

# MSA : GAUGE R&R

CONTAINMENT AND ERADICATION OF EBOLA

TEAM 5

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# AGENDA

- TOPIC
- MSA AND GAUGE R&R INTRODUCTION
- DATA
- GAUGE R&R APPLICATION
  - VARIABLE
  - ATTRIBUTE
- CONCLUSIONS

# EBOLA VIRUS: ORIGINS



- ORIGINATED IN 1976, INFECTING ~250
- MORTALITY RATE OF 53%
- POTENTIALLY FROM BATS
- FOUND IN AFRICA AND PHILIPPINES (MONKEYS)
- 3 KNOWN STRAINS

# EBOLA VIRUS: THE EPIDEMIC

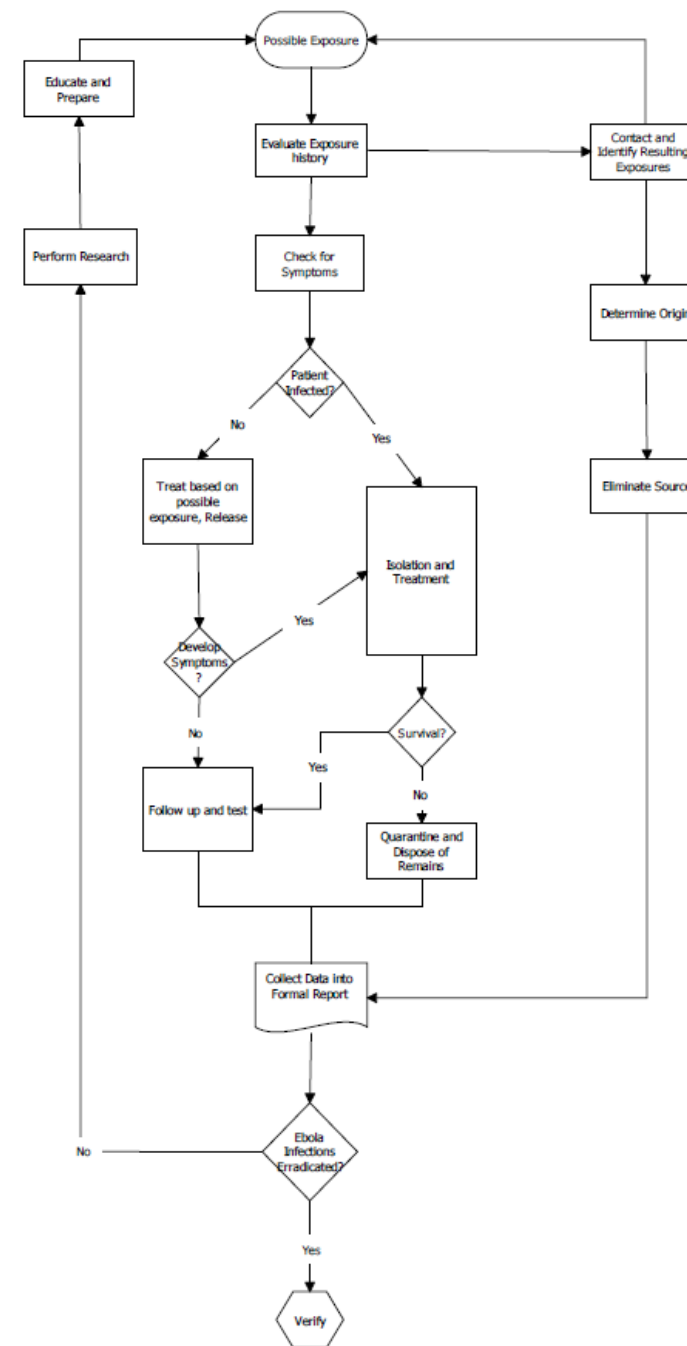
- CARRIES A PROTEIN MEANT TO DISARM THE BODY'S NATURAL DEFENSE
- TAKES 21 DAYS TO DISPLAY SYMPTOMS
- CARRIED BY FLUIDS AND CAN LIVE FOR HOURS IN OPEN EXPOSURE TO AIR
- TRANSMITTED IN BATS OR BUSH MEATS
- AVERAGE DEATH RATE OF 50%
- OVER 11,000 KNOWN DEATHS SINCE 2014 OUTBREAK

# SYMPTOMS OF EBOLA

- FEVER
- SEVERE HEADACHE
- MUSCLE PAIN
- WEAKNESS
- FATIGUE
- DIARRHEA
- VOMITING
- ABDOMINAL (STOMACH) PAIN
- UNEXPLAINED HEMORRHAGE (BLEEDING OR BRUISING)

# ISSUES IN QUALITY

- CONTRACT EBOLA
  - GO TO HOSPITAL
- FOCUS OF ANALYSIS
  - HOSPITALS
- HAS GREATEST EFFECT ON POPULATION



# MSA: MEASUREMENT SYSTEM ANALYSIS

- A METHOD USED WITH SIX SIGMA
- DETERMINES HOW MUCH MEASUREMENT VARIATION CONTRIBUTES TO TOTAL
- FIVE PARAMETERS OF MSA:
  - BIAS
  - LINEARITY
  - STABILITY
  - REPEATABILITY
  - REPRODUCIBILITY

# GAUGE R&R

- REPEATABILITY – CONCERNS VARIATION DUE TO MEASUREMENT GAUGES/EQUIPMENT
- REPRODUCIBILITY – CONCERNS VARIATION DUE TO HUMAN “APPRAISERS” USING GAUGES
- PROVIDES SEPARATE NUMERICAL ESTIMATES OF REPEATABILITY AND REPRODUCIBILITY
- TWO TYPES:
  - VARIABLES - QUANTITATIVE
  - ATTRIBUTES - QUALITATIVE
- TWO METHODS:
  - X-BAR – BASIC ANALYSIS OF AVERAGES AND RANGES
  - ANOVA – CAN EVALUATE INTERACTION BETWEEN PARTS AND APPRAISERS



# GAUGE R&R

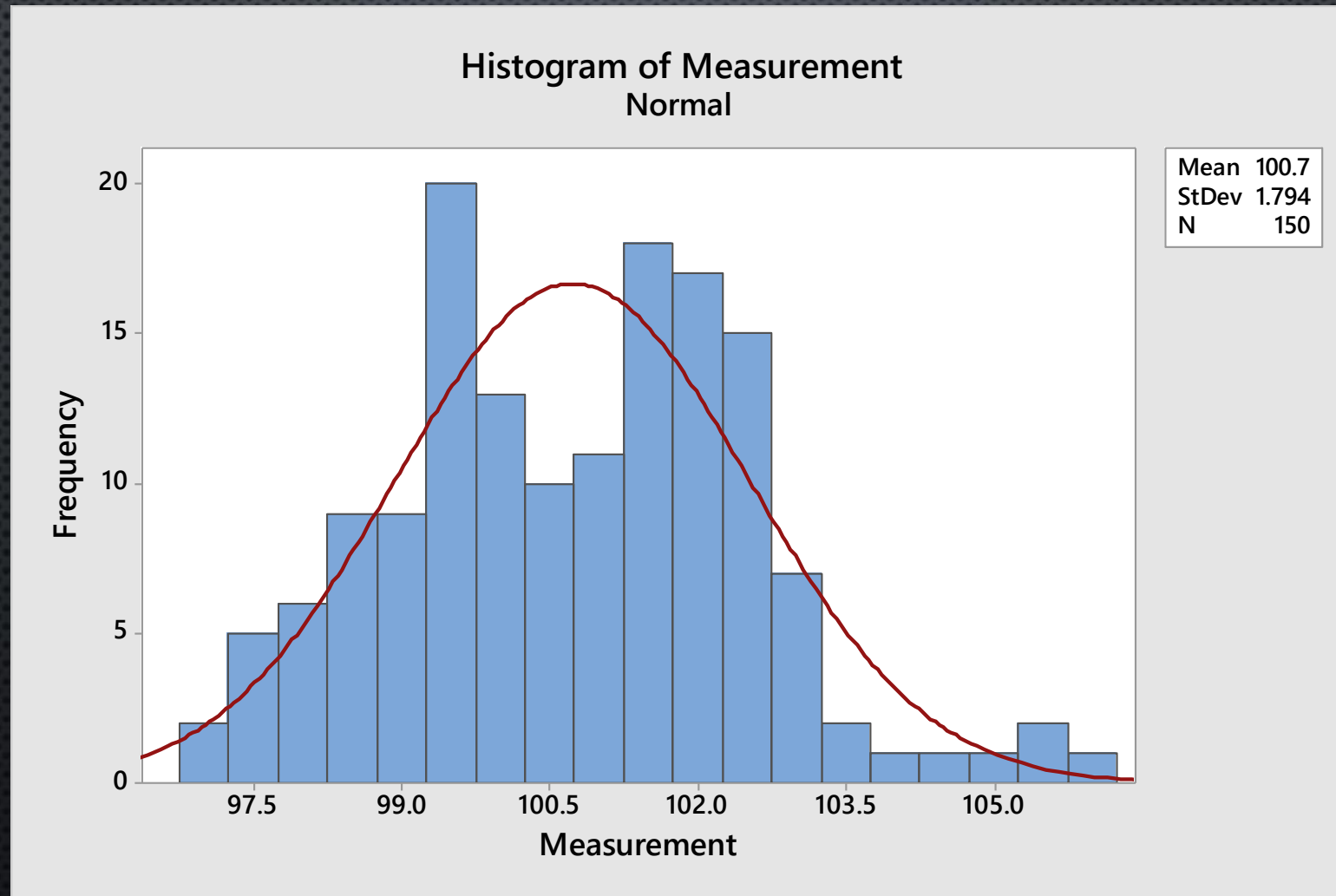
- CHOSE A HOSPITAL WITH A HIGH LEVEL OF CONSISTENT INFECTIONS
- VARIABLE:
  - MONITORED 5 NURSES/ATTENDANTS
  - RECORDED THE TEMPERATURE FOR PATIENTS
- ATTRIBUTE:
  - MONITORED THE TWO DAY-SHIFT DOCTORS QUALIFIED TO TREAT EBOLA
  - MEASURED THEIR SUCCESS RATE AT IDENTIFYING EBOLA CASES

# DATA: VARIABLE AND ATTRIBUTE

Patient	Nurse A	Nurse B	Nurse C	Nurse D	Nurse E
1	99.48	101.68	99.83	99.62	99.57
1	99.62	101.74	99.30	99.31	99.56
1	99.27	101.51	99.42	100.12	99.18
2	100.19	100.73	97.47	98.23	100.81
2	97.56	99.42	100.61	97.80	100.96
2	100.44	98.01	99.99	99.77	99.16
3	101.86	101.93	102.43	102.52	100.82
3	101.30	100.40	101.73	102.77	102.87
3	102.17	103.50	102.79	100.04	101.97
4	98.48	98.68	97.39	98.85	99.30
4	98.29	97.08	99.43	98.16	98.94
4	97.16	99.24	98.96	97.33	99.30
5	100.52	102.32	102.51	101.47	102.22
5	100.26	100.51	102.97	100.78	101.27
5	102.81	100.90	102.34	100.85	102.09
6	102.00	105.69	99.78	100.12	103.67
6	102.47	104.01	100.23	101.93	105.26
6	104.35	101.82	105.11	102.45	105.77
7	99.73	99.06	98.04	99.65	99.11
7	99.60	99.83	98.43	99.78	99.54
7	99.11	99.75	97.72	98.03	98.67
8	102.23	102.23	101.34	100.70	101.40
8	100.62	100.94	101.01	102.69	102.37
8	100.25	101.44	101.41	102.00	102.94
9	101.64	99.42	98.30	98.48	99.27
9	99.91	101.71	101.70	100.73	98.59
9	101.53	98.63	101.29	101.76	101.98
10	101.21	102.41	102.61	102.78	102.51
10	102.55	101.86	102.61	102.46	101.24
10	101.42	101.79	101.67	102.17	101.15

Patient	Attribute	Doctor	Result	Patient	Attribute	Doctor	Result
1	ebola	1	ebola	1	ebola	2	ebola
2	no	1	no	2	no	2	no
3	no	1	no	3	no	2	no
4	no	1	no	4	no	2	no
5	no	1	no	5	no	2	no
6	no	1	no	6	no	2	no
7	no	1	no	7	no	2	ebola
8	no	1	no	8	no	2	no
9	no	1	no	9	no	2	no
10	no	1	no	10	no	2	no
11	no	1	no	11	no	2	no
12	no	1	no	12	no	2	no
13	no	1	no	13	no	2	no
14	no	1	no	14	no	2	no
15	ebola	1	ebola	15	ebola	2	ebola
16	ebola	1	ebola	16	ebola	2	ebola
17	ebola	1	no	17	ebola	2	no
18	no	1	no	18	no	2	no
19	ebola	1	ebola	19	ebola	2	ebola
20	no	1	no	20	no	2	no
1	ebola	1	ebola	1	ebola	2	ebola
2	no	1	no	2	no	2	no
3	no	1	no	3	no	2	no
4	no	1	no	4	no	2	no
5	no	1	no	5	no	2	ebola
6	no	1	no	6	no	2	no
7	no	1	no	7	no	2	no
8	no	1	no	8	no	2	no
9	no	1	no	9	no	2	no
10	no	1	no	10	no	2	no
11	no	1	no	11	no	2	no
12	no	1	no	12	no	2	no
13	no	1	no	13	no	2	no
14	no	1	no	14	no	2	no
15	ebola	1	ebola	15	ebola	2	ebola
16	ebola	1	ebola	16	ebola	2	no
17	ebola	1	no	17	ebola	2	ebola
18	no	1	no	18	no	2	no
19	ebola	1	ebola	19	ebola	2	ebola
20	no	1	no	20	no	2	no

# HISTOGRAM OF VARIABLE DATA



# VARIABLE ANALYSIS: X-BAR

## %CONTRIBUTION

SOURCE	VARCOMP	(OF VARCOMP)
TOTAL GAGE R&R	1.06488	34.30
REPEATABILITY	1.04002	33.50
REPRODUCIBILITY	0.02486	0.80
PART-TO-PART	2.03952	65.70
TOTAL VARIATION	3.10440	100.00

## STUDY VAR %STUDY VAR

SOURCE	STDDEV (SD)	(6 × SD)	(%SV)
TOTAL GAGE R&R	1.03193	6.1916	58.57
REPEATABILITY	1.01982	6.1189	57.88
REPRODUCIBILITY	0.15767	0.9460	8.95
PART-TO-PART	1.42812	8.5687	81.05
TOTAL VARIATION	1.76193	10.5716	100.00

NUMBER OF DISTINCT CATEGORIES = 1

# VARIABILITY ANALYSIS: ANOVA

**TWO-WAY ANOVA TABLE WITH INTERACTION**

SOURCE	DF	SS	MS	F	P
SAMPLE	9	302.659	33.6288	23.4671	0.000
OPERATOR	4	7.755	1.9388	1.3529	0.270
SAMPLE * OPERATOR	36	51.589	1.4330	1.2189	0.220
REPEATABILITY	100	117.562	1.1756		
TOTAL	149	479.565			

**GAGE R&R**

SOURCE	%CONTRIBUTION	
	VARCOMP	(OF VARCOMP)
TOTAL GAGE R&R	1.26693	36.98
REPEATABILITY	1.24376	36.30
REPRODUCIBILITY	0.02317	0.68
OPERATOR	0.02317	0.68
PART-TO-PART	2.15900	63.02
TOTAL VARIATION	3.42593	100.00

**TWO-WAY ANOVA TABLE WITHOUT INTERACTION**

SOURCE	DF	SS	MS	F	P
SAMPLE	9	302.659	33.6288	27.0380	0.000
OPERATOR	4	7.755	1.9388	1.5588	0.189
REPEATABILITY	136	169.151	1.2438		
TOTAL	149	479.565			

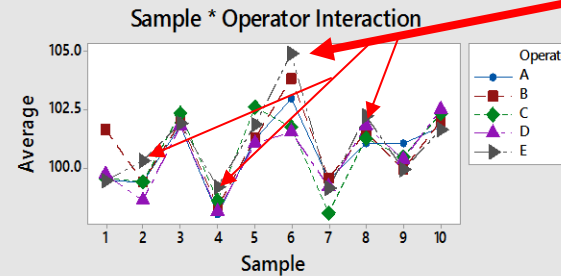
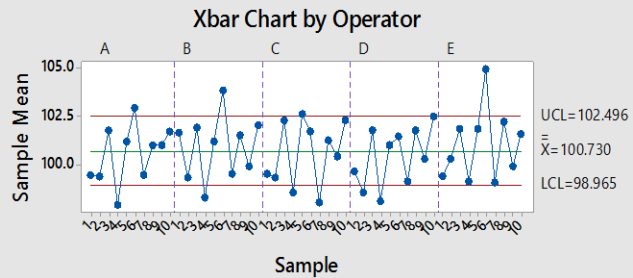
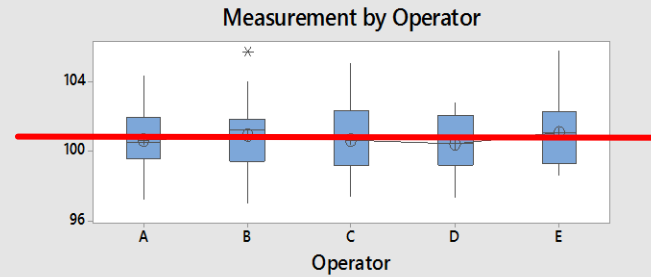
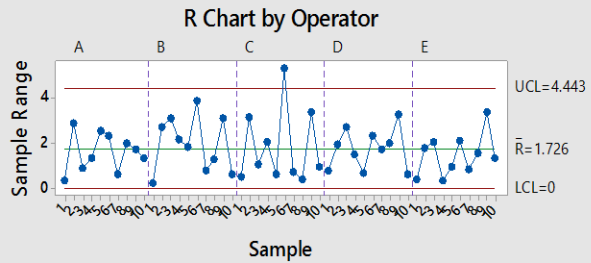
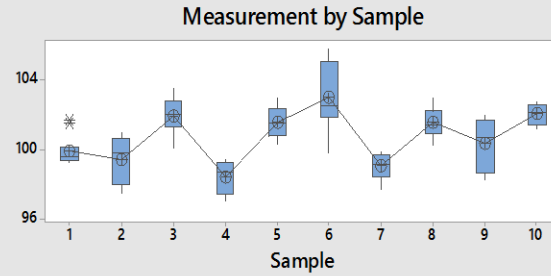
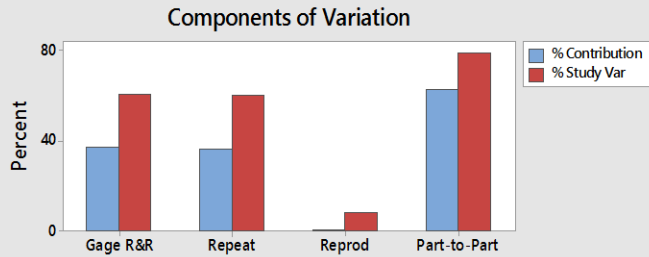
SOURCE	STUDY VAR %STUDY VAR		
	STDDEV (SD)	(6 × SD)	(%SV)
TOTAL GAGE R&R	1.12558	6.7535	60.81
REPEATABILITY	1.11524	6.6914	60.25
REPRODUCIBILITY	0.15221	0.9132	8.22
OPERATOR	0.15221	0.9132	8.22
PART-TO-PART	1.46935	8.8161	79.38
TOTAL VARIATION	1.85093	11.1056	100.00

# ANOVA CONTINUED

## Gage R&R (ANOVA) Report for Measurement

Gage name:  
Date of study:

Reported by:  
Tolerance:  
Misc:



# VARIABLE ANALYSIS: CONCLUSIONS

- TWO METHODS, SAME CONCLUSIONS:
  - REPEATABILITY
  - NEED NEW EQUIPMENT
- ANOVA
  - SUGGESTS OPERATORS ARE DOING FINE
- TRAINING ON CALIBRATION OF EQUIPMENT IF NEW EQUIPMENT NOT AVAILABLE

# VARIABILITY ANALYSIS - ATTRIBUTE

Patient	Attribute	Doctor	Result	Patient	Attribute	Doctor	Result
1	ebola	1	ebola	1	ebola	2	ebola
2	no	1	no	2	no	2	no
3	no	1	no	3	no	2	no
4	no	1	no	4	no	2	no
5	no	1	no	5	no	2	no
6	no	1	no	6	no	2	no
7	no	1	no	7	no	2	ebola
8	no	1	no	8	no	2	no
9	no	1	no	9	no	2	no
10	no	1	no	10	no	2	no
11	no	1	no	11	no	2	no
12	no	1	no	12	no	2	no
13	no	1	no	13	no	2	no
14	no	1	no	14	no	2	no
15	ebola	1	ebola	15	ebola	2	ebola
16	ebola	1	ebola	16	ebola	2	ebola
17	ebola	1	no	17	ebola	2	no
18	no	1	no	18	no	2	no
19	ebola	1	ebola	19	ebola	2	ebola
20	no	1	no	20	no	2	no
1	ebola	1	ebola	1	ebola	2	ebola
2	no	1	no	2	no	2	no
3	no	1	no	3	no	2	no
4	no	1	no	4	no	2	no
5	no	1	no	5	no	2	ebola
6	no	1	no	6	no	2	no
7	no	1	no	7	no	2	no
8	no	1	no	8	no	2	no
9	no	1	no	9	no	2	no
10	no	1	no	10	no	2	no
11	no	1	no	11	no	2	no
12	no	1	no	12	no	2	no
13	no	1	no	13	no	2	no
14	no	1	no	14	no	2	no
15	ebola	1	ebola	15	ebola	2	ebola
16	ebola	1	ebola	16	ebola	2	no
17	ebola	1	no	17	ebola	2	ebola
18	no	1	no	18	no	2	no
19	ebola	1	ebola	19	ebola	2	ebola
20	no	1	no	20	no	2	no



# ATTRIBUTE ANALYSIS: RESULTS

## Within Appraisers - CONSISTENCY

Assessment Agreement

Appraiser	# Inspected	# Matched	Percent	95% CI
1	20	20	100.00	(86.09, 100.00)
2	20	16	80.00	(56.34, 94.27)

# Matched: Appraiser agrees with him/herself across trials.

Fleiss' Kappa Statistics

Appraiser	Response	Kappa	SE Kappa	Z	P(vs > 0)
1	ebola	1.00000	0.223607	4.47214	0.0000
	no	1.00000	0.223607	4.47214	0.0000
2	ebola	0.46667	0.223607	2.08700	0.0184
	no	0.46667	0.223607	2.08700	0.0184

Kendall's Coefficient of Concordance

Only one or two distinct values in assessments. Kendall's coefficients not computed.

## Each Appraiser vs Standard - CORRECTNESS

Assessment Agreement

Appraiser	# Inspected	# Matched	Percent	95% CI
1	20	19	95.00	(75.13, 99.87)
2	20	16	80.00	(56.34, 94.27)

# Matched: Appraiser's assessment across trials agrees with the known standard.

Assessment Disagreement

Appraiser	# no / ebola	Percent	# ebola / no	Percent	# Mixed
1	1 20.00	0 0.00	0 0.00	0 0.00	
2	0 0.00	0 0.00	4 20.00		

# no / ebola: Assessments across trials = no / standard = ebola.  
 # ebola / no: Assessments across trials = ebola / standard = no.  
 # Mixed: Assessments across trials are not identical.

Fleiss' Kappa Statistics

Appraiser	Response	Kappa	SE Kappa	Z	P(vs > 0)
1	ebola	0.856631	0.158114	5.41781	0.0000
	no	0.856631	0.158114	5.41781	0.0000
2	ebola	0.733333	0.158114	4.63801	0.0000
	no	0.733333	0.158114	4.63801	0.0000

Kendall's Correlation Coefficient

Only one or two distinct values in assessments and standards. Kendall's coefficients not computed.

## Between Appraisers

Assessment Agreement

# Inspected	# Matched	Percent	95% CI
20	16	80.00	(56.34, 94.27)

# Matched: All appraisers' assessments agree with each other.

Fleiss' Kappa Statistics

Response	Kappa	SE Kappa	Z	P(vs > 0)
ebola	0.713262	0.0912871	7.81339	0.0000
no	0.713262	0.0912871	7.81339	0.0000

Kendall's Coefficient of Concordance

Only one or two distinct values in assessments and standards. Kendall's coefficients not computed.

## All Appraisers vs Standard

Assessment Agreement

# Inspected	# Matched	Percent	95% CI
20	16	80.00	(56.34, 94.27)

# Matched: All appraisers' assessments agree with the known standard.

Fleiss' Kappa Statistics

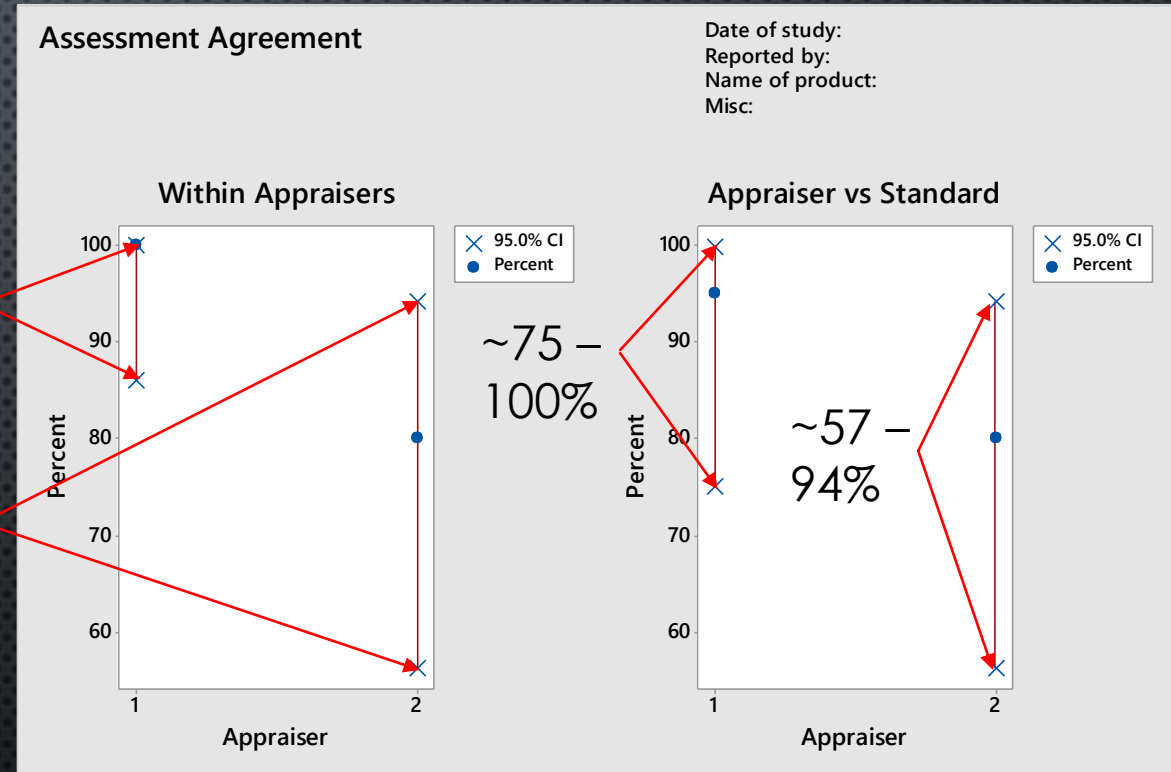
Response	Kappa	SE Kappa	Z	P(vs > 0)
ebola	0.794982	0.111803	7.11054	0.0000
no	0.794982	0.111803	7.11054	0.0000

Kendall's Correlation Coefficient

Only one or two distinct values in assessments and standards. Kendall's coefficients not computed.

# ATTRIBUTE ANALYSIS GRAPH

- WITHIN 95% CONFIDENCE...
- DOCTOR 1
  - 86~100% OF MAKING SAME DIAGNOSIS
  - 75~100% OF CORRECTLY IDENTIFYING
- DOCTOR 2
  - 57~94% OF MAKING SAME DIAGNOSIS
  - 57~94% OF CORRECTLY IDENTIFYING



# ATTRIBUTE ANALYSIS CONCLUSIONS

- DOCTOR 1
  - CONSISTENT
  - DECENT APPRAISER – NOT PERFECT
- DOCTOR 2
  - INCONSISTENT
  - LESS THAN ADEQUATE APPRAISER
- TRAINING TAILORED FOR EBOLA IDENT.

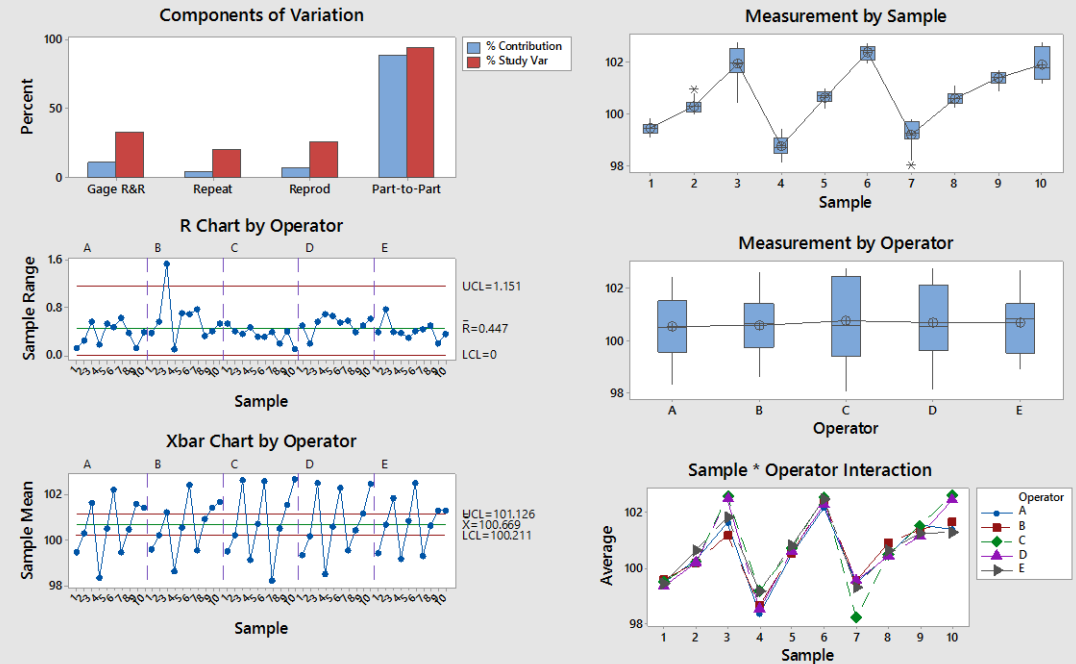
# AFTER CHANGES

%CONTRIBUTION		
SOURCE	VARCOMP	(OF VARCOMP)
TOTAL GAGE R&R	0.18626	10.96
REPEATABILITY	0.06790	3.99
REPRODUCIBILITY	0.11836	6.96
OPERATOR	0.00000	0.00
OPERATOR*SAMPLE	0.11836	6.96
PART-TO-PART	1.51384	89.04
TOTAL VARIATION	1.70010	100.00

## Gage R&R (ANOVA) Report for Measurement

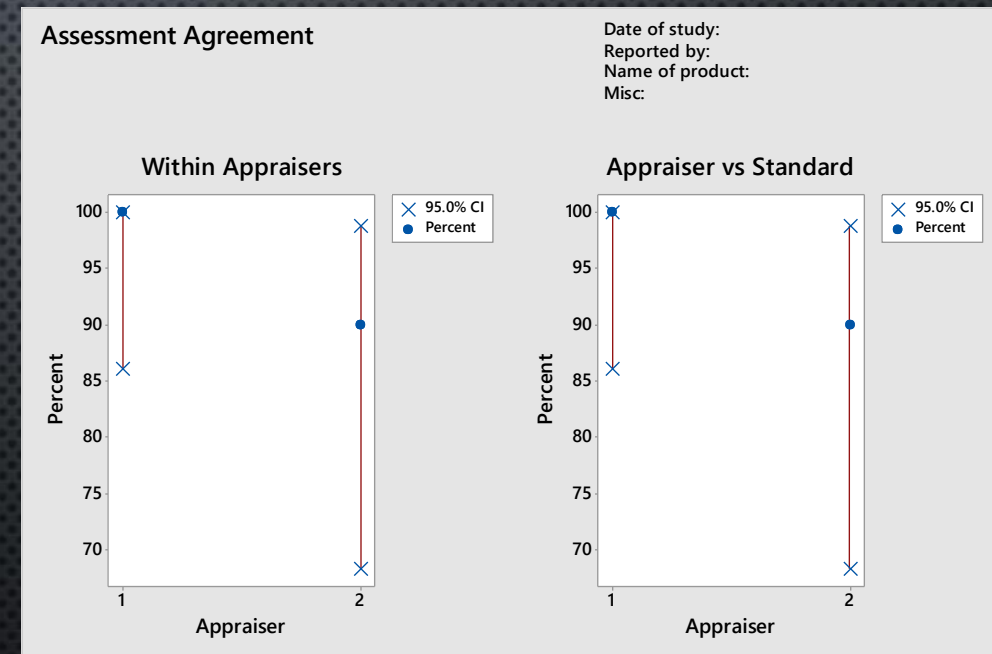
Gage name:  
Date of study:

Reported by:  
Tolerance:  
Misc:



# AFTER CHANGES - ATTRIBUTE

- DOCTOR 1
  - SLIGHT IMPROVEMENT
- DOCTOR 2
  - 20% IMPROVEMENT IN CONSISTENCY AND CORRECTNESS



# EBOLA EPIDEMIC: DRAWING CONCLUSIONS

- HOSPITAL STAFF AND PATIENTS AT RISK
  - MISDIAGNOSIS DUE TO STAFF AND EQUIPMENT
  - TRAINING FOR DOCTORS ABOUT EBOLA
- CONSISTENT AND CONTINUOUS IMPROVEMENTS SYSTEM WIDE
  - REDUCES ERRORS
- LOW RESOURCES HINDER PROGRESS
- HUMAN ELEMENT FAR TOO DIFFICULT TO TRULY ELIMINATE
- DEVELOPMENT AND DEPLOYMENT OF VACCINE BEST OPTION

THANK YOU!

QUESTIONS?

# SOURCES

- [HTTP://WWW.MEDICALDAILY.COM/EBOLA-CURE-SEARCH-DOCTORS-EXPOSE-VIRUSS-DEADLY-ANTI-IMMUNE-WEAPONS-PROTEIN-DISABLES-HUMANS-297840](http://www.MEDICALDAILY.COM/EBOLA-CURE-SEARCH-DOCTORS-EXPOSE-VIRUSS-DEADLY-ANTI-IMMUNE-WEAPONS-PROTEIN-DISABLES-HUMANS-297840)
- [HTTP://HTTP://WWW.CDC.GOV](http://HTTP://WWW.CDC.GOV)
- [HTTPS://WEB.STANFORD.EDU/GROUP/VIRUS/FILO/HISTORY.HTML](https://WEB.STANFORD.EDU/GROUP/VIRUS/FILO/HISTORY.HTML)
- [HTTPS://WWW.ISIXSIGMA.COM/Dictionary/MEASUREMENT-SYSTEM-ANALYSIS-MSA/](https://WWW.ISIXSIGMA.COM/Dictionary/MEASUREMENT-SYSTEM-ANALYSIS-MSA/)