

Instructor's Electronic Curriculum Resource-

For Techniques in Noninvasive Vascular Diagnosis-4th edition.

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Chapter 17. Quality Assurance and Statistics

Techniques In Noninvasive Vascular Diagnosis-4th edition

Quality Assurance

- **How good is your diagnostic exam?**
- **What diagnostic criteria values should be used?**
- **Ultrasound results should be compared to a "gold standard" test**

Gold Standard Tests

- **Digital subtraction angiography**
- **CTA (computerized tomography angiography with contrast)**
- **MRA (magnetic resonance angiography)**
- **Surgical findings**
- **Clinical outcome**

Gold Standard for Venous Imaging Comparison

- **Venography (seldom performed)**
- **Repeat exam within 3 days**
- **Repeat exam by another sonographer- do results concur?**
- **Exam interpreted by a second physician.**
- **Compare to clinical outcome (was there a PE?)**

Compare "Apples to Apples"

- **For carotid QA, coordinate the reporting method with the interpreter of the gold standard.**
- **For example, if you report 70-99 % ICA stenosis, and the radiologists reports "moderate to severe disease", results cannot be compared in a meaningful fashion**

Compare “Apples to Apples”

- Make sure your carotid criteria is based on the same method used to measure arteriogram , CTA, or MRA, e.g., Bulb or NASCET methods.

Methods to Assess the Efficacy of a Test

- How “good” is a test for detecting disease or a condition?
 - Sensitivity – the ability of a test to find disease when it’s present
- How “good” is a test for ruling out disease or a condition
 - Specificity – The ability of a test to show there is no disease when there is no disease present

Methods to Assess a Test Result

- How reliable is a positive test result ?
 - Some test results are “truly” positive (TP) (correct)
 - Some test results are “falsely” positive (FP) (incorrect).
- Positive Predictive Value (PPV)
 - The portion of individuals with a POSITIVE test result that actually have the condition.

Methods to Assess a Test Result

- How reliable is a negative test result ?
 - Some test results are “truly” negative (TN)(normal)
 - Some test results are “falsely” negative (FN) (falsely normal)
- Negative Predictive Value (NPV)
 - The portion of individuals with a NEGATIVE test result that actually do NOT have the condition.

Accuracy

- When TP, TN, FN and FP are considered, overall accuracy can be calculated.
- **Accuracy**- The proportion of all individuals whose tests results agree with their condition. The percentage of time the Ultrasound exam was correct.

2 x 2 square used to calculate statistics.

2 x 2 square		Gold standard	
		POS +	NEG -
Ultrasound	Test POS +		
	Test NEG -		

Jeffrey Dahmer Memorial Hospital study of venous duplex accuracy to detect DVT

- June 1979- Feb. 1981
- 1746 legs examined with duplex US
- 144 limbs had contrast venograms
- We compared results with 2 x 2 Square (sometimes called Chi Square)

Goal was to determine
Sensitivity, Specificity and
Accuracy of ultrasound for the
detection of DVT based on 144
comparison venograms.

- In all studies there are positive results (disease or a condition is present) and negative results (test was normal).

Fill in squares with following information

- TP = True positive = Duplex and venogram indicated DVT
- FP = False positive= Duplex was positive for DVT, but venogram was negative
- TN = True negative = Duplex and venogram were both negative for DVT
- FN = False negative = Duplex was negative, but venogram was positive for DVT.

Step # 1, Establish the Chi or 2 x 2 square

		Venogram Results	
		Disease POS +	Disease NEG-
Venous duplex ultrasound	Test POS +	TP	FP
	Test NEG -	FN	TN

TP = True positive
FP = False positive
TN= True negative
FN = False negative

Chi Square

		Gold standard-venogram	
		Positive +	Negative -
Venous duplex	Positive +	TP 82	FP 3
	Negative -	FN	TN

There were 85 positive ultrasounds, 82 agreed with Venog. So True Positives were 82.

There were 3 positive ultrasounds of the 85 that were negative on venography, this means 3 False Positives.

There were 91 positive venograms.

Chi Square

		Gold standard-venogram	
		Positive +	Negative -
Venous duplex	Positive +	TP 82	FP 3
	Negative -	FN 9	TN 50

There were 59 legs found negative on ultrasound, 50 agreed with venography (True Negatives-50)

There were 9 negative ultrasounds that were not negative but positive for DVT on venography (False Negatives -9).

There were 53 negative venograms.

Chi Square (animation)

		Gold standard-venogram	
		Positive +	Negative -
Venous duplex	Positive +	TP 82	FP 3
	Negative -	FN 9	TN 50

A "double check": there was a total of 91 positive venograms.

There was a total of 53 negative venograms

There was a total of 144 venograms (91 + 53)

Once the 2 x 2 square is filled in, it's easy to calculate the following stats:

- Sensitivity
- Specificity
- Positive Predictive Value (PPV)
- Negative Predictive Value (NPV)
- Accuracy
- Prevalence

Sensitivity + Specificity

		Gold standard-venogram	
		Positive +	Negative -
Venous duplex	Positive +	TP 82	FP 3
	Negative -	FN 9	TN 50

Sensitivity

Specificity

Think Positive

$$\text{Sensitivity} = \frac{TP}{TP + FN} = \frac{82}{82+9} \times 100\% = 90.1\%$$

Think Negative

$$\text{Specificity} = \frac{TN}{FP + TN} = \frac{50}{3+50} \times 100\% = 94.3\%$$

Predictive Values

		Gold standard-venogram	
		Positive +	Negative -
Venous duplex	Positive +	TP 82	FP 3
	Negative -	FN 9	TN 50

PPV

NPV

Think Positive Duplex

$$\text{PPV} = \frac{TP}{TP + FP} = \frac{82}{82+3} \times 100\% = 96.5\% \quad \text{FP} = 3.5\%$$

Think Negative Duplex

$$\text{NPV} = \frac{TN}{FN + TN} = \frac{50}{9+50} \times 100\% = 84.7\% \quad \text{FN} = 15.2\%$$

Overall Accuracy

		Gold standard-venogram	
		Positive +	Negative -
Venous duplex	Positive +	TP 82	FP 3
	Negative -	FN 9	TN 50

Accuracy- Combine sensitivity and specificity

$$\text{Sensitivity} = \frac{TP}{TP + FN} + \text{Specificity} = \frac{TN}{FP + TN}$$

$$\text{Accuracy} = \frac{TP + TN}{TP + FN + FP + TN} = \frac{132}{144} \times 100\% = 91.6\%$$

Prevalence

- Prevalence - the proportion of individuals in the study that have the disease
 - If prevalence is low, it's best to have a test with high specificity
- Prevalence data is important; if the study population is loaded with disease versus no disease statistics can be skewed.

Prevalence

		Gold standard-venogram	
		Positive +	Negative -
Venous duplex	Positive +	TP 82	FP 3
	Negative -	FN 9	TN 50

$$\text{Prevalence} = \frac{\text{TP} + \text{FN}}{\text{TP} + \text{FN} + \text{FP} + \text{TN}} = \frac{91}{144} \times 100\% = 63\%$$

Jeffrey Dahmer Hospital Vascular Lab Summary

- Sensitivity = 90.1%
- Specificity = 94.3%
- PPV = 96.5%
- NPV = 84.7%
- Accuracy = 91.6%
- Prevalence = 63%

BEWARE! "The Heading Switch"

		ULTRASOUND RESULTS	
		Positive +	Negative -
ANGIO RESULTS	Positive +	TP	FN
	Negative -	FP	TN

For the RVT exam, beware that Headings might be switched. No problem as long as you are aware, and set up the 2 x 2 table correctly.

Definitions - Summary

- **Sensitivity** - The ability of a test to find disease when it's present.
- **Specificity** - The ability of a test to show there is no disease when there is no disease present.
 - Both sensitivity and specificity deal with test "ability".
 - Predictive values deal with how "good" is a test result

Definitions - Summary

- **Positive Predictive value (PPV)** - The portion of individuals with a POSITIVE test result that actually have the condition.
- **Negative Predictive Value (NPV)** - When the test result is NEGATIVE, how many times is it truly NEGATIVE
- **Accuracy** - The proportion of all individuals whose tests results agree with their condition

Definitions - Summary

- **Prevalence** - the proportion of individuals in the study that have the disease.
 - If prevalence is low, it's best to have a test with high specificity

**On page 334 of the
4th edition, rev.1**

- In the Practice Before RVT Exam.
There is missing information required
to complete the 2x2 box. The following
should be added:
- “ Ultrasound agreed with angiography
in 100 positive angios.”
- :There were 75 negative ultrasound
exams that agreed with negative
angiograms”