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Cincinnati WADA Testing Protocol:

Purpose of the WADA procedure:

The WADA procedure is a presurgical planning procedure that helps grossly lateralize language and memory function. A WADA test that predicts good surgical outcomes will have both language and memory strongly lateralized to one side, so the individual will score very well with injection of lesion side, and that they will score poorly with injection of the non-lesion (healthy) side. Remember that we are essentially “knocking out” the injected side. A wide difference between scores of the healthy and lesioned sides indicates that resection will have minimal effects on language and memory.

General overview:

The WADA test begins with testing language functions and encoding memory items directly after injection. To test this, the patient will be asked to follow commands, perform auditory comprehension, name items, remember several words and images, and will finish by reading several sentences. These are scored by either correct naming or by time taken to complete the task (i.e. reading).

Sodium amobarbital (Amytal) and sodium methohexital (Brevital) can both be used for the procedure. Medication shortages may influence the drug of choice and currently amobarbital is no longer available. Methohexital has been shown to have a shorter recovery to baseline², which may be desired; however, it may also require multiple boluses during the procedure if the patient is returning to baseline quickly. This should be tested intermittently with strength testing.

The WADA test is performed in two stages:

- First, inject the hemisphere *with* the lesion. Start a timer at the time of injection. The patient will follow commands, perform naming, and then the person administering the exam will show them pictures of words, abstract images, and common items. Finally, the patient will be asked to read two sentences.
- After the patient has finished reading the sentences correctly, wait 10 minutes. Then, recall of the words, figures, and pictures are tested.
- Second, inject the hemisphere *without* the lesion. Start a timer at the time of injection. The same steps of commands, naming, being shown images, and reading sentences.
- 10 minutes after the patient has finished reading sentences correctly, perform memory recall testing.

Detailed Testing steps (examples are based on right hemisphere testing cards):

The WADA test is a cerebral angiogram performed by a neurosurgeon, neuroradiologist, or interventional neurologist. A needle-guided catheter is inserted once into an artery and the catheter is directed to the internal carotid artery on one side and later re-routed to the internal carotid artery on the other side. Medication administration and testing is done after proper catheter placement is confirmed with contrast dye injection into the carotid artery. A neurologist or neuropsychologist typically does the testing for the procedure. An EEG is recorded during the time of the procedure to see the results of the injection and to evaluate if a seizure occurs. An EEG technician typically keeps track of scoring, timing, and EEG changes during the procedure.

Prior to testing, one person should plan to administer the test, one person will test strength (tested by hand squeezing), and two people should individually score and time the exam and observe EEG change.

Preparation:

1. Decide which side to inject first (based on lesion localization). There are two testing booklets, one for the left side and one for the right side.
2. Make sure the patient can see and has their glasses on if needed.
3. Prior to injection, ask the patient to bring their arms out from under the covers without compromising the sterile field. The person performing strength testing should ask the patient to squeeze their fingers using the hand contralateral to injection. This provides a baseline level of strength.
4. Then have the patient raise their arms straight up into the air and wiggle their fingers, while they count backwards from 100.
5. The two individuals scoring and timing the test should have score sheets prepared, and each have a timer that they will start at the time of injection.

Injection:

1. Injection of methohexital. The person doing the injection will need to state the anesthetic used and the dose.
2. Dosing varies slightly by patient weight and physician discretion.
 1. Typical 1st injection of methohexital: 4 mg
 2. Typical 1st injection of amobarbital: 125 mg.
3. Scoring individuals should start the timer at injection time. At each section listed below, the scorer should record the time at the start of the section.
4. Once the patient has no strength in the contralateral arm, begin testing.
5. People who are scoring typically also follow the EEG and should record the time at which a delta wave becomes present on EEG.
6. The patient will develop a visual field cut, so it is important to stand on the side that they will have vision (right side for right injection and left side for left injection). As you are testing, move the card slowly across the entire visual field to ensure the patient can see the card.

Motor commands (1 pt per response)

1. Ask questions on first card “tap your shoulder and open your mouth” (1 pt if done correctly)
2. Ask “cross your fingers” (1 pt)

Auditory comprehension (+5 per correct response, -3 for incorrect response, 0 points for no response)

1. Ask “is a stove used to cook”? Repeat twice if the patient is not understanding or responding.
2. “Do you wear shoes on your feet?”
3. “Can you use a stove to wash dishes?”
4. “Do you wear shoes on your head?”

Picture naming (+1 pt per item, track paraphasic errors)

1. Have patient name objects displayed in book (cake, table, dog, bell).

*Typical 2nd of methohexital (2 mg) is needed before verbal memory or when strength in the arm is regained. May need to repeat 1-2 mg if strength is regained again.

Verbal memory

1. Say “Remember the word RUG”, while demonstrating the written text RUG in front of the patient. Repeat the word 2-3 times, always repeat the same amount.
2. Say “Remember the word CARE” while displaying. Repeat the word 2-3 times, always repeat the same amount.
3. Say “Remember the word SHIRT” while displaying. Repeat the word 2-3 times, always repeat the same amount.

Nonverbal memory

1. Display the figures (a combination of lines and shapes) to the patient, one at a time. Say, “remember this figure”. Show the card across the entire visual field slowly 2-3 times, always repeat the same amount as you did prior.
2. Display the second and third figure in the same way.

Dual modality memory (say word and have picture)

1. Ask the patient to name the figure (i.e. carrot) (if they do not name it then that is okay). Say “remember the word CARROT”. Repeat the word 2-3 times, always repeat the same amount as prior, while displaying figure.
2. Repeat for other images.

Reading

1. Display the sentence on the next card (“We went to the store to buy some milk”).
2. Have the patient read the sentence from this card and the next card from the beginning until they read both, one after the other, correctly all the way through without paraphasic errors.

Once the patient reads both sentences correctly, wait 10 minutes. Then begin testing for memory.

Scoring memory:

You will now have a set of cards that follows the initial set. This set has all the pictures and words from the memory items above and pictures and words that were not included. Explain this to the patient and that they will need to identify which pictures or words that they saw and say “no” for ones they have not seen or heard.

Spontaneous recall—

1. Before showing any cards, first ask the patient what words they remember, if any.
2. Add +5 points for each correct answer. Subtract -3 points for each incorrect answer.

Delayed verbal recognition—max 15 points

1. Show the patient cards, while reading the word aloud. Ask if they remember the word (i.e. “Do you remember the word COST?”)
2. +5 points for true positive answers, -3 points for false positives

Delayed nonverbal recognition—max 15 points

1. Show the patient cards with abstract figures, asking if they remember the figure.
2. +5 points for true positive answers, -3 points for false positives

Delayed dual modality recognition—max 15 points

1. Show the patient the picture cards, while naming the object in the picture aloud. Ask if they remember the word (i.e. “Do you remember HANGER?”)
2. +5 points for true positive answers, -3 points for false positives

FIRST SIDE IS COMPLETE. After the catheter is moved (without full removal of catheter) to the other internal carotid artery, repeat all the steps using the unique card deck for the opposite and matching injection side.

2nd injection: Dosing varies slightly by patient weight and physician discretion.

1. Typical contralateral injection of methohexital: 3 mg (repeat after verbal memory is typically 2 mg)
2. Typical contralateral injection of amobarbital: 100 mg

*Following the second injection and testing, the test is complete. The patient will be taken to recovery. If family or a friend accompanied the patient, notify them of completion of the test. **Visit the patient***

approximately 30 minutes later to perform an NIH Stroke Scale and document result. Notify all those involved if there are any positive findings with the NIHSS.

Final scoring and report:

- Language score is recorded for each side, 4/4 being the highest score. Report will summarize whether language is left dominant, right dominant, or mixed.
- Memory score is out of 45 for either side. A high discrepancy between scores (with higher score on the opposite side of the lesion) is indicative of a better surgical prognosis in regard to memory.
- Remember, this is a GROSS scoring system, used to evaluate who is a good surgical candidate. Other presurgical planning will help further localize the epileptic focus and contribute to pre-surgical risk.

(see supplemental documents with scoring sheets)

References:

1. Bajammal S, Babbain F, Alqadi K, Baeesa S, Kurdi K, Madani N, Al Said Y. The Optimal Dose of Amobarbital in the Wada Test for the Presurgical Evaluation of Patients With Temporal Lobe Epilepsy. Clin Neuropharmacol. 2020 Nov/Dec;43(6):185-190. doi: 10.1097/WNF.0000000000000411. PMID: 32969970.
2. Buchtel, H.A., Selwa, L.M., Gomez-Hassan, D., Passaro, E., Ryan, K. and Deveikis, J. Brevital as anesthetic in the Wada Test for language and memory. Presented to the 53rd Annual Meeting of the American Epilepsy Society, Orlando FL, December 3-8. 1999.

Patient Label

Cerebral Angiogram with Wada Test Form

Patient Name:	Test Date:
MRN:	Referring Epilepsy MD:
Date of Birth:	Performing MD:
History:	
<p>INJECT FIRST (CIRCLE): LEFT RIGHT</p> <p><i>Note: Typically inject the hemisphere where seizures originate first to test the unaffected side.</i></p>	
<p>Handedness (Circle): Left Right</p>	

Patient Label

Inject LEFT Hemisphere
(Test RIGHT Hemisphere)

Patient Weight:	Substance Injected:	Amount Injected: mg
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During the procedure, if the patient fails to respond to an item after **three** prompts, move on to the next item.
NR= No Response

Injection (Start timer) Actual Time (24h): _____

Delta Wave Present: Post-Injection Time: _____ Actual Time: _____

1. **Motor Commands** Post-Injection Time: _____ Score: _____

(a) + - (b) + -

2. **Auditory Comprehension** Post-Injection Time: _____ Score: _____

	+	-	+	-		
(a)	Yes				No	NR
(b)	Yes				No	NR
(c)		Yes	No			NR
(d)		Yes	No			NR

3. **Picture Naming** Post-Injection Time: _____ Score: _____

(a) Cake: _____	(c) Dog: _____
(b) Table: _____	(d) Bell: _____

Paraphasic Errors (Y/N): _____

4. **Verbal Memory** Post-Injection Time: _____

- (a) Rug
- (b) Care
- (c) Shirt

5. **Presentation of Nonverbal Items** Post-Injection Time: _____

6. **Dual Modality Items** Post-Injection Time: _____

- (a) Carrot
- (b) Glasses
- (c) Squirrel

7. **Reading** Post-Injection Time: _____ Paraphasic Errors (Y/N): _____

- Read Correctly
- (a) We went to the store to buy some milk.
 - (b) They heard him speak on the radio last night.

8. **Delta Wave Absent** Post-Injection Time: _____

Read Correctly Post-Injection Time: _____

10 minutes after patient reads correctly: Test Memory

Patient Label

Inject LEFT Hemisphere
(Test RIGHT Hemisphere)

10 minutes after patient reads correctly

9. Delayed Spontaneous Recall

Post-Injection Time: _____

Check (v) if patient spontaneously recalls item. Write incorrect responses. Total should be 6.

- | | |
|------------------|---------------------|
| (a) Rug: _____ | (d) Carrot: _____ |
| (b) Care: _____ | (e) Glasses: _____ |
| (c) Shirt: _____ | (f) Squirrel: _____ |

Scoring method: True positive (Yes, +) 5 points
False positive (Yes, -) -3 points

10. Delayed Verbal Recognition

Post-Injection Time: _____ Score: _____/15

	+	-	+	-
Cost		Yes	No	
Glove		Yes	No	
Shirt	Yes			No
Rake		Yes	No	
Care	Yes			No
Silence		Yes	No	
Rug	Yes			No
Wheel		Yes	No	

11. Delayed Nonverbal Recognition

Post-Injection Time: _____ Score: _____/15

	+	-	+	-
Yes	Yes	No		No
	Yes	No		
	Yes	No		
	Yes	No		
Yes			No	
Yes			No	
	Yes	No		

12. Delayed Dual Modality Recognition

Post-Injection Time: _____ Score: _____/15

	+	-	+	-
Hanger		Yes	No	
Carrot	Yes			No
Guitar		Yes	No	
Sewing machine		Yes	No	
Horse		Yes	No	
Glasses	Yes			No
Squirrel	Yes			No
Strawberries		Yes	No	

13. End Testing (RIGHT hemisphere)

Post-Injection Time: _____

TOTAL RIGHT HEMISPHERE SCORE: _____/45

Patient Label

Inject RIGHT Hemisphere
(Test LEFT Hemisphere)

Patient Weight:	Substance Injected:	Amount Injected: mg
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During the procedure, if the patient fails to respond to an item after **three** prompts, move on to the next item.
NR= No Response

Injection (Start timer) Actual Time (24h): _____

Delta Wave Present: Post-Injection Time: _____ Actual Time: _____

1. **Motor Commands** Post-Injection Time: _____ Score: _____

(a) + - (b) + -

2. **Auditory Comprehension** Post-Injection Time: _____ Score: _____

+ - + -

(a) Yes No NR

(b) Yes No NR

(c) Yes No NR

(d) Yes No NR

3. **Picture Naming** Post-Injection Time: _____ Score: _____

(a) Lamp: _____ (c) Knife: _____

(b) Umbrella: _____ (d) Ladder: _____

Paraphasic Errors (Y/N): _____

4. **Verbal Memory** Post-Injection Time: _____

(a) Baby

(b) Right

(c) Chair

5. **Presentation of Nonverbal Items** Post-Injection Time: _____

6. **Dual Modality Items** Post-Injection Time: _____

(a) Firetruck

(b) Drum

(c) Toothbrush

7. **Reading**

Read Correctly Post-Injection Time: _____ Paraphasic Errors (Y/N): _____

(a) Near the table in the dining room.

(b) I stopped at his front door and rang the bell.

8. **Delta Wave Absent** Post-Injection Time: _____

Read Correctly Post-Injection Time: _____

10 minutes after patient reads correctly: Test Memory

Patient Label

Inject Right Hemisphere (Test Left Hemisphere)

10 minutes after patient reads correctly

1. Delayed Spontaneous Recall

Post-Injection Time: _____

Check (V) if patient spontaneously recalls item. Write incorrect responses. Total should be 6.

- | | |
|------------------|-----------------------|
| (a) Baby: _____ | (d) Toothbrush: _____ |
| (b) Right: _____ | (e) Firetruck: _____ |
| (c) Chair: _____ | (f) Drum: _____ |

Scoring method: True positive (Yes, +) 5 points
False positive (Yes, -) -3 points

2. Delayed Verbal Recognition

Post-Injection Time: _____ Score: _____/15

	+	-	+	-
Praise		Yes	No	
Stove		Yes	No	
Baby	Yes			No
Idea		Yes	No	
Chair	Yes			No
Clock		Yes	No	
Right	Yes			No
Salt		Yes	No	

3. Delayed Nonverbal Recognition

Post-Injection Time: _____ Score: _____/15

	+	-	+	-
Yes	Yes		No	
	Yes		No	
	Yes		No	
	Yes		No	
Yes			No	
Yes			No	
	Yes		No	

4. Delayed Dual Modality Recognition

Post-Injection Time: _____ Score: _____/15

	+	-	+	-
Toothbrush	Yes			No
Fish		Yes	No	
Handbag		Yes	No	
Drum	Yes			No
Comb		Yes	No	
Bird		Yes	No	
Fork		Yes	No	
Firetruck	Yes			No

End Testing (LEFT hemisphere)

Post-Injection Time: _____

TOTAL LEFT HEMISPHERE SCORE: _____/45