East Bay Municipal Utility District

EBMUD

MEASUREMENT QUALITY OBJECTIVES

Bathroom Scale Tales

Why We Believe the Laboratory's Results… and Why We Trust the Market Place When We Buy a Chicken for Dinner.

East Bay Municipal Utility District

EBMUD

OVERVIEW

- Defining measurements
- Role of the Laboratory
- Data Validation
- Measurement Error
- Interpreting the Data

TWO BIG QUESTIONS

- Are the data acceptable?
- What do the data mean?

East Bay Municipal Utility District

MEASUREMENT OBJECTIVES

The objectives of a measurement are to answer the questions

- *what is in the sample?*
- *how much?*

The objectives of the measurement process are

- *control sources of error*
- *provide data for scientifically valid conclusions.*

MEASUREMENT ERROR

ALL measurements have:

- Systematic error (bias)
- Random error

SYSTEMATIC ERROR

- Invariant
- Determinant
- Controllable
- Sources: Contamination
  Calibration
  Matrix

RANDOM ERROR

- Variable
- Indeterminant
- Not controllable
- Sources:
  Methodology
  Murphy

East Bay Municipal Utility District

VALIDATION

are the data acceptable?

- Precision = Duplicates
- Accuracy = LCS, SPIKES
- Background = Blanks
- Detection = DL Studies
- Calibration = Standards

PRECISION

- = agreement of observations
- = Percentage

(Dup Differences)/(Dup Average)

- Measure of reproducibility
- Measure of random error

Scale tale #1

A Story of precision

What is my weight?

Trial (#)	Weight (pounds)	
1	160	
2	158	
3	159	Avg = 160
4	162	Stdev = 1

Rand error: variability = 1 pound

Prec = 100 x std dev/average

= 100 x 1/160 = 0.6%

Conclusion: I weigh 160 plus or minus one pound.

Tale #2

Do lunches count?

After lunch I weigh 162 pounds – have I gained weight?

A difference of 2 pounds exceeds 1 pound (0.6%), but … if I use … control limits

UCL = Avg + 3 x Stdev
= 160 + 3 x 1 pounds
= 163 pounds

Whew! Weight change is under the upper control limit.

Tale #3

A story of Accuracy

something is wrong!!!

My weight on a friend's scales = 170 pounds!!!

Sack of potatoes stamped: IDAHO GROWN ** 100 pounds ** (SRM CERTIFIED!)

Scale results: 110 pounds

Accuracy

= 100 x (110/100)

= 110%

Conclusion: keep my friend, but don't use the scales.

Tale #4 BLANKS

when something

should be nothing

Friends scales again:

Scale reading with nothing added

= 10 pounds

Systematic bias = 10 pounds

Corrective action: recalibrate scales

Tale #5

what is my weight?

True = Scales +/- error

Error = systematic (bias) + random

Conclusion (using friend's scales)

True = scales – bias +/- random

= 170 – 10 +/- 3

157 # < true weight < 163 #

Tale #6

it's 100% recovered

but inaccurate

Friends scales again

Body weight = 170 #
Body + 100 pound SRM = 270 #
Recovery = (270-170)/100
= 100%

Scale reading of 100 # weight
= 110 #
Accuracy = 100 x 110/100
= 110%

Tale #7

Even when I swim?

My weight in water: 100 #

My weight + 100 # SRM: 162 #

Recovery = $\frac{100x(\text{spiked} - \text{unspiked})}{\text{spiking amount}}$

= 100 x (162 - 100)/100

= 62%

Conclusion: Matrix effect reduces measurement to 62% of matrix-free value

Corrective Action: don't weigh yourself in the bathtub.

Tale #8

How low can you go?

Less than detection: anything below the upper control limit for zero

MDL = 3.14 x standard deviation of seven method blanks or seven low level replicates

Control measure for data censure

Includes random error only (usually)

Tale #8 (cont)

How low can you go?

How to determine an MDL for my bathroom scales:

Repeatedly weigh a one pound SRM seven (or more) times

1, 1, 1, 2, 0, 1, 1 pounds

Average = 1 pound

Standard deviation = 0.6 pounds

MDL = 3.14 x 0.6

= 1.8 ~ 2 pounds

Tale #9

weigh my rat

Rat is weighed seven times:
0, 0,1,0,0,1,1 (in pounds)

Average = 0.4 pounds
Std dev = 0.5 pounds

0 < True Weight of Rat < 1.5
UCL < MDL so…

Conclusion: Rat does not exist!

CONCLUSIONS

- Measurements have error
- All error can be measured
- Recovery is not accuracy
- Not detected is not zero
- Don’t weigh yourself in a bathtub
- Don’t discuss weight loss diets with someone who won’t calibrate scales