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Clinical Considerations and Risk Management for a Patient with Cerebral Hyperperfusion Syndrome: A Case Report

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Abstract

Background: Cerebral hyperperfusion syndrome is a rare post-operative complication with high mortality rates if not managed properly. The purpose of this case report is to describe the rehabilitation and outcomes of a patient with cerebral hyperperfusion syndrome that may be informative for physical therapists encountering these patients. **Case Description:** A 58-year-old male presented to the emergency department after a seizure and subsequent hemiparesis. He had undergone a carotid endarterectomy 4 days prior to going to the hospital. The patient was found to have cerebral hyperperfusion syndrome, a rare post-operative complication of carotid endarterectomy. The patient remained in the hospital for 4 days in order to normalize his blood pressure. Physical therapy interventions included gait and therapeutic exercises to challenge the patient's blood pressure within parameters set by the neurology team. **Outcome Measures:** The primary outcome measure utilized was the AM-PAC Inpatient Basic Mobility Short Form. Over the course of his 4-day hospital stay, the patient's score improved from 16 to 24. **Discussion:** Current research shows blood pressure lability correlates with the development and progression of CHS after carotid endarterectomy. This case study explains one way of managing a patient with CHS and the role physical therapists can play. Future research could work to identify an appropriate blood pressure range to utilize with CHS patients to prevent the development of intracerebral hemorrhage.

Keywords: Cerebral hyperperfusion syndrome; neurology; physical therapy; rehabilitation

Background

Cerebrovascular accidents, or strokes, are a leading cause of death in the United States and have the potential to leave a patient with lasting functional deficits if survived. Carotid artery disease is a major contributor, causing between 15-20% of all cerebrovascular accidents.[1] Because of these two facts, doctors treat carotid artery disease aggressively, typically with carotid endarterectomies, in order to prevent strokes.[2,3] Although effective in addressing carotid artery disease, carotid endarterectomies are not without their own set of risks. Cerebral hyperperfusion syndrome (CHS) is a rare and unpredictable postoperative complication of carotid endarterectomy that can present up to a month after surgery in less than 3% of patients with possible life threatening adverse effects if not diagnosed early.[2,4]

CHS is not well understood, however it is said to be caused by intracranial vessels losing their ability to constrict due to chronic vasodilation. After carotid endarterectomy, blood flow is increased and the vessels are unable to limit this blood flow to the brain which results in CHS.[4] Common symptoms include hemiparesis, seizures, headaches, and myoclonus.[4] Other adverse effects, generally seen later in the progression of CHS, include cerebral edema and intracerebral hemorrhage, which can lead to loss of consciousness and death. Although there is limited research on CHS, it is clearly a potentially fatal postoperative complication of carotid endarterectomy with up to a 50% mortality rate that requires early recognition and treatment before it causes intracerebral hemorrhage.[4]

Prevention of hypertension and maintenance of a safe systolic blood pressure are the most measurable and reliable ways to avoid progression of CHS toward intracerebral hemorrhage.[2] Despite the fact that blood pressure (BP) management is crucial in the treatment of CHS, there is no data yet to indicate the best parameters for systolic BP during physical therapy intervention.[5,6] Because the risk is high when working with this patient population, BP management by physical therapists is critical for treating patients in a safe and controlled manner.

Due to the relative rarity of CHS, many physical therapists might not be familiar with the diagnosis and associated risks. Thus, the purpose of this case report is to describe the clinical considerations and appropriate monitoring for risk management while providing physical therapy treatment to a patient with CHS. The focus will be on treatment parameters utilized to establish a safe environment for improving overall function of patients with CHS and preventing secondary complications associated with immobility in the intensive care unit.

Case Description

A 58-year-old male had undergone a left carotid endarterectomy 4 days prior to coming to the emergency department. He was discharged the day after surgery without complications. The patient presented to the emergency department after having a tonic clonic seizure. He reported feeling generally unwell earlier in the day and had called his doctor complaining of high BP readings. His doctor added a calcium channel blocker to the patient's medication list and told him to pick it up from his pharmacy. Later in the day, the patient began experiencing twitching of his right arm and the right side of his face before having the seizure. After the seizure, he developed right arm weakness and difficulty speaking causing him to go to the emergency room. The patient also reported a mild headache on the right side of his forehead. Vitals were taken and labs were drawn in the emergency department. Results are in **Table 1**.

Table 1. Vitals taken in the Emergency Department.

Test	Value	Result
Temperature	97.7° F	Normal
Heart rate	105 bpm	High
Respiratory Rate	27 breaths/min	High
Blood Pressure	179/125 up to 234/85 mmHg	High
SpO2	96% on room air	Within Normal Range

In the emergency department, a computed tomography scan and computed tomography angiography of the patient's head were ordered and completed immediately. The computed

tomography was negative for intracranial hemorrhage. The computed tomography angiography showed "increased cerebral artery enhancement of the left compared to the right, consistent with cerebral hyperperfusion syndrome" per doctor's notes. Approximately 90% stenosis was noted in the right proximal internal cerebral artery on computed tomography angiography.

While in the emergency department, the patient experienced a second tonic-clonic seizure lasting approximately 60 seconds. Before being admitted to the neuro trauma intensive care unit, a neurological exam performed by the neurologist was normal—which in this hospital indicated symmetry in facial features, tongue midline, and pupils equal, round, and reactive. The patient was treated with medication to lower his systolic BP and given strict systolic BP guidelines to be maintained between 100 and 130 mmHg. An arterial line was placed to most effectively manage BP. In addition, hourly neurological checks were initiated upon admission to the neuro-trauma intensive care unit. At that time his neurological scores were within normal limits and as follows: National Institute of Health Stroke Scale score of 7, a Glasgow Coma Scale of 15, and a Modified Rankin Score of 0.

For the purpose of this case report, it is important to note that patient's past medical history was significant for hypertension, hyperlipidemia, previous myocardial infarction, peripheral vascular disease, coronary artery disease, and bilateral carotid artery stenosis.

Examination and Evaluation:

Admission day 1:

Physical therapy was unable to see the patient his first day in the hospital due to a 24 hour electroencephalogram to monitor possible seizure activity. The electroencephalogram was "normal while awake and asleep" according to doctor's notes.

Admission day 2:

A physical therapist was able to evaluate the patient his second day in the hospital. Nursing staff and the neurology team were consulted prior to the evaluation, and both relayed the importance of maintaining the patient's systolic BP between 100 and 130 mmHg for the duration of treatment. The patient had an arterial line in place to monitor beat-by-beat BP.

Upon interview, it was discovered the patient's requirements for safe discharge to home were minimal—needing to ambulate from his car to front door but with no stairs to enter his home or within his home. It was also noted that he would have the support of his fiancé at home, but previously had no need for assistance from her, assistive devices, or other medical equipment. The patient stated that his goal was to return home with his fiancé upon discharge.

Prior to beginning the physical examination, nursing staff assisted with attaching the arterial line to a portable monitor. This monitor also displayed readings for electrocardiogram, saturation of peripheral oxygen, heart rate, and a secondary BP via an external cuff. All of these readings were to be monitored during mobility and gait, with priority placed on the arterial line BP readings.

The patient's systolic BP was reading between 108 and 114 mmHg at rest according to the arterial line. Two therapists were present due to the amount of monitoring required as well as the patient's history of recent seizures. On exam, no deficits were found with manual muscle testing or range of motion for the upper or lower extremities. The patient required contact guard assistance for safety with all tasks including bed mobility and transfers. Due to ability to maintain BP below 130 with functional movement tasks, ambulation was attempted. Upon sitting at the edge of bed before walking, the patient's systolic BP read 126 mmHg. A rest break was taken and the reading recovered below 115 mmHg within 1 minute. After standing, the patient's systolic BP increased to 136 mmHg. Nursing was consulted and therapists were given the go ahead to continue working with the patient and walk with BP readings up to 150 mmHg, reportedly due to positional changes affecting the arterial line reading. To try and reduce the patient's exertion with ambulation, a front-wheeled walker was utilized. The patient was able to ambulate 300 feet, but required six rest breaks lasting 1 minute each due to systolic BP readings over 140 mmHg. A Five Times Sit to Stand test was completed to test functional strength during the evaluation in 9.08 seconds, a time not indicative of fall risk.

The examination suggested that the patient's biggest limiting factor was his elevated BP with activity. His high BP increased his risk for intracerebral hemorrhage, which could lead to long-term functional deficits and possibly death. It also did not allow the patient to fully participate in his daily life. Therefore, it was decided that physical therapy intervention would focus on improving activity tolerance without a dramatic increase in systolic BP and ultimately allow return to home and daily activities without complications.

Intervention

Gait was the primary intervention utilized with adjunct therapeutic exercises as time allowed. The patient's BP was challenged and intermittently elevated above his systolic BP parameters, showing the intensity of interventions was as high as the patient could safely achieve at the time. **Figure 1** charts the patient's systolic BP at rest and his highest systolic BP during gait throughout his admission. **Figure 2** shows the amount of rest breaks the patient required while walking 300 feet to maintain systolic BP within set parameters during his stay.

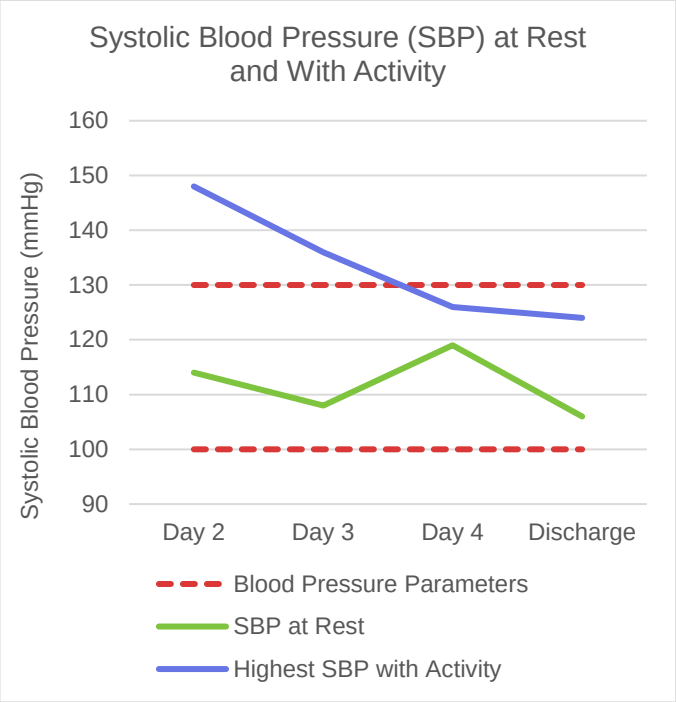

Figure 1. Systolic blood pressure readings during ambulation throughout the patients hospital stay.

Admission day 3:

When the physical therapist arrived the third day in the hospital and had the patient sit up, his systolic BP read 136 mmHg. The physical therapist had been informed by nursing that his BP was trending under 100 mmHg earlier in the day. Once within parameters again, ambulation was attempted. He was able to safely ambulate 300 feet without an assistive device and with 3 rest breaks in order to maintain a safe BP. Near the end of ambulation, his systolic BP was reading 92 mmHg and he was complaining of lightheadedness and dizziness. After consulting nursing while the patient rested, the physical therapist was instructed to discontinue ambulation. With systolic BP readings consistently below 100 mmHg, seated therapeutic exercises were initiated to attempt to safely raise the patient's BP within set parameters. Exercises including ankle pumps, long arc quads, marching, resisted hip abduction and adduction, and glute sets were completed. After this treatment session, the patient's systolic BP had normalized within his set parameters to 114 mmHg.

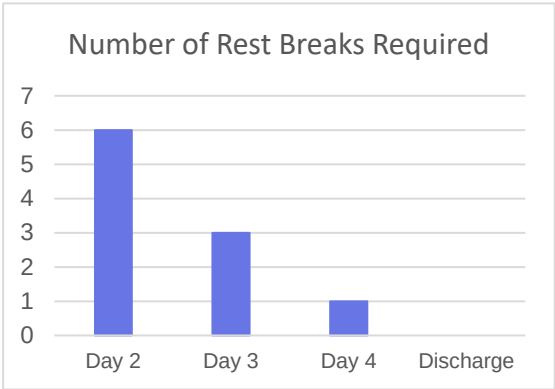

Figure 2. Number of rest breaks required during 300 feet of ambulation to maintain systolic BP within parameters.

Admission day 4:

Physical therapy staff was unable to work with the patient on his fourth day in the hospital despite two separate attempts. In the morning, the patient's systolic BP was reading 151 mmHg, he reported not feeling well, and the physical therapist left him to rest. After lunch, the patient had just walked 300 ft with nursing staff and wanted to rest. Systolic BP readings were 119 mmHg. The patient was allowed to rest and nursing relayed that the patient required one rest break during ambulation.

Discharge:

Physical therapy staff was unable to see the patient again before he was discharged. The patient was able to walk household and community distances safely within his BP parameters once his antihypertensive medications were adjusted. He was able to perform all tasks necessary to enter his home environment and get in and out of a bed and car without assistance. Magnetic resonance imaging showed no acute intracranial hemorrhage before the patient was discharged home in stable condition.

Outcomes

After five days at the hospital, the patient was discharged home with his fiance without further physical therapy services. The patient was seen for two visits during his hospital stay. Physical therapy was attempted on two additional days, but was unable to treat the patient due to medical instability or testing being done. Nursing was consulted to ambulate the patient under close BP monitoring to prevent immobility the days he was not seen.

The primary standardized outcome measure utilized was the Boston University Activity Measure for Post-Acute Care (AM-PAC) Basic Mobility Inpatient Short Form or “6 Clicks”. This measure is computer based and can be answered by the clinician or patient.[7] In this instance, the physical therapist filled out the AM-PAC at evaluation and upon discharge, as was standard in this clinical setting. The AM-PAC is based on responses to six questions regarding how difficult a task is for the patient and also how much help the patient needs to complete a given task. Mobility tasks include turning over in bed, sitting down on and standing up from a chair with arms, moving from lying down to sitting edge of bed, transferring from bed to chair, walking in a hospital room, and climbing 3-5 steps with a railing.[8] **Table 2** shows the scoring guidelines for the AM-PAC.[8]

Table 2. AM-PAC Mobility Description Definitions

How much difficulty does the patient currently have…		
Unable	1 point	If the patient is not able to do the activity.
A Lot	2 points	If it is a struggle, requiring great effort and/or time.
A Little	3 points	If the patient can manage to do the activity, but it takes more effort and/or time than you think it should.
None	4 points	If the patient does not experience any problems.
How much help from another person does the patient currently need…		
Total	1 point	Total / Dependent Assist
A Lot	2 points	Maximum / Moderate Assist
A Little	3 points	Minimum Assist / Contact Guard Assist / Supervision
None	4 points	Modified Independence / Independent

The AM-PAC Basic Mobility Inpatient Short form has been shown to be valid in the acute care setting and can provide useful data to clinicians to assist in discharge planning from the hospital as well as determining if the patient is a good candidate for therapy services while admitted.[9] Lower scores are indicative of more limitations. A score of 18 correlates with a patient who is ideal for nursing mobility. A score above 20 on the AM-PAC correlates with a patient going home without services.[10]

The patient scored a 16 at initial evaluation and received a score of 24 upon discharge. His evaluation score correlates with “a little” help or difficulty on all mobility tasks except being unable to perform stairs. His discharge score correlates with no help or difficulty on all mobility tasks. This 8 point improvement is above the reported Minimal Detectable Change (MDC) of 4.28.[7] There is no reported Minimal Clinically Important Difference (MCID) for the AM-PAC.

During his first session, the patient required six rest breaks and a walker during a 300 foot ambulation to keep his systolic BP within his parameters. By discharge, he no longer required rest breaks or the walker to complete this task. The patient also showed improvement in overall distance ambulated from 300 feet at evaluation to 1000 feet at discharge. Over the course of his hospital stay, the patient made improvements in his functional capacity shown by increased activity performed within safe systolic BP parameters. The patient could walk community distances without an assistive device, was able to stand without significant increases in BP, and showed no signs of long term functional deficits before discharge.

Other outcome measures that could have been used for this patient include the 6 Minute Walk Test or 30 Second Sit to Stand to better assess endurance and repetitive tasks. These tests would have likely increased the patient's BP beyond set parameters initially, and thus, were not chosen at evaluation due to safety concerns.

Discussion

CHS is a rare post-operative complication of carotid endarterectomy presenting in 0.18% to 3% of patients that can lead to long term functional deficits and even death if not properly managed and controlled.[4,6,11] If treated appropriately, research has shown 83% of patients make a "good recovery" if intracerebral hemorrhage is prevented.[6] While there is not current research regarding proper management of a patient with CHS during physical therapy treatments, this case study attempted to show one way of managing it during intervention.

Current research shows blood pressure lability after carotid endarterectomy plays a role in the development and progression of CHS, regardless of other factors. Postoperative hypertension is independently associated with CHS and was found to be the most important postoperative variable.[4] Interestingly, postoperative hypotension is also independently associated with CHS and was found to be the second most important postoperative variable.[4] Post-operative hypertension and hypotension make the patient 4.1 and 3.21 times as likely and to develop CHS, respectively.[4] It was decided by the neurology team that BP control was the best way to manage the risks associated with CHS for this patient as is suggested in current research.[4,6]

Research is lacking in what BP ranges to use to safely manage CHS, but many articles mention "normotension" and one article mentions lowering systolic BP below 140 mmHg. The same systematic review also stated that there were no published cases of CHS presenting below a systolic BP of 135 mmHg.[6] This research would indicate that the chosen systolic BP range for this patient was within the safe parameters for his condition. Initially, BP was tightly managed via an arterial line for beat-by-beat BP. However, halfway through the patient's admission, his arterial line was removed and BP was monitored only through readings from an external blood pressure cuff. This led to less stringent management of BP due to the time required for the machine to take a reading.

The purpose of this case study was to show one way of managing a patient with CHS during physical therapy treatments and the steps taken to prevent progression to intracerebral hemorrhage. Current evidence supported and gave rationale for the way this patient was managed through control of hypertension. Limitations of this report include varying blood pressure parameters utilized for mobility and the patient not receiving physical therapy daily. While this case turned out successfully, further research is needed to identify a safe BP range to maintain in order to prevent progress of CHS to intracerebral hemorrhage. Additional research in non-pharmacological management of BP, including physical therapy, would provide insight into the best possible treatment for patients with CHS.

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