Statistics in Psychosocial Research
Lecture 6
Validity II

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Outline

- Roadmap
- Criterion Validity – ROC
- Construct Validity - MTMC

Validity

weak

good

Face Validity

Content Validity

Criterion Validity

predictive, concurrent, postdictive

Construct Validity

a) internal

i) discriminant

ii) convergent

b) external/nomological

Criterion Validity

1. Correspondence between a test item and a criterion variable. The size of the correspondence is a direct measure of the amount of criterion validity
2. Requires a gold standard
3. Highlights correspondence alone

Sensitivity & Specificity

		Disease Status		
		Yes (D+)	No (D-)	
Test Result	T+	A	B	Pr(T+)=A+B/N
	T-	C	D	Pr(T-) =C+D/N
		Pr(D+)=A+C/N	Pr(D-)=B+D/N	N

- Sensitivity – Does the Test Identify Cases?

$$P(T+|D+) = \frac{A}{A+C}$$

- Specificity – Does the test Identify Non-cases?

$$P(T-|D-) = \frac{D}{B+D}$$

Positive & Negative Predictive Value

		Disease Status		
		Yes (D+)	No (D-)	
Test Result	T+	A	B	Pr(T+)=A+B/N
	T-	C	D	Pr(T-) =C+D/N
		Pr(D+)=A+C/N	Pr(D-)=B+D/N	N

- PPV – What does a positive test result mean?

$$P(D+|T+) = \frac{A}{A+B}$$

- NPV – What does a negative test result mean?

$$P(D-|T-) = \frac{D}{C+D}$$

Sensitivity and Specificity of a Blood Glucose Level of 5.6 mM for Determination of Diabetes Status

	– True Disease Status –	
Blood Glucose Level (mM)	Diabetics	Nondiabetics
>= 5.6 mM classified as diabetics	62 (A)	215 (B)
<5.6 mM classified as nondiabetics	1 (C)	125 (D)

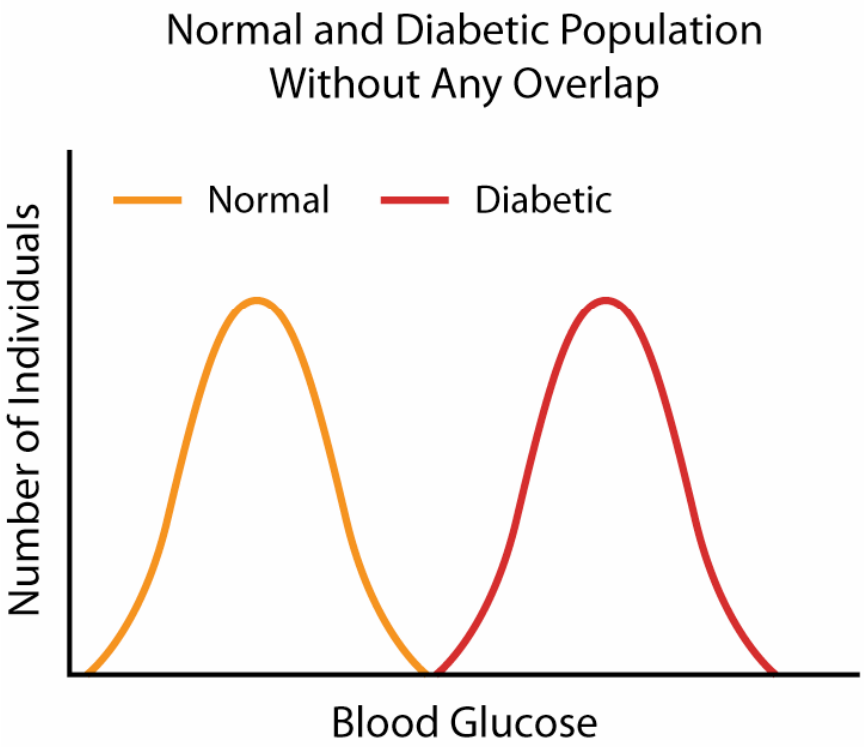
Sensitivity =

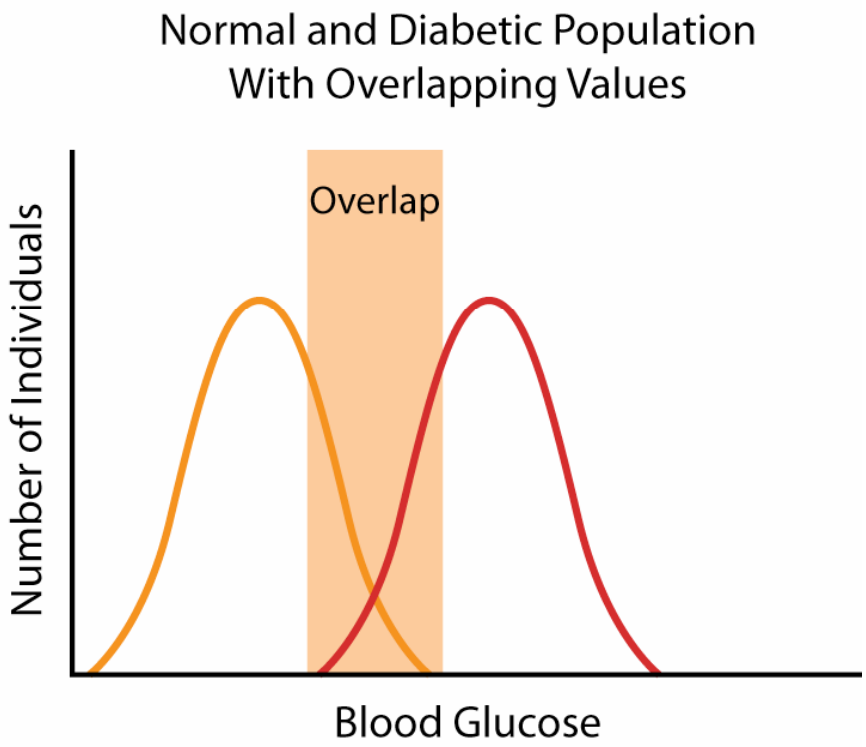
Specificity =

Positive predictive value =

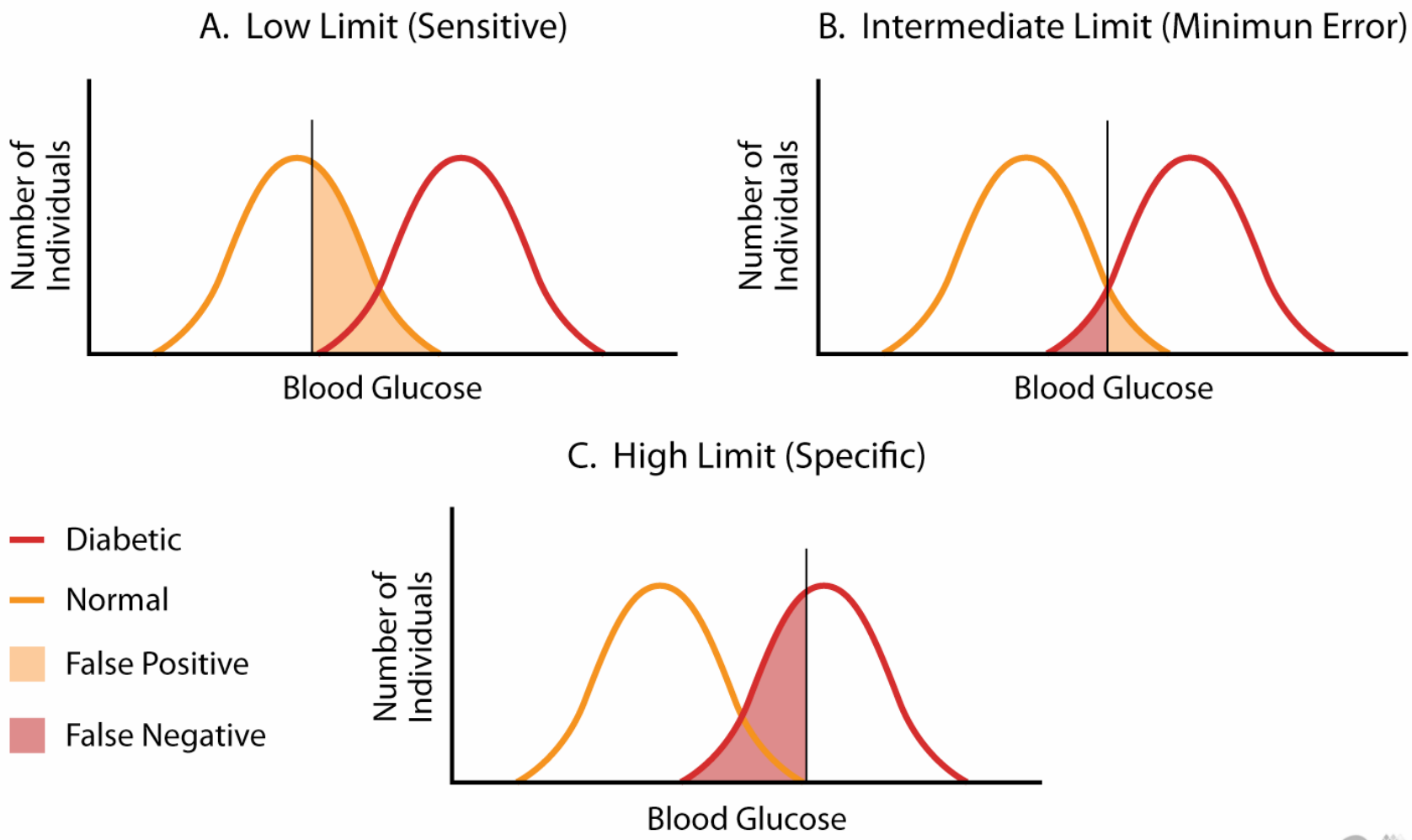
Negative predictive value =

Hypothetical Distribution of Blood Glucose Values





Effect of Setting Different Blood Glucose Levels on False Positives and False Negatives



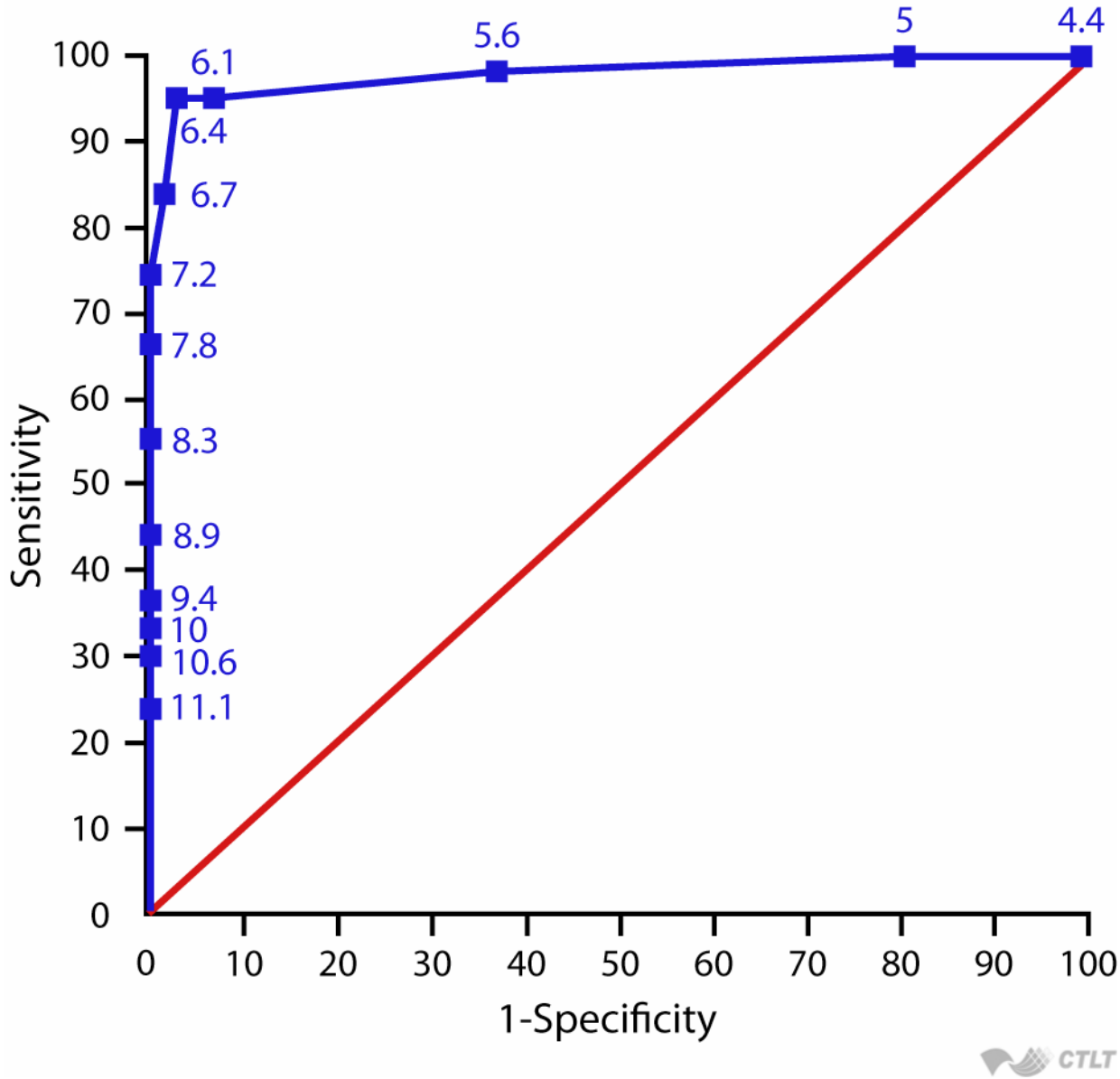
Sensitivity and Specificity

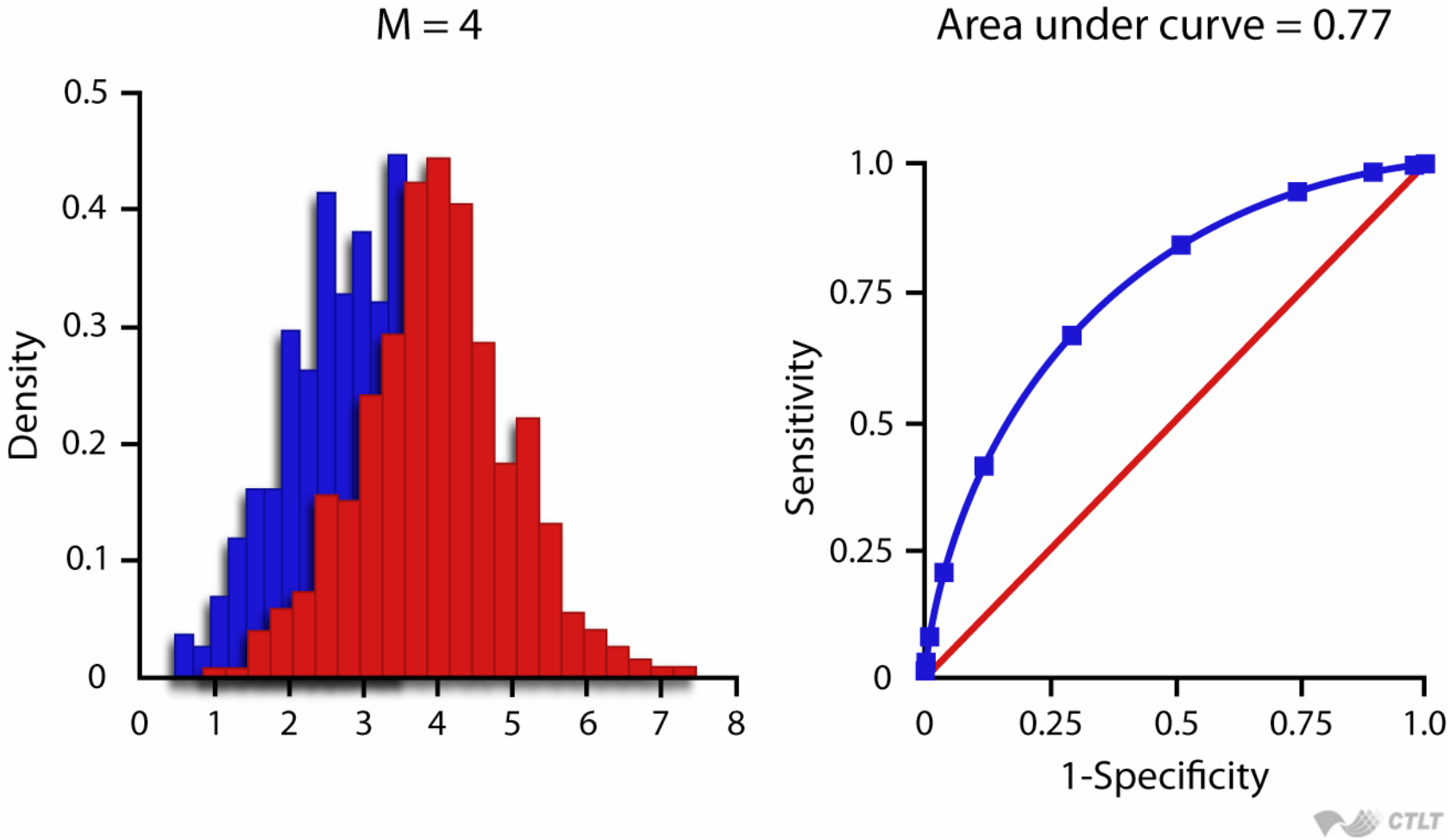
Sensitivity and specificity of 2-hour postprandial blood test for glucose for 63 true diabetic patients and 340 true nondiabetic patients at different levels of blood glucose

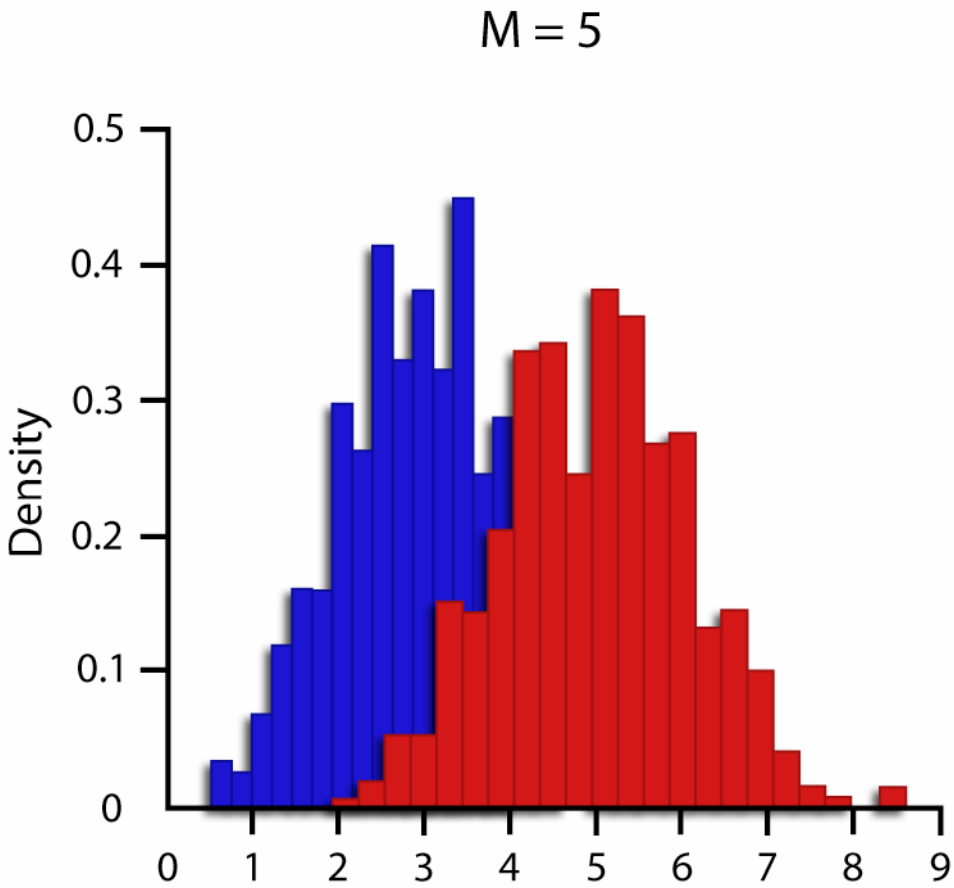
Reference Value (mg/dl)	Blood Glucose (mM)	Sensitivity* (%)	Specificity* (%)
80	4.4	100.0 (63/63)	0.6 (2/340)
	5.1	100.0 (63/63)	19.7 (67/340)
	5.6	98.4 (62/63)	63.2 (215/340)
	6.1	95.2 (60/63)	93.5 (318/340)
115	6.4	95.2 (60/63)	97.4 (331/340)
	6.7	84.1 (53/63)	100 (340/340)
	7.2	74.6 (47/63)	100 (340/340)
140	7.8	66.7 (42/63)	100 (340/340)
	8.3	55.6 (35/63)	100 (340/340)
	8.9	44.4 (28/63)	100 (340/340)
	9.4	36.5 (23/63)	100 (340/340)
	10.0	33.3 (21/63)	100 (340/340)
	10.6	30.2 (19/63)	100 (340/340)
200	11.1	23.8 (15/63)	100 (340/340)

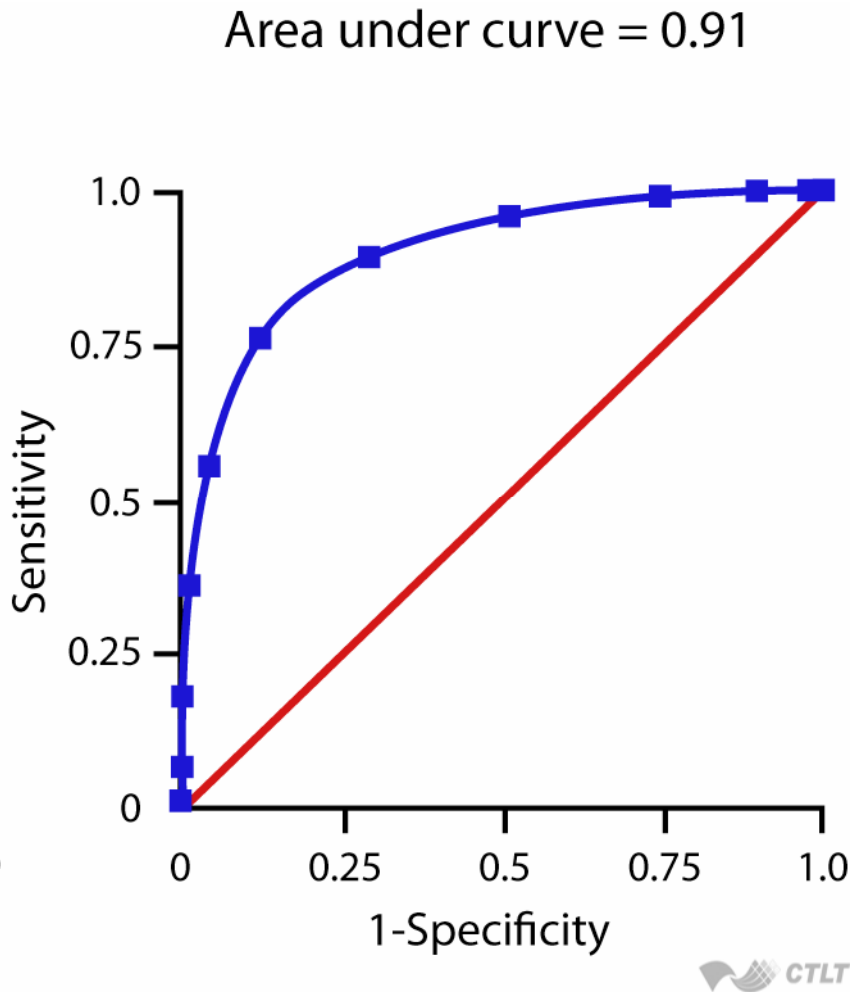
Figures in parentheses are the number of diabetic patients with 2-hour postprandial blood glucose level at or above the specified level.

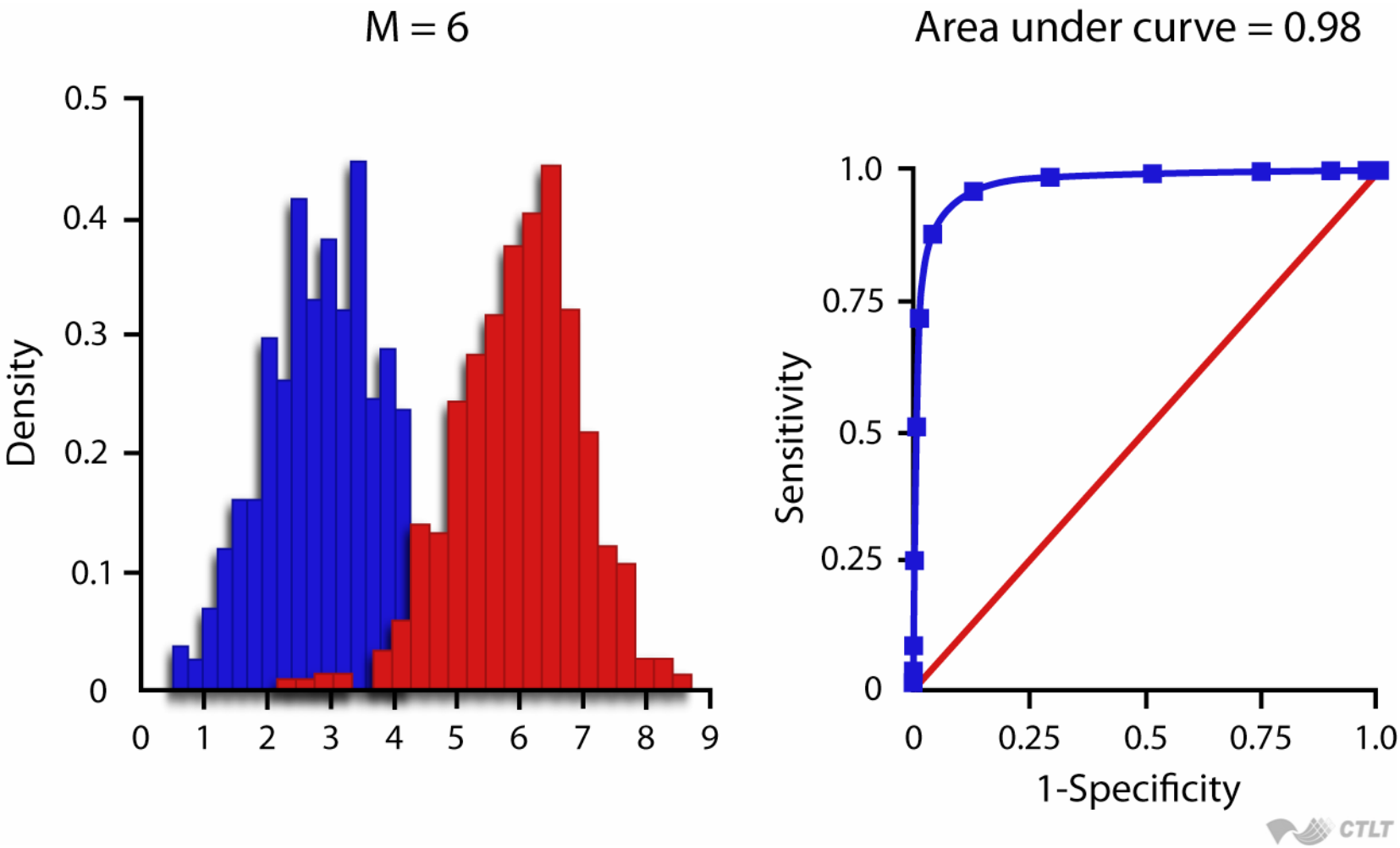
Source: Wadena County Health Study (unpublished)


Sensitivity
1-Specificity
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
6.1
5.6
5
4.4
6.4
6.7
7.2
7.8
8.3
8.9
9.4
10
10.6
11.1


M = 4
Density
0.5
0.4
0.3
0.2
0.1
0
0 1 2 3 4 5 6 7 8
Area under curve = 0.77
Sensitivity
1.0
0.75
0.5
0.25
0
0 0.25 0.5 0.75 1.0
1-Specificity
CTLT


M = 5
Density
0.5
0.4
0.3
0.2
0.1
0
0 1 2 3 4 5 6 7 8 9


Area under curve = 0.91
Sensitivity
1.0
0.75
0.5
0.25
0
0 0.25 0.5 0.75 1.0
1-Specificity


M = 6
Density
0.5
0.4
0.3
0.2
0.1
0
0 1 2 3 4 5 6 7 8 9
Area under curve = 0.98
Sensitivity
1.0
0.75
0.5
0.25
0
0 0.25 0.5 0.75 1.0
1-Specificity
CTLT

Relation between the Prevalence of Disease in a Population and the Positive and Negative Predictive Value of a Test

Population Prevalence Rate (per 100 persons)	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
15.6	.98	.37	.22	.99
23	.98	.37	.32	.99
37.5	.98	.37	.48	.97

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Construct Validity

a) internal

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Multi-trait Multi-method

- Assesses construct validity
- Campbell & Fiske (1959)
- multiple concepts (traits) and multiple methods (scales or observers)
- matrix of correlation coefficients

Synthetic Example- Method Blocks

		method 1			method 2			method 3		
	traits	A	B	C	A	B	C	A	B	C
method 1	A B C	mono method								
method 2	A B C	hetero method			mono method					
method 3	A B C	hetero method			hetero method			mono method		

Synthetic Example – Reliability Diagonals

Reliability Coefficients should be the highest values in the matrix

		method 1			method 2			method 3		
	traits	A	B	C	A	B	C	A	B	C
method	A	(.89)								
	B		(.89)							
	C			(.76)						
method	A				(.93)					
	B					(.94)				
	C						(.84)			
method	A							(.94)		
	B								(.92)	
	C									(.85)

Adapted from http://www.socialresearchmethods.net/kb/mtmmmat.htm

Synthetic Example – Validity Diagonals

Validity coefficients (Mono-trait Hetero-method – MTHM)
these should be sig. different from 0 (convergent)

		method 1			method 2			method 3		
	traits	A	B	C	A	B	C	A	B	C
method 1	A	(.89)								
	B		(.89)							
	C			(.76)						
method 2	A	.57			(.93)					
	B		.57			(.94)				
	C			.46			(.84)			
method 3	A	.56			.67			(.94)		
	B		.58			.66			(.92)	
	C			.45			.58			(.85)

Adapted from http://www.socialresearchmethods.net/kb/mtmmmat.htm

Synthetic Example – Hetero-trait Mono-method

Validity coefficients should be greater than any HTMM coefficients (traits should "hang togther" more closely than methods)

		method 1			method 2			method 3		
	traits	A	B	C	A	B	C	A	B	C
method 1	A	(.89)								
	B	.51	(.89)							
	C	.38	.37	(.76)						
method 2	A	.57			(.93)					
	B		.57		.68	(.94)				
	C			.46	.59	.58	(.84)			
method 3	A	.56			.67			(.94)		
	B		.58			.66		.67	(.92)	
	C			.45			.58	.58	.60	(.85)

Adapted from http://www.socialresearchmethods.net/kb/mtmmmat.htm

Synthetic MTMM – Hetero-trait Heter-method

Validity coefficients should be greater than the HTHM coefficients in the same row and column

		method 1			method 2			method 3		
	traits	A	B	C	A	B	C	A	B	C
method 1	A	(.89)								
	B		(.89)							
	C			(.76)						
method 2	A	.57	.22	.09	(.93)					
	B	.22	.57	.10		(.94)				
	C	.11	.11	.46			(.84)			
method 3	A	.56	.22	.11	.67	.42	.33	(.94)		
	B	.23	.58	.12	.43	.66	.34		(.92)	
	C	.11	.11	.45	.34	.32	.58			(.85)

Adapted from http://www.socialresearchmethods.net/kb/mtmmmat.htm

MTMM(Reliability) > MTHM(Validity) > HTMM / HTHM

		method 1			method 2			method 3		
	traits	A	B	C	A	B	C	A	B	C
method 1	A	(.89)								
	B	.51	(.89)							
	C	.38	.37	(.76)						
method 2	A	.57	.2	.09	(.93)					
	B	.22	.57	.10	.68	(.94)				
	C	.11	.11	.46	.59	.58	(.84)			
method 3	A	.56	.22	.11	.67	.42	.33	(.94)		
	B	.23	.58	.12	.43	.66	.34	.67	(.92)	
	C	.11	.11	.45	.34	.32	.58	.58	.60	(.85)

Adapted from http://www.socialresearchmethods.net/kb/mtmmmat.htm

Another Perspective (Inside out)…

		trait A			trait B			trait C		
	methods	1	2	3	1	2	3	1	2	3
trait A	1	(.89)								
	2	.57	(.89)							
	3	.56	.67	(.76)						
trait B	1	.51	.2	.22	(.93)					
	2	.22	.68	.42	.57	(.94)				
	3	.23	.43	.67	.58	.66	(.84)			
trait C	1	.38	.09	.11	.37	.10	.12	(.94)		
	2	.11	.59	.33	.11	.58	.34	.46	(.92)	
	3	.11	.34	.58	.11	.32	.60	.45	.58	(.85)

Adapted from http://www.socialresearchmethods.net/kb/mtmmmat.htm

A Multitrait-Multimethod Matrix Assessing Children's Mental Disorders

	Child			*Mother*			*Father*		
	Dep.	Anx.	Ext.	Dep.	Anx.	Ext.	Dep.	Anx.	Ext.
Child									
Dep.	(.75)								
Anx.		(.74)							
Ext.			(.72)						
Mother									
Dep.	*.26*			(.71)					
Anx.		*.22*			(.76)				
Ext.			*.41*			(.81)			
Father									
Dep.	*.11*			*.27*			(.65)		
Anx.		*.05*			*.48*			(.62)	
Ext.			*.21*			*.57*			(.76)

A Multitrait-Multimethod Matrix Assessing Children's Mental Disorders

	Child			*Mother*			*Father*		
	Dep.	Anx.	Ext.	Dep.	Anx.	Ext.	Dep.	Anx.	Ext.
Child									
Dep.	(.75)								
Anx.		(.74)							
Ext.			(.72)						
Mother									
Dep.	*.26*	.24	.15	(.71)					
Anx.	.15	*.22*	-.00		(.76)				
Ext.	.38	.34	*.41*			(.81)			
Father									
Dep.	*.11*	.10	.07	*.27*	.21	-.04	(.65)		
Anx.	-.01	*.05*	-.12	.31	*.48*	.10		(.62)	
Ext.	.24	.19	*.21*	.21	.16	*.57*			(.76)

A Multitrait-Multimethod Matrix Assessing Children's Mental Disorders

	Child			*Mother*			*Father*		
	Dep.	Anx.	Ext.	Dep.	Anx.	Ext.	Dep.	Anx.	Ext.
Child									
Dep.	(.75)								
Anx.	.38	(.74)							
Ext.	.51	.55	(.72)						
Mother									
Dep.	*.26*	.24	.15	(.71)					
Anx.	.15	*.22*	-.00	.64	(.76)				
Ext.	.38	.34	*.41*	.35	.31	(.81)			
Father									
Dep.	*.11*	.10	.07	*.27*	.21	-.04	(.65)		
Anx.	-.01	*.05*	-.12	.31	*.48*	.10	.48	(.62)	
Ext.	.24	.19	*.21*	.21	.16	*.57*	.30	.29	(.76)

A Multitrait-Multimethod Matrix Assessing Children's Mental Disorders

Mental Disorder	Ci	Ce	Mi	Me	Fi	Fe
Child Report						
Internalizing	(.77)					
Externalizing	.64	(.74)				
Mother Report						
Internalizing	*.28*	.07	(.78)			
Externalizing	.43	*.41*	.36	(.81)		
Father Report						
Internalizing	*.09*	-.03	*.42*	.04	(.68)	
Externalizing	.26	*.21*	.21	*.57*	.34	(.76)