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Association between Cerebral Performance Category, Modified Rankin Scale, and Discharge Disposition after Cardiac Arrest

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Abstract

Background—Cerebral Performance Category (CPC), Modified Rankin Scale (mRS) and discharge disposition are commonly used to determine outcomes following cardiac arrest. This study tested the association between these outcome measures.

Methods—Retrospective chart review of subjects who survived to hospital discharge between 1/1/2006 and 12/31/2009 was conducted. Charts were reviewed for outcomes (CPC, mRS, and discharge disposition). Discharge disposition was classified in 6 categories: home with no services, home with home healthcare, acute rehabilitation facility, skilled nursing facility, long term acute care facility, and hospice. Intra- and inter-rater reliabilities were calculated for outcome measures. Rates of “good outcome” (defined as a CPC of 1–2, mRS of 0–3, or discharge disposition to home or acute rehabilitation facility) were also determined. Kendall’s tau correlation coefficients explored relationships among measures.

Results—A total of 211 charts were reviewed. Mean age was 60 years (SD 16), the majority (75%) were white males, in- and out-of hospital cardiac arrests were equally prevalent, and ventricular dysrhythmia was most common (N=109, 52%). Half of the subjects were comatose following resuscitation and 75 (35%) received therapeutic hypothermia. Inter-rater percentage agreement for CPC and mRS abstraction was 95.24% (kappa 0.89, $p < 0.001$) and 95.24% (kappa 0.90, $p < 0.001$) respectively.

“Good outcomes” were found in 44 subjects (20%) using the CPC definition, 47 subjects (22%) using the mRS definition, and 129 subjects (61%) subjects using discharge disposition definition. There was fair relationship between the CPC and mRS (tau 0.43) and poor relationships between CPC and discharge disposition (tau 0.23) and between mRS and discharge disposition (tau 0.25).

Conclusions—Determination of the CPC, mRS and discharge disposition at hospital discharge is reliable from chart review. These instruments provide widely differing estimates of “good outcome.” Agreement between these measures ranges from poor to fair. A more nuanced outcome measure designed for the post-cardiac arrest population is needed.

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Conflict of Interest Statement

The authors have no conflicts of interest to report.

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Introduction

Determining the neurological and physical disability status of cardiac arrest survivors is important for evaluating the outcome of resuscitation interventions. The Cerebral Performance Category (CPC) has been the traditional standard outcome measure for cardiac arrest survivors and can be determined through chart review. [1–3] However, previous work demonstrated that the CPC has limited ability to discriminate between mild and moderate brain injury. [4] The Modified Rankin Scale (mRS) has been used as a measurement of global disability in stroke, brain injury, and neurosurgical patients. [5–7] The mRS has some similarity to the CPC, though more focused on functional domains, and can also be determined using chart review. [8] Finally, discharge disposition has been used as a surrogate for the CPC or mRS on the assumption that disposition is largely determined by patient condition. [9–11]

Presently, several definitions of a “good outcome” are used in the literature, each based on summative outcome measures. In previous work, good outcome after cardiac arrest has been defined as a CPC of 1–2 [12], mRS of 0–3 [13], or discharge disposition to home or acute rehabilitation facility [10, 11]. While these measures are used interchangeably to define “good outcome,” it is unknown which of these measures are most useful or reliable for describing the patient outcome **at discharge**, because each of these measures is differentially affected by four factors: cognitive and physical impairments, recovery of function, and ability to participate in everyday life. Furthermore, the CPC, mRS and discharge disposition are global scores that each place different emphases on these factors. **The utility of discharge disposition lies only in its ability to capture current status and predict future outcomes. However, the CPC and mRS can be repeated over time, thus capturing short and long-term patient outcomes. Like discharge disposition, scores at discharge may be used to predict future patient outcomes.**

It is critical for clinical studies to employ a valid and reliable outcome measure, and it is desirable to be able to compare studies that use different outcome measures. However, there is a paucity of comparative performance data about the CPC, mRS and discharge disposition. Therefore, this study examined the association among the CPC, mRS, and discharge disposition as outcome descriptors in a well-characterized cardiac arrest population. For the CPC and mRS we also determined the intra- and inter-rater reliability of assessment from chart review. This study tested the hypothesis that these different outcomes would be strongly associated with each other.

Materials and Methods

Participants and Procedures

We completed a retrospective review of all subjects >18 years of age and resuscitated following either in-hospital cardiac arrest (IHCA) or out-of-hospital cardiac arrest (OHCA) who survived to hospital discharge in a single tertiary care facility between 1/1/2006 and 12/31/2009. Since 2007, this facility has incorporated a comprehensive post-cardiac arrest care program that includes use of therapeutic hypothermia for all comatose post-cardiac arrest patients regardless of initial cardiac rhythm. [9] We defined cardiac arrest as a loss of pulse requiring chest compressions, rescue shock, or both. Cardiac arrests that occurred in the emergency department were classified as IHCA. In our facility, an integrated electronic medical record is used that provides access to all chart elements. Charts were primarily reviewed by one author (YK) who is a certified and licensed occupational therapist. He was trained by three authors (JCR, KR, MBH) in the medical chart review process. To prevent protocol drift, one author (KR) performed random audits after every 50 patients. Data were compared using inter-rater reliability statistics. Charts were reviewed for demographic

information and outcomes (CPC, mRS, and discharge disposition). Initial post-cardiac arrest neurological dysfunction was determined within 6 hours of admission using the Full Outline of Unresponsiveness score [14] and initial cardiopulmonary dysfunction was determined using the cardiac and pulmonary subscales of the Sequential Organ Failure Assessment score. [15] When considering outcome measures, the primary reviewer (YK) focused on the following: 1) occupational and physical therapy notes, 2) cardiac rehabilitation notes, 3) discharge summaries, 4) attending post-cardiac arrest service notes, and 5) attending physical medicine and rehabilitation notes. The occupational and physical therapy and cardiac rehabilitation notes, which were recorded by rehabilitation therapists, have specified fields to record data. The discharge summary, post-cardiac arrest service, and physical medicine and rehabilitation notes were dictated by the medical staff. The team determined *a priori* that the scorer would always choose the worst score if there was a conflict in data determining the score. Additionally, charts for which such conflicts were determined were tagged by the reviewer (YK). Conflicts were resolved via consensus between two authors (KR and YK). The Institutional Review Board at the University of Pittsburgh deemed this study exempt.

Outcome Measures

All outcome measures were determined by medical chart review by one author (YK) at hospital discharge. The primary outcome measure was the CPC [Table 1], a 5-category scale for measuring neurological status after cardiac arrest. [1, 16, 17] The 5 categories are: CPC 1, conscious and alert with good cerebral performance; CPC 2, conscious and alert with moderate cerebral performance; CPC 3, conscious with severe cerebral disability; CPC 4, comatose or in persistent vegetative state; and CPC 5, brain dead, circulation preserved. The mRS was also used to evaluate disability. The mRS is a 7-point scale that ranges 0 (no symptoms at all) to 6 (death). A standardized form [Figure 1] was used to determine the CPC and mRS as in our prior work. [4] Discharge disposition was determined and classified in 6 categories: Discharge to home with no services, discharge to home with home healthcare, discharge to acute rehabilitation facility, discharge to skilled nursing facility, discharge to long term acute care facility, and discharge to hospice. Local practice requires that patients be able to tolerate >3 hours of therapy per day to qualify for acute rehabilitation facility.

Statistical Analyses

Descriptive statistics were generated for all demographic variables. Intra-rater reliability for one author (YK) was calculated for the CPC and mRS using a random sample of 23 subjects (11%) who survived to hospital discharge. Inter-rater reliability was also calculated for the CPC and mRS between two authors (KR and YK) using a random sample of 21 subjects (10%), who survived to hospital discharge. Kendall's tau correlation coefficients were used to explore relationships among measures. Similar to prior work, Kendall's tau was selected due to the tied ranks produced when calculating the Spearman's correlation coefficient. [4, 18] Correlations ranging from 0 to 0.25 indicated little or no relationship (poor); those from 0.26 to 0.50 suggested a fair degree of relationship; values from 0.51 to 0.75 indicated a moderate relationship; and values above 0.76 were considered a good relationship. [18] Scatter plots were then generated to examine these relationships for individual participants. Statistical calculations were performed using Stata 11.0 (StataCorp. LP, College Station, Texas, USA).

Results

Of the 512 subjects treated during the study period, 216 (42%) survived and had outcome measures determined. Five subjects were transferred to other hospitals, two due to insurance

coverage and three due to psychiatric illness. These 5 subjects were excluded from analysis leaving 211 subjects for analysis.

Mean age was 60 years (SD 16) and the majority (75%) was white males. [Table 2] IHCA and OHCA were equally prevalent, and ventricular dysrhythmia was most common (N=109, 52%). Half of the subjects were comatose (defined as not following commands) following resuscitation and 75 (36%) received therapeutic hypothermia. Median hospital length of stay was 14 days (IQR 8, 23; range 3–115).

The intra-rater percentage of agreement for CPC abstraction was 91.30% ($\kappa=0.87$, $p<.001$), and was 82.61% ($\kappa=0.73$, $p<.001$) for the mRS. Data abstraction was reliable between raters with an inter-rater percentage of agreement for CPC abstraction of 95.24% ($\kappa=0.89$, $p<.001$), and 95.24% ($\kappa=0.90$, $p<.001$) for the mRS.

The majority of subjects (N=153, 73%) were classified as a CPC of 3. [Table 2] Outcomes using the mRS demonstrated that a mRS classification of 4 was most common (N=139, 66%). Discharge disposition indicated that the most common disposition was return to home either with no services or with home healthcare (N=95, 45%).

Few subjects (N=44; 20%) met the CPC definition of “good outcome.” Similarly, only 47 (22%) subjects met the mRS definition of “good outcome.” However, 129 (61%) subjects met the discharge disposition definition of “good outcome.” There was only a fair relationship between the CPC and mRS with a tau value of 0.43. [Figure 2A] However, an examination of the scatter plot demonstrates little variability of the mRS for the individual CPC values. The CPC and discharge disposition demonstrated a poor relationship with a tau value of 0.23. [Figure 2B] Again, a CPC of 1 demonstrated discharge dispositions ranging from “discharge to home with no services” to “skilled nursing facility,” And a discharge disposition of CPC 3 ranged from “discharge to home with no services” to “long term acute care” and “hospice.” Finally, mRS and discharge disposition demonstrated a poor relationship with a tau value of 0.25. [Figure 2C] Examination of the scatter plots again revealed large variation with subjects of mRS 0–5 being discharged to home with no services. Similarly, discharge disposition of subjects with the most common mRS score of 4 ranged from home with no services to “long-term acute care” and “hospice.”

Discussion

The purpose of the study was to examine associations among CPC, mRS, and discharge disposition. These results do not support our hypothesis that these different outcome measures are strongly associated with each other. In contrast, significant variability exists among CPC, mRS, and discharge disposition as outcome measures. Relationships among these measures range from poor to fair. Thus, the percentage of subjects demonstrating a “good outcome” following cardiac arrest varies greatly depending on the outcome measure chosen. In this cohort, discharge disposition yields the highest percentage of “good outcomes” (61%) of the three definitions. Both mRS and CPC yield conservative estimates (mRS 22%, CPC 20%) of “good outcomes.” Clinically, the immediate ramifications of these data suggest a significant proportion of patients with disability (as captured by the CPC and mRS) may not receive post-discharge rehabilitation services. This may help explain our prior results demonstrating worse CPC and mRS scores at one month following cardiac arrest compared to discharge. [4] It is unknown if early rehabilitation efforts may improve these outcomes.

One potential reason for this variation among measures is how these global measures weight different domains of function. The International Classification of Functioning, Disability and Health describes two components for functioning and disability assessment: body

functions and structures, and activity and participation. [19] The CPC is heavily weighted toward mental functions, while the mRS considers both body functions and structures, and activity and participation. This focus of CPC may also explain the lack of agreement between CPC and the Functional Status Questionnaire reported by others [20]. Likewise, there is significant variability in the Health Utilities Index for patients who have similar CPC scores. [4, 21]

In addition, assessing a patient only with CPC at hospital discharge may be inadequate. The CPC has been criticized as poorly defined and using subjective criteria, [20, 22] and uses criteria that are not suitable for current hospital environment. For example, the criteria for a CPC of 2 (moderate cerebral performance) are, “Conscious. Sufficient cerebral function for part-time work in a sheltered environment or independent activities of daily life (dress, travel by public transportation, food preparation).” These criteria include broad-meaning and subjective terms, such as “sufficient” or “cerebral function”. Furthermore, it is hard to determine whether patients can travel by public transportation or prepare food because these tasks are not undertaken while they are in the hospital. While we utilized standardized criteria to determine CPC and mRS, this may not be the norm in many institutions. Therefore, future studies should consider these findings during the design phase and consider repeated measurements of outcome over time with multiple instruments.

Discharge disposition correlates poorly with the CPC and fairly with the mRS, making it suspect as an outcome measure. This observation may be related to the multiple factors extraneous to the patient, which determine discharge location. For example, insurance coverage, support of family members, and preexisting illnesses all can influence to what location a patient is discharged from the hospital. Moreover, a hospital or clinician’s individual criteria for hospital discharge may not correlate with what an individual patient considers a “good outcome.” These and prior data [4] demonstrate that hospital discharge represents a transition point in the post-arrest care of a patient and not an end point *per se*. In fact, the large number of subjects with mRS of 4 at hospital discharge probably reflects the fact that achieving the level of independence described by mRS of 3 is very nearly the same criteria for discharge from an acute care hospital. It is possible that these subjects continued to change in their functional status after discharge. Thus, defining outcome at hospital discharge alone may be an inadequate assessment of the patient’s outcome.

These data suggest that dichotomous outcomes (good versus bad) at hospital discharge are inadequate to measure outcomes after cardiac arrest. The actual distribution of scores on multiple instruments, measured at specified times, may be more appropriate. Developing a comprehensive outcome measure for cardiac arrest survivors incorporating each functional domain of the ICF should be a priority to the resuscitation community. As noted above, none of the traditional outcome measures individually provides adequate representation of the post-cardiac arrest patient’s outcome. Developing a comprehensive outcome measure in post-cardiac arrest patients will likely require rigorous evaluation and validation of components of several outcome measures in order to determine both utility and reproducibility. Without established reliability and validity, [4, 20] the CPC serves as a dubious gold standard for measuring outcomes following cardiac arrest. In the absence of a gold standard for construct validation, it is often possible to apply criterion tests for components of the overall instrument. [23] For example, the cognitive impairment – neuropsychological assessments. Similarly, the activity limitation and participation restriction component can be compared to the Modified Rankin Scale. Meanwhile, a more complete assessment of patient outcome can be achieved by using multiple instruments over time.

Strengths of this study include the large sample size, high intra-rater reliability across raters, and use of standardized criteria to determine CPC and mRS. However, the outcomes in this study are temporally limited to discharge disposition. We acknowledge that outcomes following cardiac arrest are dynamic between hospital discharge and one month post-arrest. [4] We believe these data argue for ongoing rehabilitation opportunities for this population.

Conclusion

Determination of the CPC, mRS and disposition at hospital discharge after cardiac arrest is reliable from chart review using standardized instruments. However, different instruments provide widely differing estimates of “good outcome”. Agreement between these measures ranges from poor to fair. A more nuanced outcome measure specifically designed for the post-cardiac arrest population is needed.

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Figure 1.
Classification of the Modified Rankin Scale
Abbreviations: mRS = Modified Rankin Scale

2A)

2B)

2C)

Figure 2.

Scatter plots comparing measures at hospital discharge. Figure 2A demonstrates the CPC and mRS interactions (tau 0.43). Figure 2B illustrates the CPC and discharge disposition interactions (tau 0.23). Figure 2C illustrates the mRS and discharge disposition interactions (tau 0.25).

Abbreviations: mRS=Modified Rankin Scale, CPC= Cerebral Performance Category, Home- = discharge to home with no services, Home-Care= discharge to home with home health care, Acute rehabilitation= discharge to acute rehabilitation facility, SNF= skilled nursing facility, LTAC= long-term acute care hospital, Hospice= discharge to home hospice or hospice facility.

Table 1**Cerebral Performance Category**

○ CPC 1	Conscious, alert, able to work and lead a normal life. May have minor psychologic or neurologic deficits (mild dysphasia, non-incapacitating hemiparesis, or minor cranial nerve abnormalities)
○ CPC 2	Conscious. Sufficient cerebral function for part-time work in sheltered environment or independent activities of daily life (dress, travel by public transportation, food preparation). May have hemiplegia, seizures, ataxia, dysarthria, or permanent memory or mental changes.
○ CPC 3	Conscious. Dependent on others for daily support (in an institution or at home with exceptional family effort). Has at least limited cognition. This category includes a wide range of cerebral abnormalities, from patients who are ambulatory but have severe memory disturbances or dementia precluding independent existence, to those who are paralyzed and can communicate only with their eyes, as in the “locked in” syndrome.
○ CPC 4	Unconscious. Unaware of surroundings, no cognition. No verbal and/or psychologic interaction with environment.
○ CPC 5	Brain dead, circulation preserved.
○ Death at discharge	

Table 2

Demographic information of 211 study subjects who survived to hospital discharge.

Age, in years	60 (16)
Male	126 (60%)
Race	
White	159 (75%)
Black	29 (14%)
Other	23 (11%)
OHCA	106 (50%)
Hypothermia Treatment	75 (36%)
Rhythm	
VF/VT	109 (52%)
PEA	46 (22%)
Asystole	29 (14%)
Unknown	27 (13%)
FOUR Motor Score	
0	16 (10%)
1	4 (3%)
2	49 (32%)
3	24 (15%)
4	61 (40%)
FOUR Brainstem Score	
0	3 (2%)
1	1 (1%)
2	15 (10%)
3	0 (0%)
4	130 (87%)
SOFA Cardiovascular Score	
0	98 (76%)
1	12 (9%)
2	4 (3%)
3	3 (2%)
4	13 (10%)
SOFA Respiratory Score	
0	26 (23%)
1	21 (19%)
2	20 (18%)
3	25 (23%)

4	19 (17%)
Length of stay, days (IQR)	14 (8, 23)
CPC	
1	41 (19%)
2	3 (1%)
3	153 (73%)
4	14 (7%)
mRS	
0	29 (14%)
1	12 (6%)
2	3 (1%)
3	3 (1%)
4	139 (66%)
5	25 (12%)
Discharge Disposition	
Home- No Services	63 (30%)
Home- Care	32 (15%)
Acute Rehabilitation	34 (16%)
Skilled Nursing Facility	36 (17%)
Long-term Acute Care	35 (16%)
Hospice	11 (6%)

Abbreviations: OHCA= out-of-hospital cardiac arrest, VF/VT= ventricular fibrillation/ventricular tachycardia, PEA= pulseless electrical activity, FOUR= Full Outline of Unresponsiveness, SOFA = Sequential Organ Failure Assessment, CPC = Cerebral Performance Category, mRS=Modified Rankin Scale.