



# A Comparison of Paper-and-Pencil and Computerized Neuropsychological Testing For the Sub-Acute and Chronic Assessment of Pediatric Mild Traumatic Brain Injury (pmTBI)



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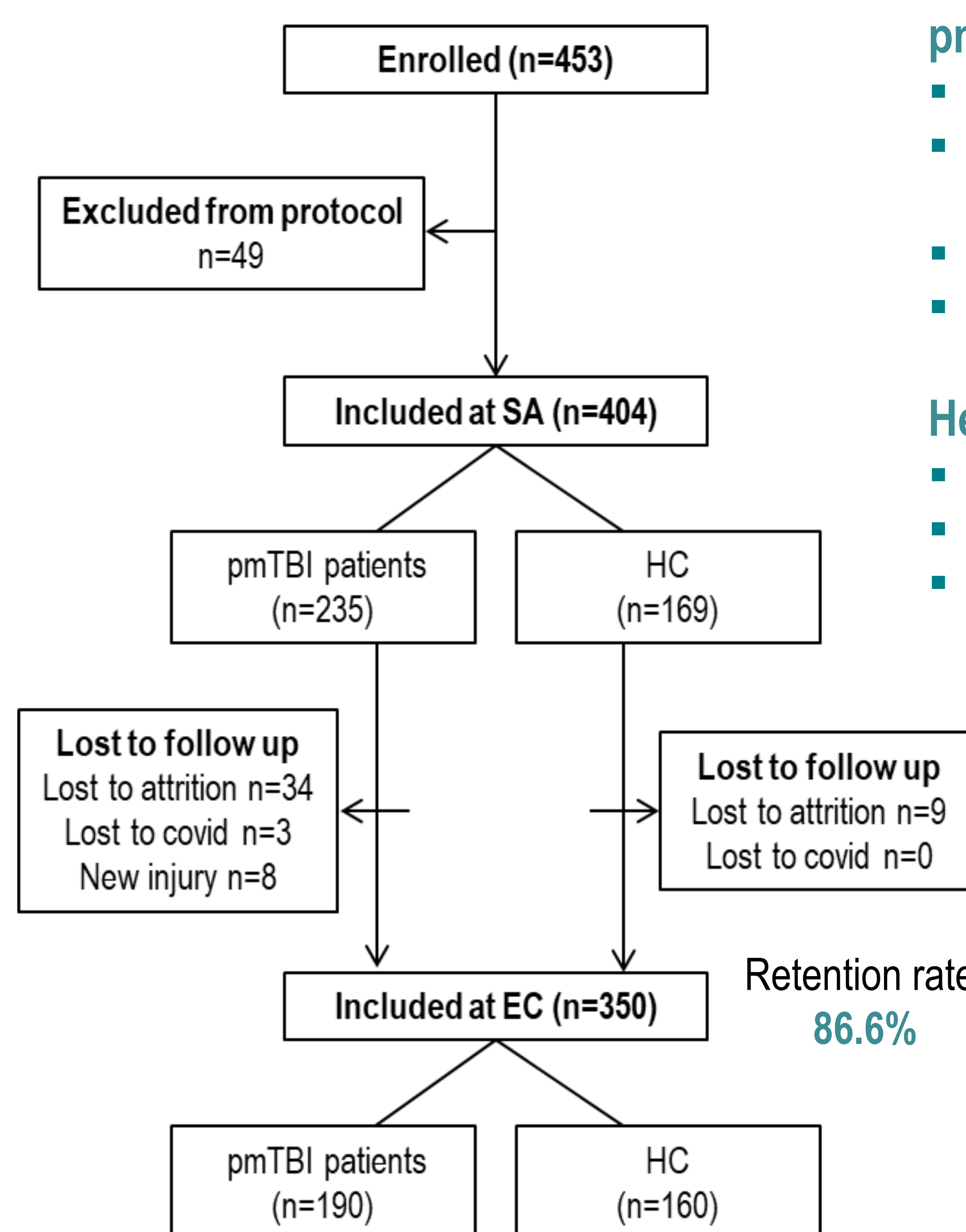
## INTRODUCTION

- Neuropsychological testing = important component of the assessment of pediatric mild traumatic brain injuries (pmTBI) or concussions<sup>1</sup>
- Lack of a clear pattern of neuropsychological dysfunction
- Subset of impaired individuals beyond expected numbers in pediatric and adults<sup>2-3</sup>
- What are the most clinically useful measures to ensure appropriate assessment?
- Computerized testing popularity ↑ over the last decade
- Paper-and-pencil and computerized batteries have their respective strengths and weaknesses<sup>4-5</sup>
- Little published work directly comparing performance paper-and-pencil or computerized batteries

THE OBJECTIVE OF THE CURRENT STUDY IS TO COMPARE SENSITIVITY AND SPECIFICITY OF A COMMONLY USED PAPER-AND-PAPER BATTERY AND A COMPUTERIZED BATTERY IN THE SUB-ACUTE (SA) AND EARLY CHRONIC (EC) PHASES OF INJURY BY TWO APPROACHES:

- Scores on individual tasks included in each battery
- Number of indicators of impairment on each battery

## PARTICIPANTS & PROCEDURES



### pmTBI patients

- Recruited prospectively from ED
- Inclusion criteria based on ACRM<sup>6</sup> and CISG<sup>1</sup> guidelines
- SA = 1-11 days post-injury (7.39 ± 2.2 days)
- EC = ~ 4 months post-injury (132.7 ± 20.4 days)

### Healthy controls (HC)

- Recruited from local community
- ~4 months between visits (124.88 ± 15.5 days)
- No ADHD/learning disability

- Participants lost to follow-up or subsequently excluded were older, had lower WRAT-4 scores and parental education ( $p \leq 0.042$ )
- However, participants included at SA and EC visits were similar on key demographics and injury characteristics
- Urine-based drug screens were conducted each visit and positive results were exclusionary

### PROCEDURES

- Part of an ongoing study
- All participants included herein completed the paper-and-pencil (selected tests from the D-KEFS, WAIS-IV/WISC-V, and HVT-R) and computerized (Cogstate brief) batteries

TABLE 1. Participant demographic information

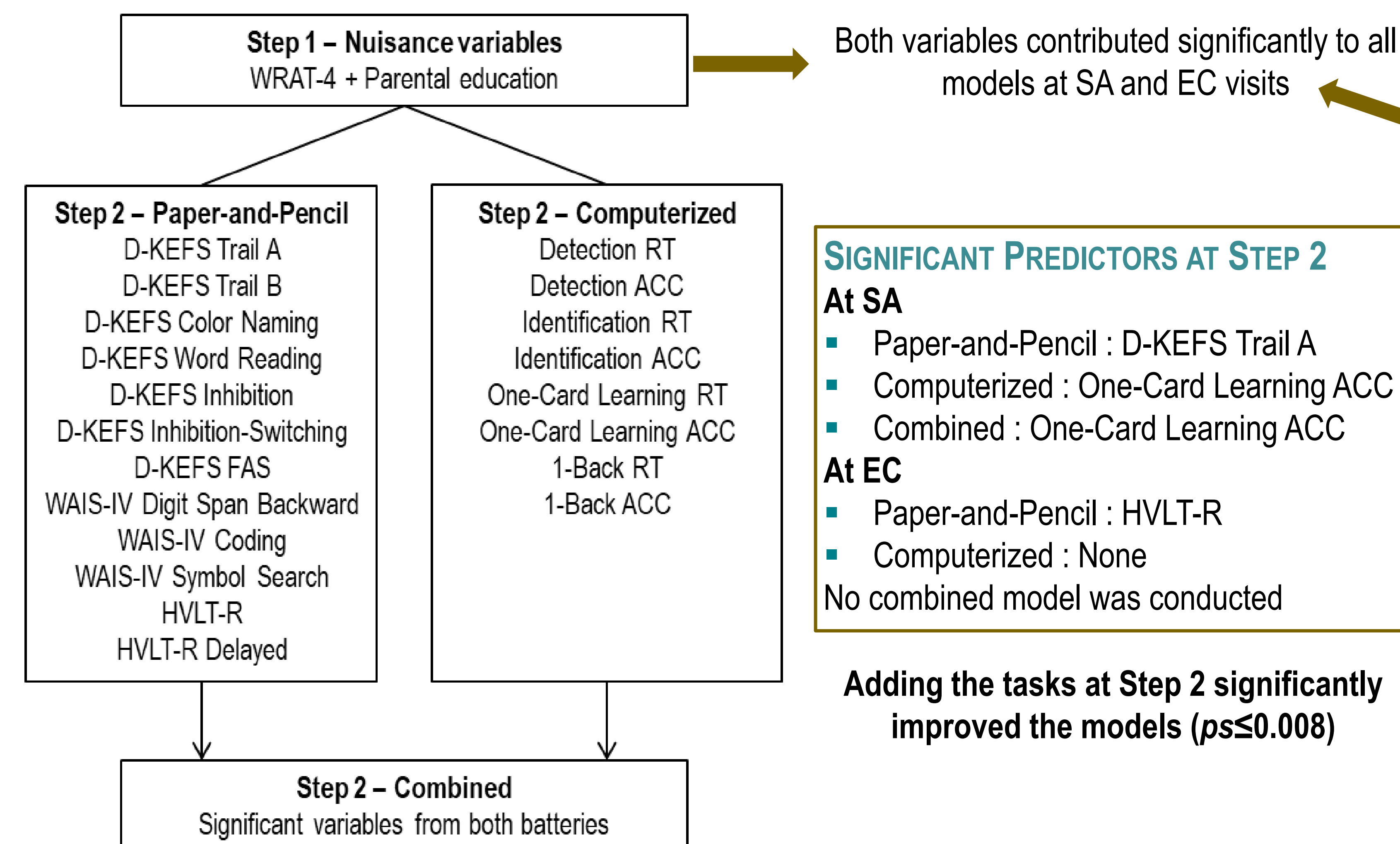
Characteristic	Sub-Acute		Early Chronic	
	pmTBI	HC	pmTBI	HC
Age, Mean (SD)	13.91 (2.7)	13.61 (2.9)	13.77 (2.7)	13.57 (2.8)
Female Sex, n (%)	100 (42.6%)	72 (42.6%)	80 (42.1%)	68 (42.5%)
WRAT-4, Mean (SD)	50.14 (10.3)	55.5 (10.9) ***	50.69 (10.8)	55.68 (11.0) ***
Parental Education, Mean (SD)	14.63 (3.3)	17.20 (3.5) ***	14.72 (3.3)	17.32 (3.4) ***
Sport-Related Injuries, n (%)	139 (59.1%)	-	117 (61.6%)	-

Nuisance variables = WRAT-4 and parental education

## APPROACH 1 : SCORES ON TASKS

### LOGISTIC REGRESSIONS FOR SCORES ON INDIVIDUAL TASKS FOR EACH BATTERY

Hierarchical logistic regressions were conducted



### SIGNIFICANT PREDICTORS AT STEP 2

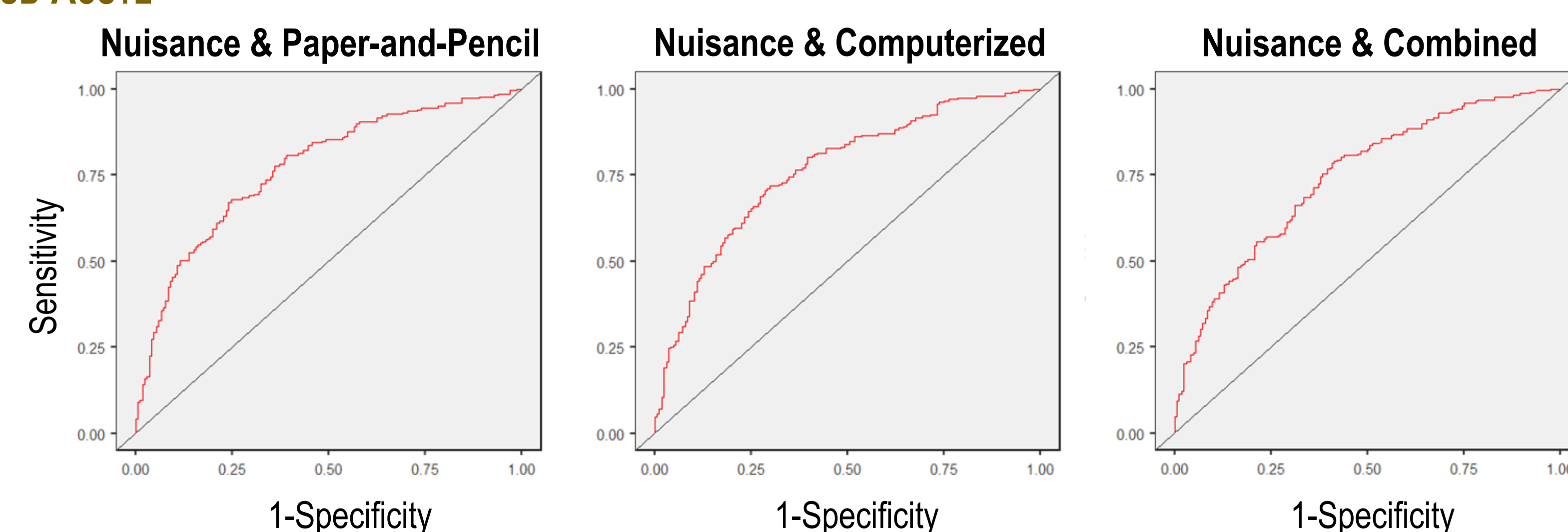
- At SA**
- Paper-and-Pencil : D-KEFS Trail A
  - Computerized : One-Card Learning ACC
  - Combined : One-Card Learning ACC
- At EC**
- Paper-and-Pencil : HVT-R
  - Computerized : None
  - No combined model was conducted

Adding the tasks at Step 2 significantly improved the models ( $p \leq 0.008$ )

TABLE 2. Predictive measures from these logistic regressions at each visit

Models	Sub-Acute			Early Chronic		
	Accuracy	Sensitivity	Specificity	Accuracy	Sensitivity	Specificity
<b>Paper-and-Pencil</b>						
Nuisance only	0.665	0.767	0.530	0.667	0.729	0.596
Nuisance & Tasks	0.714	0.808	0.590	0.685	0.746	0.615
<b>Computerized</b>						
Nuisance only	0.673	0.788	0.512	0.674	0.738	0.599
Nuisance & Tasks	0.711	0.814	0.567	0.665	0.716	0.605
<b>Combined</b>						
Nuisance only	0.668	0.781	0.512	-	-	-
Nuisance & Sig. Tasks	0.704	0.785	0.591	-	-	-

### SUB-ACUTE



### EARLY CHRONIC

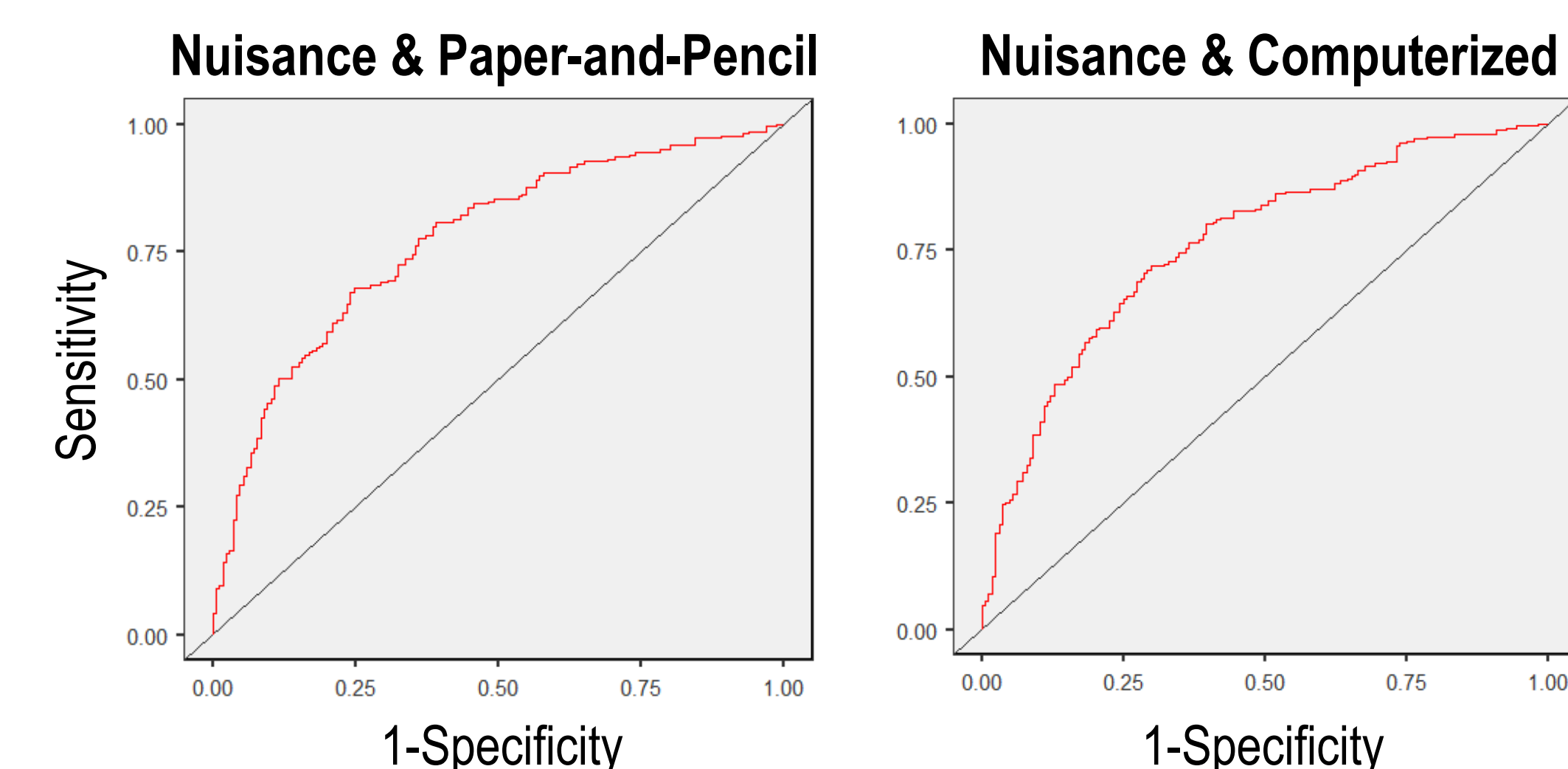


FIGURE 1. ROC curves for each logistic regressions

## APPROACH 2 : NUMBER OF INDICATORS

### NUMBER OF IMPAIRMENTS ON EACH BATTERY

- Cognitive impairment = 2 SD below control's group average on a task
- $\chi^2$  test were conducted to compare the proportion of pmTBI and controls showing at least 1, 2, or 3 impairments on the two batteries at each visit
- A series of hierarchical logistic regressions were conducted
  - Step 1 : Nuisance variables
  - Step 2 : At least X number of impairments

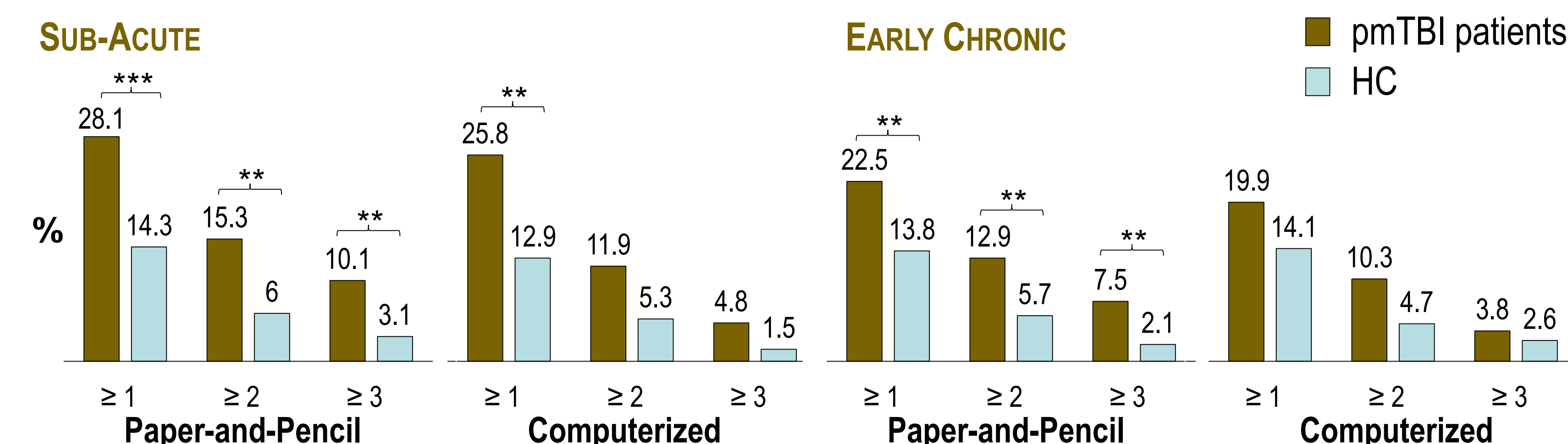


FIGURE 2. % of participants exhibiting at least 1, 2, or 3 indicators of impairments at each visit

### SIGNIFICANT PREDICTORS AT STEP 2

- At SA**
- Paper-and-pencil :  $\geq 2$  or  $\geq 3$  impairments
  - Computerized : None
- At EC**
- Paper-and-Pencil :  $\geq 3$  impairments
  - Computerized : None

TABLE 3. Predictive measures from these logistic regressions at each visit

Models	Sub-Acute			Early Chronic		
	Accuracy	Sensitivity	Specificity	Accuracy	Sensitivity	Specificity
<b>Paper-and-Pencil</b>						
Nuisance only	0.665	0.767	0.530	0.667	0.729	0.596
Nuisance & $\geq 1$ indicator	0.675	0.795	0.518	0.667	0.734	0.590
Nuisance & $\geq 2$ indicators	0.675	0.763	0.560	0.664	0.712	0.609
Nuisance & $\geq 3$ indicators	0.683	0.763	0.578	0.673	0.723	0.615
<b>Computerized</b>						
Nuisance only	0.675	0.780	0.530	0.672	0.734	0.599
Nuisance & $\geq 1$ indicator	0.673	0.789	0.512	0.666	0.723	0.599
Nuisance & $\geq 2$ indicators	0.670	0.780	0.518	0.672	0.723	0.611
Nuisance & $\geq 3$ indicators	0.673	0.784	0.518	0.669	0.734	0.592

## CONCLUSIONS

### AFTER CONTROLLING FOR PREMORBID GROUP DIFFERENCES

- BOTH APPROACHES YIELDED SIMILAR PREDICTIVE ABILITY**
- CONTRARY TO HYPOTHESIS, EXECUTIVE FUNCTIONING TASKS WERE NOT THE MOST USEFUL MEASURES**
- HAVING AT LEAST 3 IMPAIRMENTS ON THE PAPER-AND-PENCIL BATTERY WAS PREDICTIVE OF GROUP MEMBERSHIP**
- NO BATTERY OUTPERFORMED THE OTHER**

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