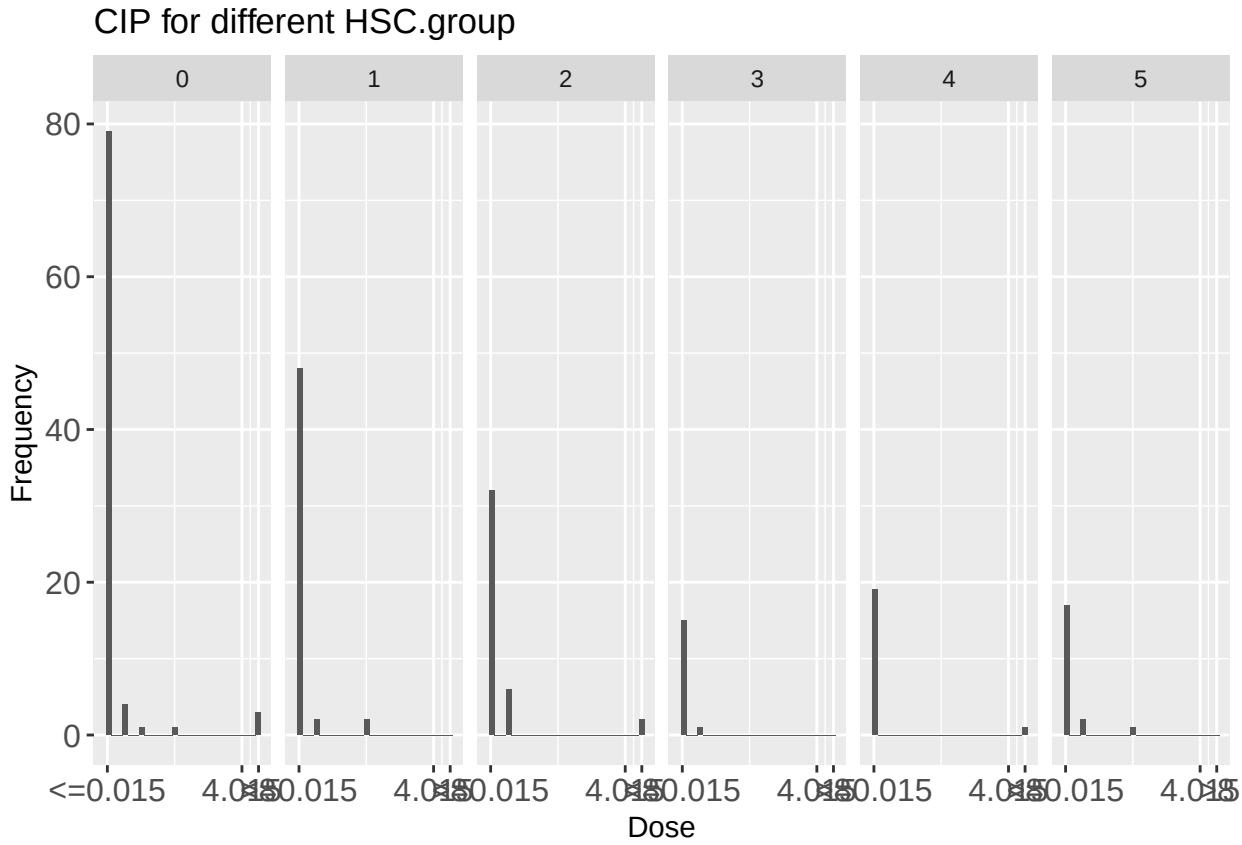

```
graphisch("HSC.group", "MERO", 0.03 ,  -0.06,   0.015,0.015)
```

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



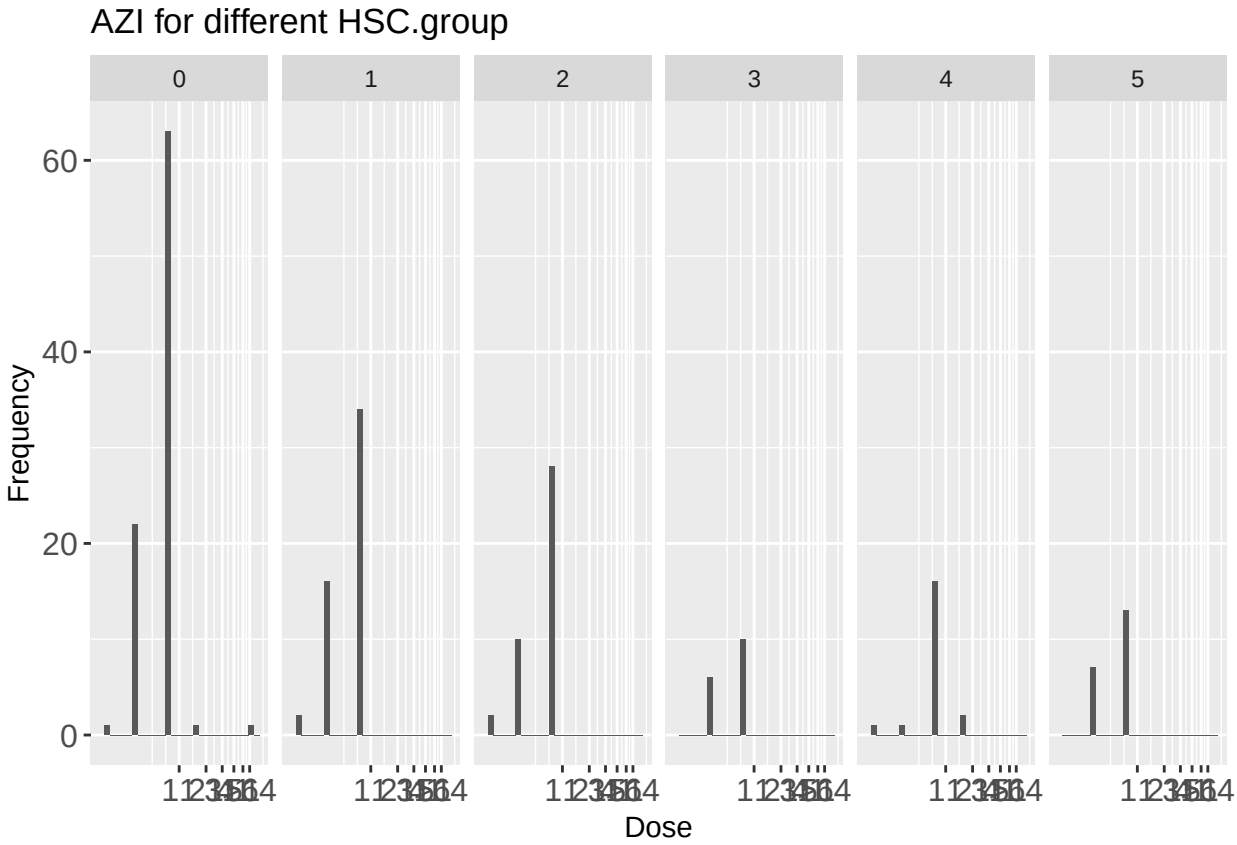

```
  graphisch("HSC.group", "CIP" , 0.015,   8   ,   0.015,   4    )
```

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



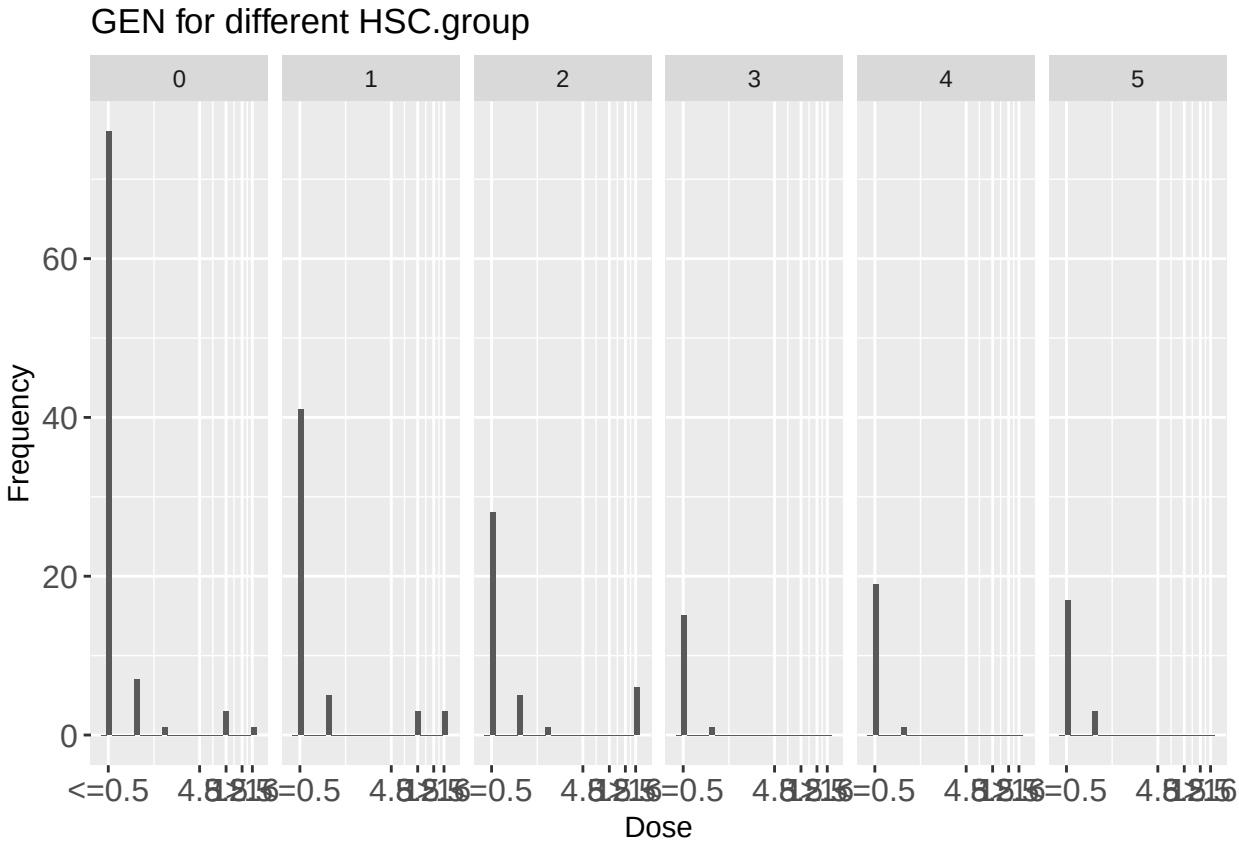

```
graphisch("HSC.group", "AZI" , 2    ,  64   ,   1    ,   10    )
```

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



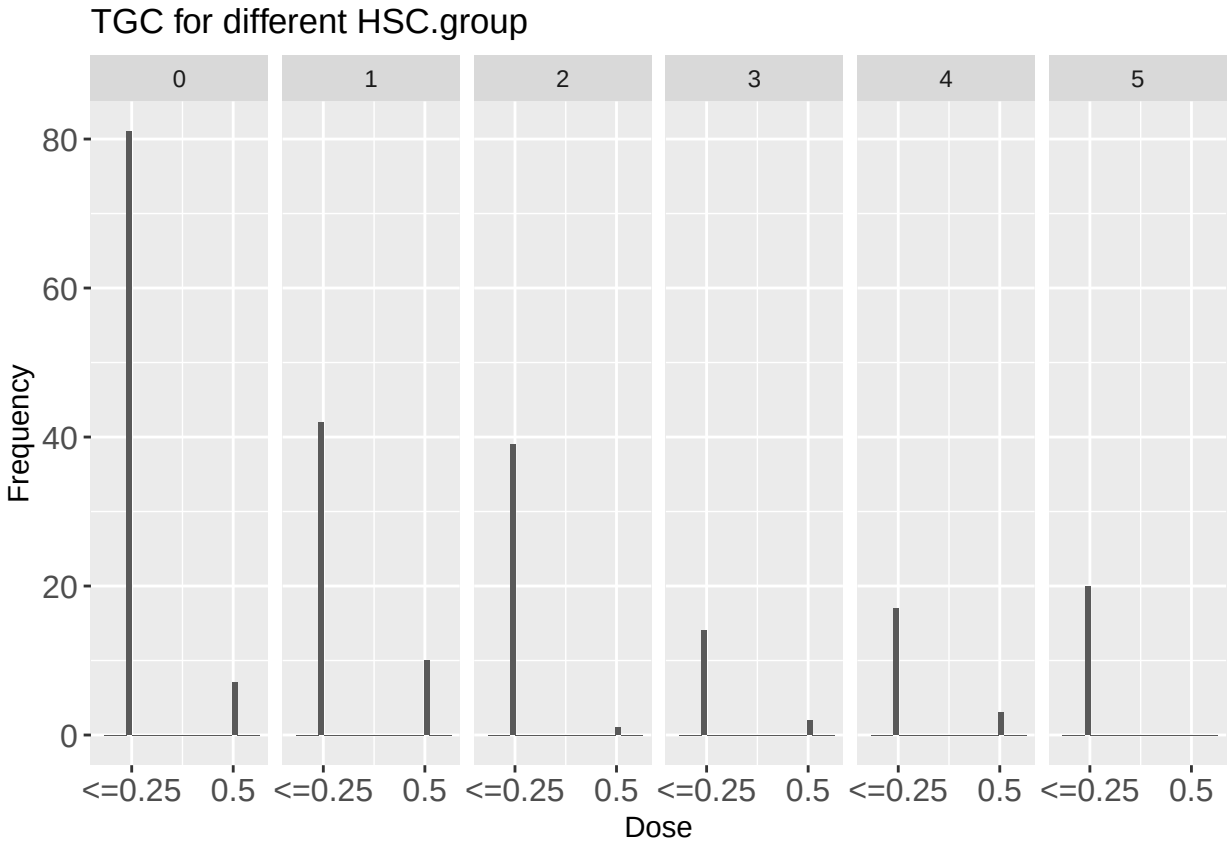

```
graphisch("HSC.group", "GEN" , 0.5  ,  16   ,   0.5  ,   4    )
```

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



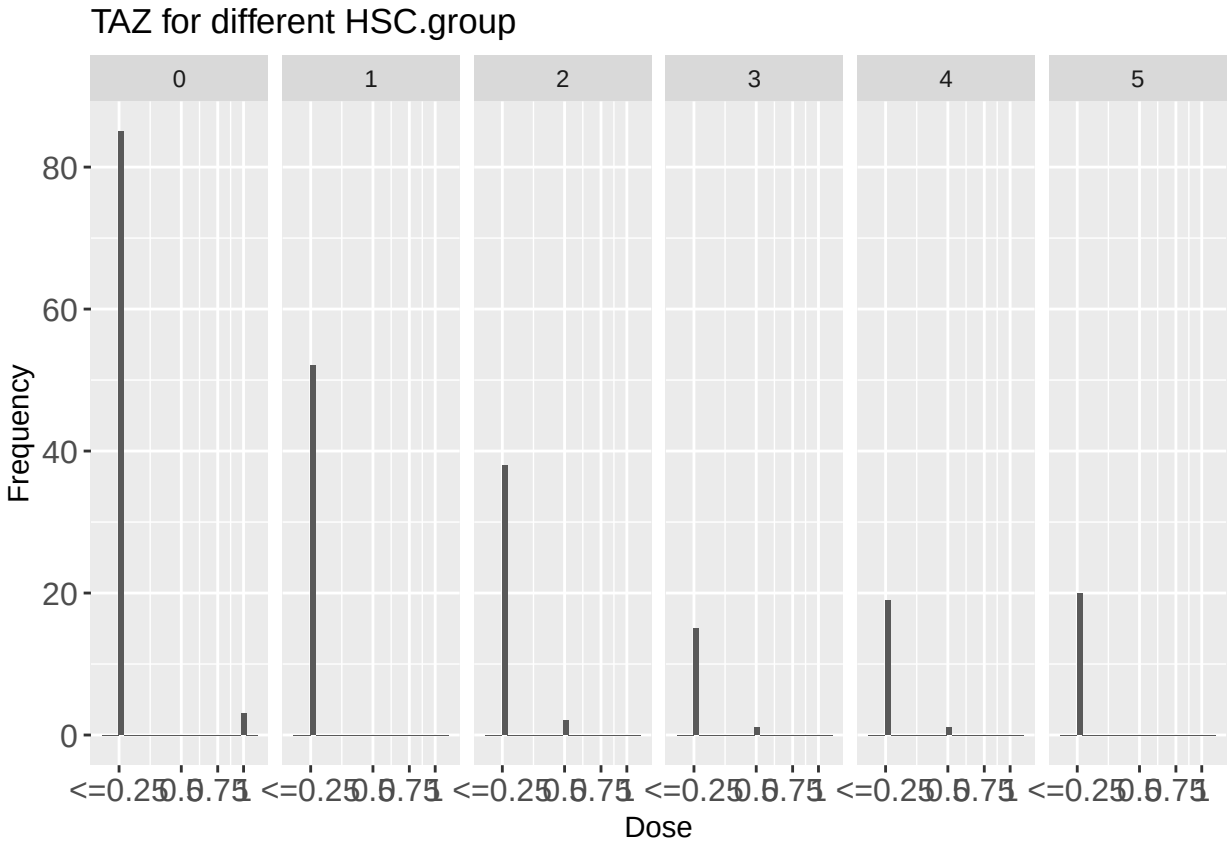

```
graphisch("HSC.group", "TGC" , 0.25 ,  -0.5 ,   0.25 ,   0.25 )
```

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



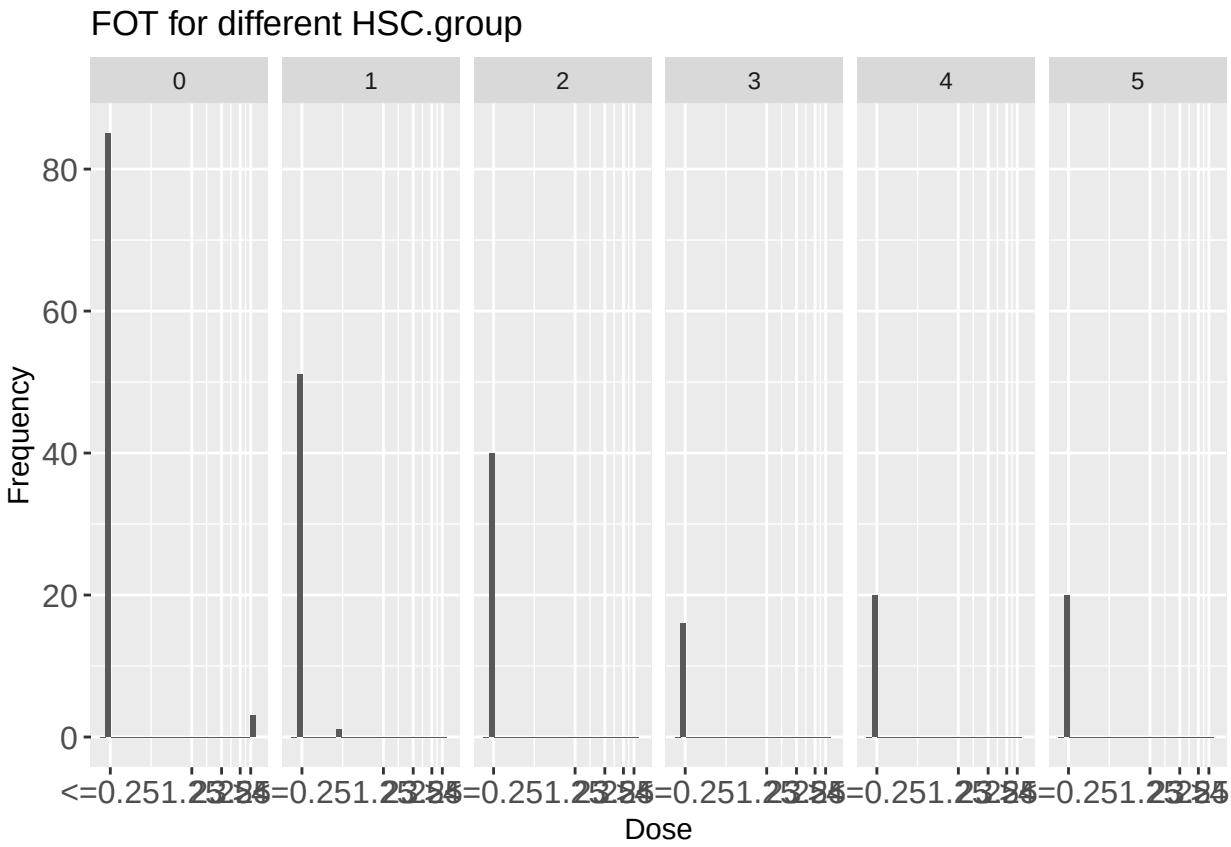

```
graphisch("HSC.group", "TAZ" , 0.25 ,  -1   ,   0.25 ,   0.25 )
```

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



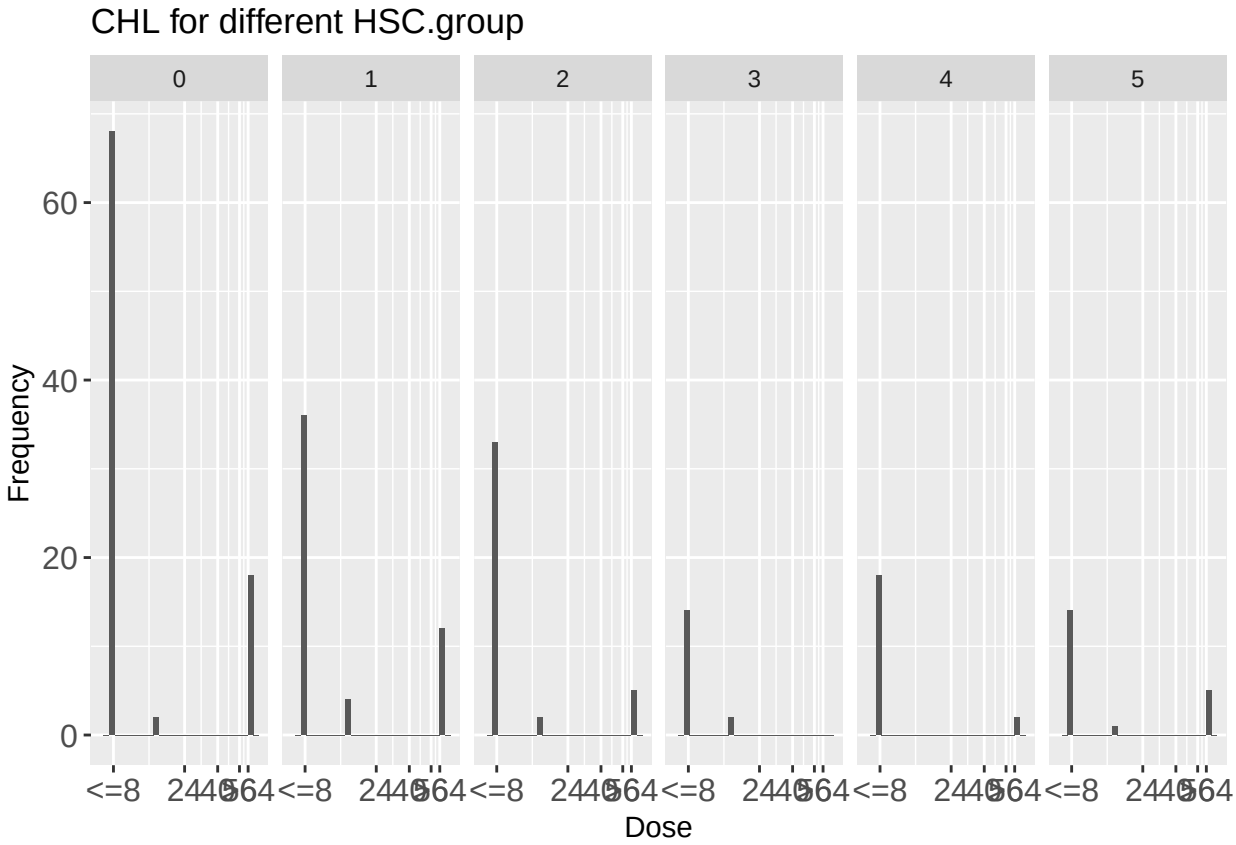

```
  graphisch("HSC.group", "FOT" , 0.25 ,   4    ,   0.25 ,   1    )
```

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



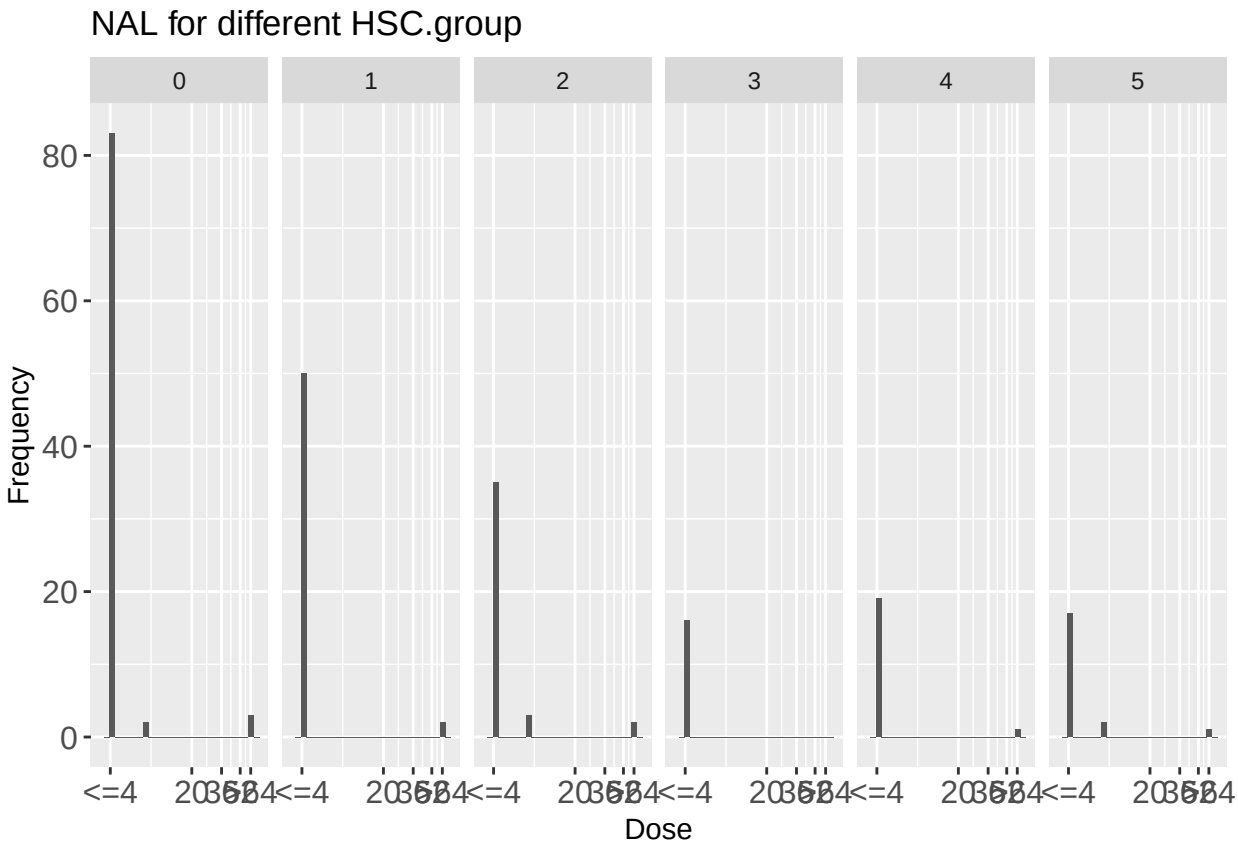

```
graphisch("HSC.group", "CHL" , 8    ,  64   ,   8,16   )
```

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



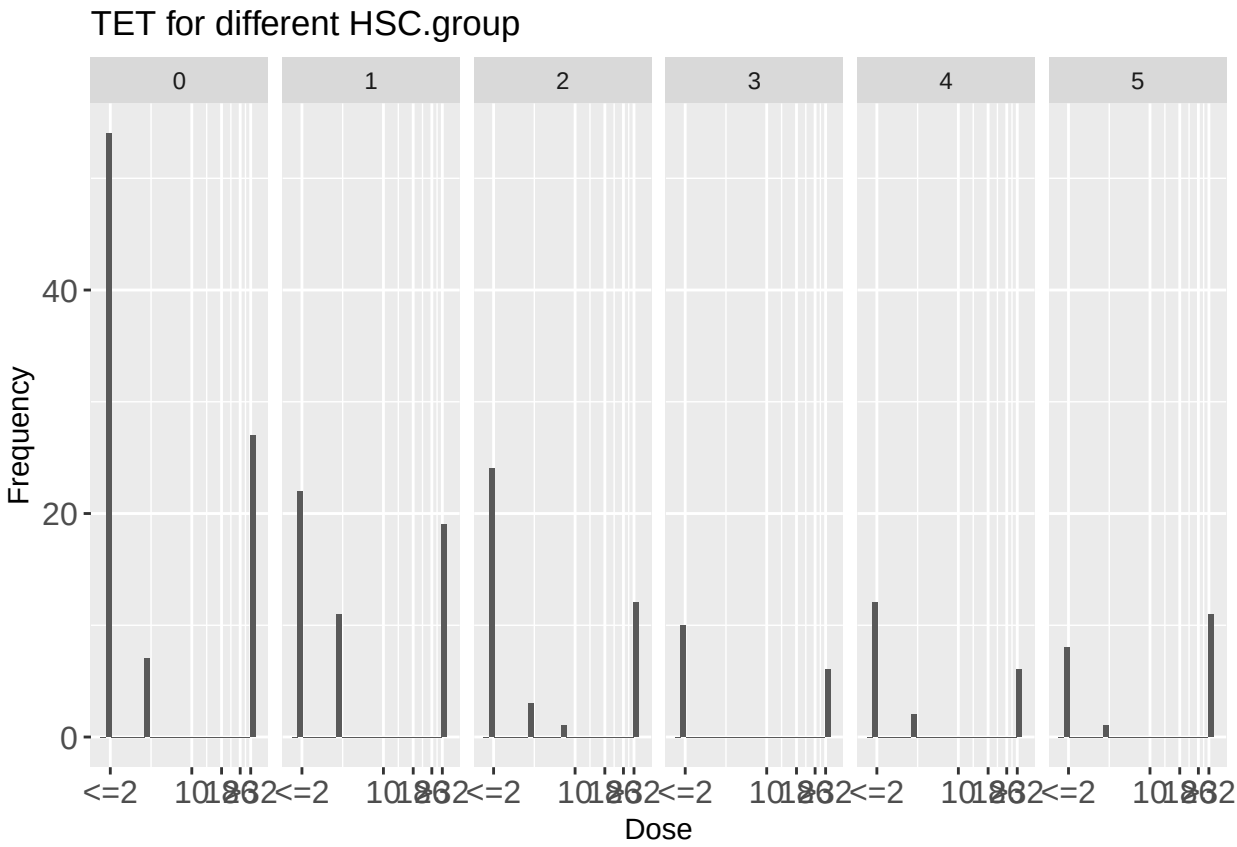

```
   graphisch("HSC.group", "NAL" , 4    ,  64   ,   4,16   )
```

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



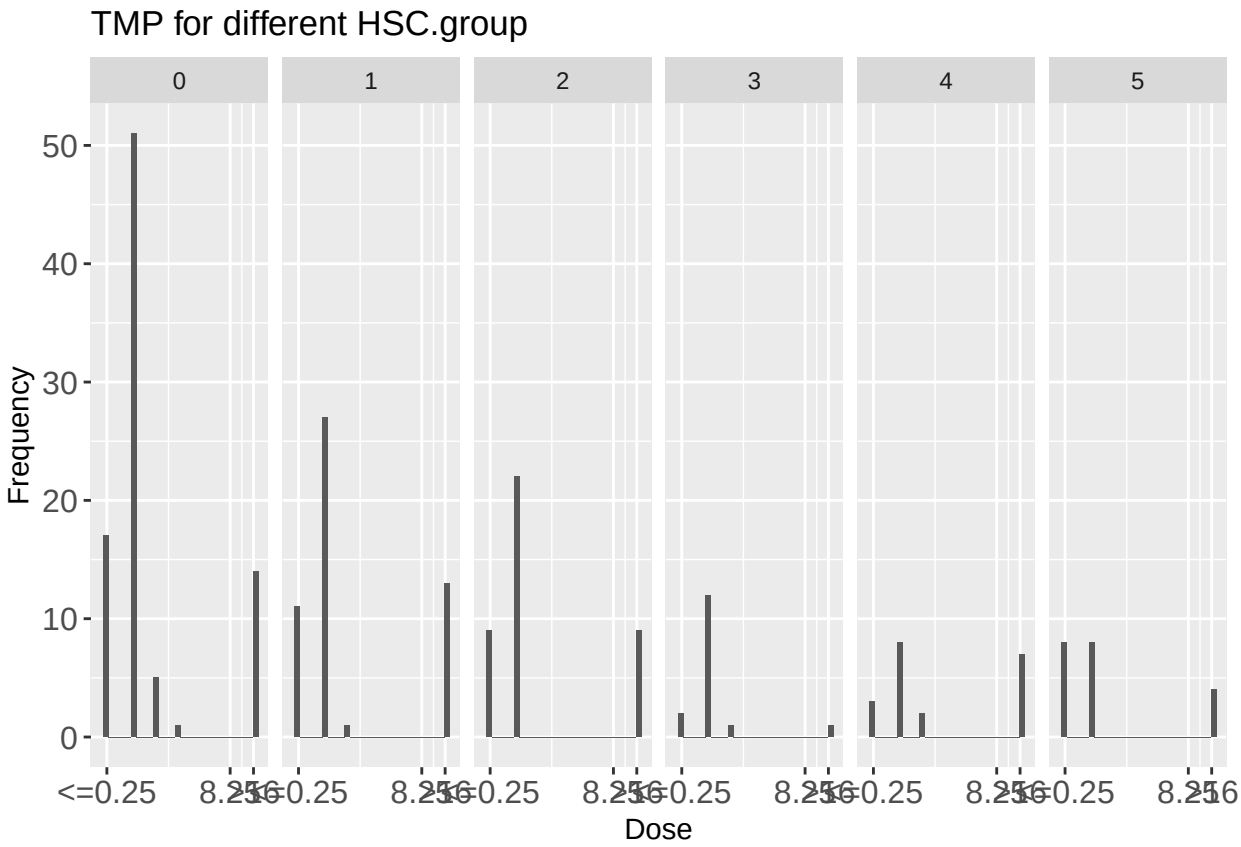

```
graphisch("HSC.group", "TET" , 2    ,  32   ,   2,8    )
```

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



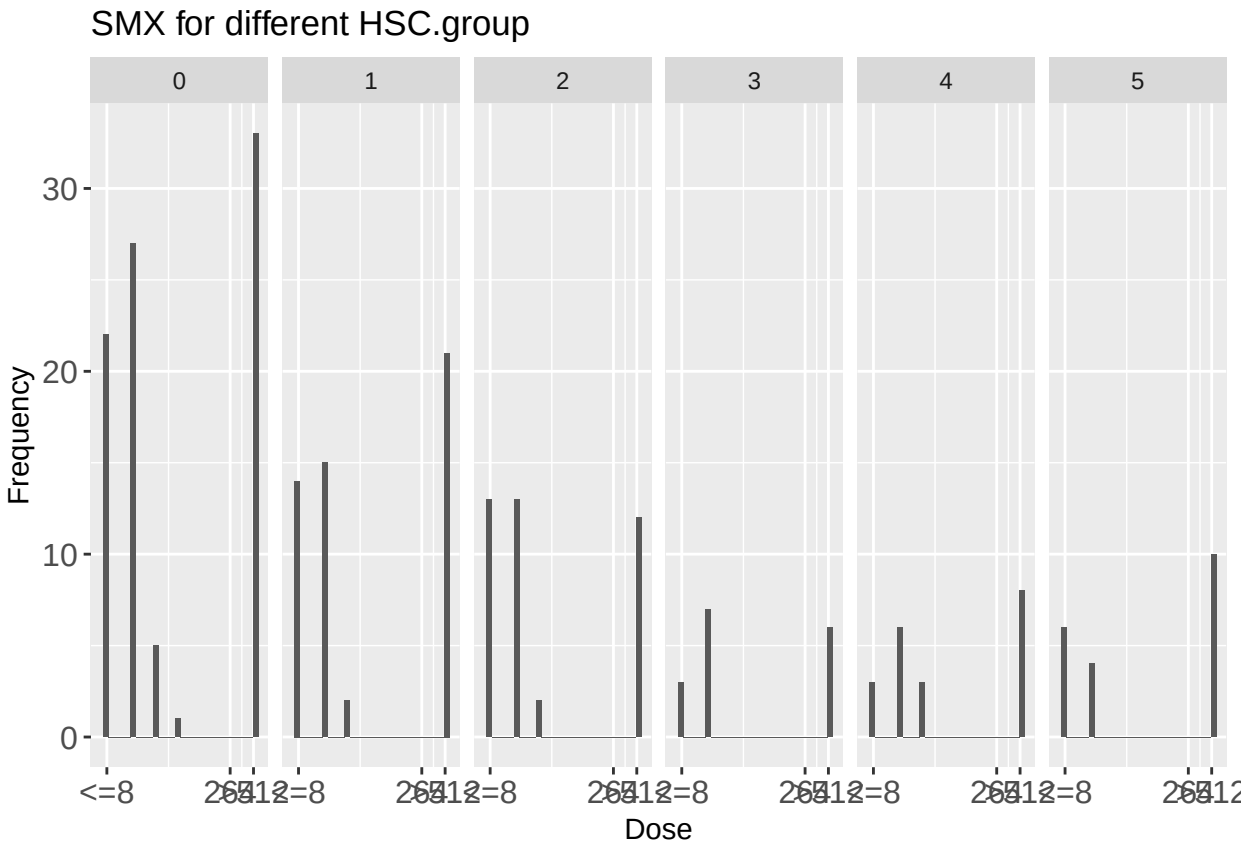

```
graphisch("HSC.group", "TMP" , 0.25 ,  16   ,   0.25,8    )
```

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




```
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 geplotted 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: ??