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Neurocognitive Function: Are CPC Scores Enough?

Sue Sendelbach, PhD, RN, CCNS



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ABBOTT
NORTHWESTERN
HOSPITAL
Allina Hospitals & Clinics

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Presenter Disclosure Information

- Sue Sendelbach
- FINANCIAL DISCLOSURE:
 - None
- UNLABELED/UNAPPROVED USES DISCLOSURE:
 - None



Overview & Objectives

- Overview
 - Assessing neurocognitive function
 - History of CPC scores
 - Studies of cognitive function post cardiac arrest
 - Our approach to assessing and managing neurocognitive dysfunction
- Objectives
 1. Identify two limitations of the CPC scores;
 2. Describe a post hospital program focusing on neurocognitive rehabilitation.



Assessing Neurocognitive Function

- *Glasgow Outcome Scale: A five-point scale –*
 1. death
 2. persistent vegetative state
 3. severe disability
 4. moderate disability
 5. good recovery



Jennett B & Bond M. 1975. Assessment of outcome after severe brain damage. *Lancet*. March 1. 480-484.

Outcome after Resuscitation



- Quality of life¹⁻⁴

¹Jennett & Bond. 1975. Assessment of outcome after severe brain damage. *Lancet*. March 1. 480-483.
²Safar P. Resuscitation after Brain Ischemia, in Grenvik A and Safar P. Eds: Brain Failure and Resuscitation, Churchill Livingstone, New York, 1981:155-184.
³Hsu J, Madsen CD & Callahan ML. 1996. Quality-of-life and formal functional testing of survivors of out-of-hospital cardiac arrest correlates poorly with traditional neurologic outcome scales. *Annals of Emergency Medicine*. 28(6):597-605.
⁴Stiell IG et al. 2009. Comparison of the Cerebral Performance Category Score and the Health Utilities Index for survivors of cardiac arrest. *Annals of Emergency Medicine*. 53(2):241-248.



CPC and OPC Scores

Adapted from Jennett & Bond, 1975. AND Safar, 1981.

Cerebral Performance Categories	Overall Performance Categories
CPC 1. Good cerebral performance: Conscious, alert, able to work, might have mild neurologic or psychologic deficit.	OPC 1. Good overall performance: -Healthy, alert, capable of normal life, CPC 1.
CPC 2. Moderate cerebral disability: Conscious, sufficient cerebral function for independent activities of daily life. Able to work in sheltered environment.	OPC 2. Moderate overall disability: -Conscious (CPC 2), or moderate disability from non-cerebral systems dysfunction alone (CPC 1), or both. -Performs independent activities of daily life, but is disabled for competitive work.
CPC 3. Severe cerebral disability: Conscious, dependent on others for daily support because of impaired brain function. Ranges from ambulatory state to severe dementia or paralysis.	OPC 3. Severe overall disability: -Conscious (CPC 3), or severe disability from non-cerebral organ systems dysfunction alone (CPC 1 or 2), or both. -Dependent on others for daily support.
CPC 4. Coma or vegetative state: Any degree of coma without the presence of all brain death criteria. Unawareness, even if appears awake (vegetative state) without interaction with environment; may have spontaneous eye opening and sleep-awake cycles. Cerebral unresponsiveness.	OPC 4. Coma or vegetative state: Same as CPC 4.
CPC 5. Brain death. Apnea, areflexia, EEG silence, etc.	OPC 5. Brain death: Same as CPC 5.



Are CPC Scores Enough?



- “Intellectual and cognitive deficits may be overlooked in a brief clinical interview, but may be revealed by formal psychometric testing.”¹
- “In addition to CPC And OPC, we should learn to evaluate loss in learning ability, memory, changes in emotional status, and maladjustment to society, using a variety of tests...”²



¹ Jennett & Bond. 1975. Assessment of outcome after severe brain damage. *Lancet*. March 1, 480-483.

² Safar P. Resuscitation after Brain Ischemia, in Grenvik A and Safar P. Eds: *Brain Failure and Resuscitation*, Churchill Livingstone, New York, 1981:155-184.

Limitations of CPC Scores

- Not well validated^{1,2}
- Assessed by chart review²
- Subjective²
- Not well defined²
- Very little discriminative ability



¹ Stiell IG et al. 2009. Comparison of the Cerebral Performance Category Score and the Health Utilities Index for survivors of cardiac arrest. *Annals of Emergency Medicine*. 53(2):241-248.

² Hsu J et al. 1996. Quality-of-life and formal functional testing of out-of-hospital cardiac arrest correlates poorly with traditional neurologic outcome scales. *Annals of Emergency Medicine*. 28(6):597-605.

Studies of Therapeutic Hypothermia post Cardiac Arrest and Outcome Measure(s)

Study	Outcome measure	Hypothermia	Normothermia
Bernard <i>et al.</i> 1997	Glasgow Coma Scale	50% good outcome 5% severe disability 45% mortality	14% good outcome 4.5% severe disability 4.5% vegetative state 77% mortality
Bernard <i>et al.</i> 2002	Rehabilitation specialist evaluation for discharge location (good outcome - discharge to home or rehabilitation facility Poor outcome = whether patient was conscious or unconscious)	49% good outcome 51% mortality	26% good outcome 6% severe disability 68% mortality
Hypothermia after Cardiac Arrest Study Group 2002	Pittsburgh Cerebral Performance Category (within 6 months)	55% good outcome 41% mortality	39% good outcome 55% mortality
Hachimi-Idrissi <i>S et al.</i> 2001	Overall Performance Category	13% good outcome 6% severe overall disability 81% mortality	7% severe overall disability 93% mortality
Yanagawa <i>et al.</i> 1998	Glasgow Outcome Scale	23% complete recovery 8% severe disability 27% vegetative state 46% mortality	6% normal/ minimal disability 23% vegetative state 67% mortality
Zeiner <i>et al.</i> 2000	Cerebral Performance Categories based on Glasgow Outcome Performance Categories (best CPC score between 3 days and 6 months)	52% good outcome 7% bad outcome 41% mortality	

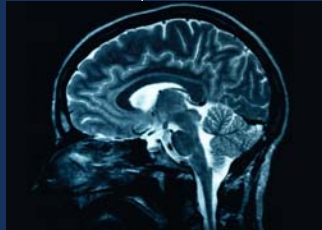


CPC Scores: Are They Enough?

- **INTCAR (International Cardiac Arrest Registry)**
 - **CPC**
 - **Best CPC during ICU stay?**
 - **CPC at ICU discharge?**
 - **CPC at hospital discharge?**



Sequelae of Cerebral Anoxia



- Cardiac arrest
 - Global cerebral ischemia and hypoxic-ischemic injury
- Neuropsychological sequelae of hypoxic-ischemic injury
 - Disturbances of memory, including amnesic syndrome, variable executive deficits, changes of personality and behavior, visuspatial deficits, and impairment of expressive language



Caine D, Watson JD. 2000. Neuropsychological and neuropathological sequelae of cerebral anoxia: A critical review. *J Int Neuropsychol Soc.* 6:86-99.

Executive Function

- Cognitive abilities necessary for complex goal-directed behavior and adaptation to a range of environmental changes and demands. It includes the ability to plan and anticipate outcomes (cognitive flexibility) and to direct attentional resources to meet the demands of nonroutine events.



Loring DW. 1999. *INS Dictionary of Neuropsychology*. New York/Oxford. Oxford University Press.

Cognitive Impairment Post Cardiac Arrest *without* Therapeutic Hypothermia (n=57)

- Domains evaluated (6 months after resuscitation)
 - Immediate and delayed memory
 - Attention
 - Verbal fluency
- Evaluation tools
 - Rey's Auditory Verbal Learning Test (AVLT)
 - Stroop Color Word Test
 - Trail Making A and B
 - Controlled oral word association
- Results
 - 11% to 28% of survivors were cognitively impaired
 - 58% scored unimpaired for all tests



SOURCE: van Alem AP *et al.* Cognitive impairment in survivors of out-of hospital cardiac arrest. *American Heart Journal.* 2004;148:416-421.

Cognitive Impairment Post Cardiac Arrest *without* Therapeutic Hypothermia (n=45)

- | | |
|--|--|
| <ul style="list-style-type: none"> • Domains evaluated <ul style="list-style-type: none"> - Orientation - Attention - Memory (Immediate recall) - Memory (Early recall) - Memory (Delayed recall) - Recognition - Reasoning • Timing of measurement (post arrest) <ul style="list-style-type: none"> - Time 1: Within 3 weeks of initial arrest - Time 2: 6 to 9 weeks - Time 3: 12 to 15 weeks - Time 4: 22 to 25 weeks • Results <ul style="list-style-type: none"> - Time 1: Most frequent impairment was in delayed recall and the most severe deficit was in recognition - Time 2: Most common deficit was memory - Time 4: 50% of subjects had impairments in one or more memory outcome | <p>Evaluation Tools</p> <ul style="list-style-type: none"> - Neurobehavioral Cognitive Status Examination - Symbol Digit Modalities Test - Rey Auditory Verbal Learning Test - Memory Scan Test - Oral Word Association Test |
|--|--|



SOURCE: JM *et al.* Factors associated with cognitive recovery after cardiopulmonary resuscitation. *AJCC.* 1996;5(2):127-139.

Cognitive Impairment Post Cardiac Arrest *without* Therapeutic Hypothermia (n=68)

- Domains evaluated (3 months and one year)
 - Intellectual ability
 - Memory
 - Verbal
 - Visual perception
- Evaluation tools
 - Wechsler Adult Intelligence Scale (WAIS)
 - Wechsler Memory Scale
 - Word fluency, naming, comprehension of short sentence
 - Poppelreuter's overlapping figures
- Results
 - 3 months: 60% of patients were found to have moderate to severe cognitive deficits
 - 12 months: 48% of 54 survivors still had moderate to severe deficits
 - Most common neuropsychological sequela was the impairment of delayed memory



Roine RO *et al.* Neuropsychological sequelae of cardiac arrest. *JAMA*. 1993;269(2):237-242.

Outcome with TH Post Cardiac Arrest

- Neuropsychological outcomes 3 months post cardiac arrest
 - Patients randomized into the Hypothermia After Cardiac Arrest trial and surviving at least 3 months
- Domains evaluated
 - Cognition
 - Learning and memory
 - Executive functioning
 - Verbal fluency
 - Speed of performance
- Most common impaired cognitive domains:
 - executive functioning
 - memory and learning

	Therapeutic hypothermia	Normothermia
Cognitively intact or very mild impairment	67%	44%
Severe deficits	15%	28%



Tianen M *et al.* Cognitive and neurophysiological outcome of cardiac arrest survivors treated with therapeutic hypothermia. *Stroke* 2007;38:2303-2308.

Statement of Consensus on Assessment of Neurobehavioral Outcomes after Cardiac Surgery

- Selection of tests should take the following issues into consideration:
 - The cognitive domain of the test
 - The sensitivity and reliability of the test
 - The time taken to perform the test
 - The degree to which learning may occur in the test
 - The availability of parallel forms of the test
 - The physical effort required to perform the test
 - The overall balance of the cognitive domains assessed in the battery



Murkin JM et al. 1995. *Annals of Thoracic Surgery*. 59;1289-95.

Statement of Consensus on Assessment of Neurobehavioral Outcomes after Cardiac Surgery

- Performance on neuropsychologic tests can be influenced by mood state and mood state variations. Mood state assessments should be performed concurrently with the neuropsychologic assessments.



Murkin JM et al. 1995. *Annals of Thoracic Surgery*. 59;1289-95.

Approach to Identify Cognitive Dysfunction

- Our challenge:
 - Select array of tests with validity and reliability in this population
 - Acceptably easy to administer
 - Broad yet focused
- Our reference model was a screening test
 - Method that would find survivors with any cognitive dysfunction after Cool-it
 - Know method will over identify dysfunction
 - Recognize that not all dysfunction identified would be due to effects of hypothermia



Testing Battery

Test	Domain
Mini-Cog (includes 3-word repetition, Clock Drawing, and word recall)	Mental Status, basic Visuoconstruction and Executive skills
Rey Auditory Verbal Learning Test	Attention and Verbal Memory
Digit Span	Attention and Working Memory
Trails A and B	Attention, Processing Speed, Executive Functioning
Controlled Oral Word Association	Language and Executive Functioning
Symbol Digit Modalities Test	Attention, Psychomotor Speed
Grooved Pegboard	Psychomotor Speed and Coordination



(31271) Hypothermia Post Therapeutic Phase III - Transfer

Consult to hospitalist	Cool It/Hypothermia Patient Staff to call consultant(s), add to treatment team, and update the order with date and time of call placed
Consult to Neuropsychology	Cool It/Hypothermia Patient Staff to call consultant(s), add to treatment team, and update the order with date and time of call placed
Consult to Physical Medicine and Rehab	Cool It/Hypothermia Patient Staff to call consultant(s), add to treatment team, and update the order with date and time of call placed



Phase 3 Transfer out of ICU

- Phase 3 – Transfer out of the ICU to the progressive care unit
 - New consults to include:
 - Physical Therapy
 - Occupational Therapy
 - Speech/Language Pathology
 - **Neuropsychology**
 - Physical Medicine and Rehab
 - Cardiac Rehab



Phase 4: Prep for Discharge

- Orders completed *after* discharge planning meeting
- 30 – 45 day follow up appointments with OT and neuropsychologist

Family must be present at the time of discharge

Discharged to acute rehabilitation

Discharged to home

Discharge to nursing home

Cardiologist to follow

2-4 day follow up phone call by home health coordinator



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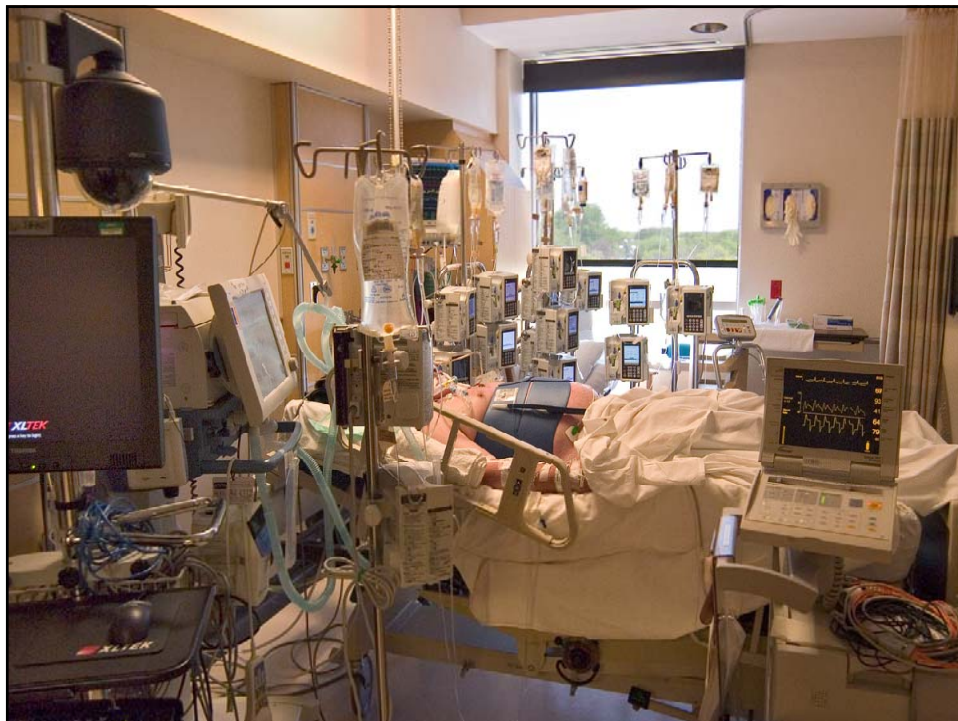
- **Research considerations**
 - **Absence of control subjects** – what is an appropriate control group
 - **How to estimate the incidence of decline** (e.g., 20% decline on 20% of tests?)
 - **Unable to measure baseline neurocognition**



Selnes O & Gottesman R. 2010. Neuropsychological outcomes after coronary artery bypass grafting. *Journal of the International Neuropsychological Society*. 16:221-226.

Neurocognitive Function: Are CPC Scores Enough?

- **Need to know the question you want answered**
 - Clinical
 - Research



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2008 Survivors

