

# Cerebral Amyloid Angiopathy: A Different Kind of Stroke



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## ABSTRACT

When a patient presents with stroke-type symptoms, the correct diagnosis is imperative to determine appropriate treatment. Cerebral amyloid angiopathy (CAA), a buildup of amyloid proteins on the brain artery walls, is a cause of intracerebral hemorrhage. Improved diagnostic criteria and enhanced neuroimaging have resulted in earlier detection of CAA, which will hopefully lead to better outcomes for these patients. More research is being conducted, and neuroscience nurses need to stay informed about this condition to be able to appropriately care for and educate their patients who are diagnosed with CAA.

**Keywords:** cerebral amyloid angiopathy, hemorrhagic stroke, intracerebral hemorrhage, stroke

## Case Study

Mr M, an 81-year-old white male, presents to emergency department (ED) with the chief complaint of pain in his left hip most likely related to his lumbar disc disease. His medical history also includes Parkinson disease treated with levodopa-carbidopa (Sinemet), hypothyroidism, and peripheral neuropathy. Surgical history consists of a lumbar laminectomy almost 30 years ago and a left lower lobectomy, chemotherapy, and radiation 15 years ago for stage 3b adenocarcinoma of the lung. He is currently cancer free.

While in the waiting room of the ED, he suddenly develops a left-sided facial droop, drooling, lack of sensation to the left side of his face, slurred speech, and left-sided pronator drift. A stroke code is activated. His National Institutes of Health Stroke Scale score is 6. His 12-lead electrocardiogram reveals normal sinus rhythm with occasional premature ventricular contractions. An urgent computed tomography of the brain and neck is negative. The initial symptoms resolve within 40 minutes, so thrombolytics are not ordered. The episode is diagnosed as a transient ischemic attack (TIA), and Mr M is admitted to the neurosurgical step-down unit for monitoring.

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That same evening, he has 2 more similar neurological events. A magnetic resonance imaging (MRI)/magnetic resonance angiography of the brain confirms lacunar bleeds in Mr M's right posteroparietal area with minimal surrounding swelling. He is discharged to a rehabilitation facility to receive physical therapy for his back (MRI revealed herniations of L3-L5) and told to take a baby aspirin every day and nonsteroidal anti-inflammatory drugs to abate the back pain. Because of the recent strokes, a lumbar laminectomy is postponed until 2 months later. Six months after the surgery, he has 3 more lacunar, lobular strokes within a month confirmed on computed tomography scan. Each time, the symptoms resolved within an hour with no residual effects. With the multiple small strokes and transient neurological symptoms happening within a short period and coupled with some cognitive decline, the neurologists begin to explore the possibility of cerebral amyloid angiopathy (CAA).

## Stroke Symptoms Have Many Causes

Discovering the cause of stroke symptoms can be challenging, but it is important to try to pinpoint the cause for appropriate treatment. Intracerebral hemorrhage (ICH) is responsible for approximately 10% to 15% of first-time strokes. Although the incidences are lower than other stroke types, it is one of the major reasons for stroke-related death and disability.<sup>1</sup> Vessel damage and rupture account for many ICH cases. Vessel damage is caused by chronic hypertension, but CAA can be suspected in up to 30% of these cases.<sup>1</sup>

CASE STUDY

Cerebral amyloid angiopathy is a common, well-defined small vessel disease. It is a largely untreatable cause of ICH and a contributor to age-related cognitive decline and now encompasses not only a specific cerebrovascular pathological finding but also different acute, progressive clinical syndromes and brain parenchymal lesions seen on neuroimaging.<sup>2</sup> In the past, CAA could only be definitively diagnosed at autopsy, but now, a set of diagnostic criteria have resulted in an increase in detection of the disease during life.

Cerebral amyloid angiopathy occurs when amyloid proteins build up on the walls of the brain arteries.<sup>3</sup> These progressive amyloid deposits are usually found in the walls of small cortical and leptomeningeal arteries.<sup>4,5</sup> It is classified according to the involved amyloid protein with at least 7 different ones identified and amyloid  $\beta$ -protein being the most common.<sup>6</sup> At the pathophysiological level, CAA appears to be in part a protein elimination failure angiopathy, which potentially leads to worsening vascular amyloid- $\beta$  accumulation, activation of vascular injury pathways, and impaired vascular physiology.<sup>2</sup> From a clinical standpoint, CAA is characterized by individual focal lesions (microbleeds, cortical superficial siderosis, microinfarcts) and large-scale alterations (white matter hyperintensities, structural connectivity, cortical thickness), both cortical and subcortical.<sup>2</sup>

The exact cause of CAA is unknown, but inflammation may play a role in its pathophysiology.<sup>7</sup> There are also genetic factors as there are several types (Dutch or Icelandic) with hereditary predisposition and earlier onset.<sup>8</sup> Advancing age is a significant risk factor for CAA development.<sup>3</sup> In postmortem examinations of more than 400 individuals aged 40 to 90 years, CAA was found in the brains of 28% of women and 18% of men.<sup>8</sup> Other autopsy series showed greater than 50% incidence in persons older than 90 years.<sup>8</sup> Although CAA can occur by itself, it is also seen in association with Alzheimer disease or dementia.<sup>1</sup> In Alzheimer disease, the prevalence of CAA and its associated hemorrhage can be as high as 80% to 90%.<sup>6</sup> Cerebral amyloid angiopathy is a recognized risk factor for recurrent ICH, particularly in lobar locations of the brain. If complete erosion of the vessel occurs, the patients are predisposed to hemorrhage.<sup>8</sup> Typically, bleeding occurs in the outer parts of the brain and not in the deep areas.<sup>3</sup>

When protein deposits are the result of the usual aging process, individuals can be neurologically healthy and asymptomatic. However, if the condition is more severe or the protein metabolism is impaired, damage to the vessel walls will cause symptoms.<sup>3</sup> There can be a variety of symptoms, and many are consistent with the signs of a stroke. Symptoms include any combination of the following: weakness or paralysis of extremities, loss of sensation, focal neurological deficits,

balance/coordination difficulties, difficulty speaking or swallowing, seizures, confusion, dementia, vomiting, and sudden or severe headache. Some of these symptoms may present as mild or come and go depending on the severity of the bleeding or damage to the brain tissue.<sup>3</sup> Patients may also present with cognitive decline, some of which progresses rapidly.<sup>8,9</sup> In nondemented patients with CAA, the risk of dementia is high particularly post ICH. It is now known that CAA physiological alterations probably start many years before the first clinical manifestations.<sup>10,11</sup>

## Diagnosis of CAA

Differentiating CAA-related transient focal neurological episodes from a TIA is quite challenging due to the overlapping clinical symptoms. Cerebral amyloid angiopathy should be considered in patients older than 55 years who have numerous lobar hemorrhages without an obvious cause. Obtaining MRI is needed to confirm the diagnosis.<sup>12</sup> The increasing number of MRI markers may help to discriminate CAA from other small vessel diseases and dementia subtypes.<sup>11</sup>

There are associated neuroimaging biomarkers for CAA including strictly lobar cerebral microbleeds, cortical superficial siderosis, and hyperintensities of the white matter.<sup>5</sup> If available, positron emission tomography scans using imaging agents may also serve as useful methods to detect CAA.<sup>8</sup> Other distinguishing features include the smooth spread of symptoms, the absence of hemodynamically significant stenosis, and the presence of small microhemorrhages in the region of the cortex associated with symptoms.<sup>13</sup> The Boston criteria, first established in 1995 and modified in 2010, combine clinical findings, imaging, and pathological parameters and have shown accuracy in the diagnosis of CAA<sup>6</sup> (Table 1).

Differential diagnoses include head injury/trauma, lobar extension of a hypertensive putaminal hemorrhage, a hemorrhagic transformation of an ischemic stroke, an arteriovenous malformation, or a hemorrhagic tumor.<sup>2,11</sup> Patients must also be evaluated for complications of anticoagulation or bleeding tendencies, which may contribute to ICH. In some patients, cerebrospinal fluid may have abnormalities such as lower levels of amyloid  $\beta$ 42 and  $\beta$ 40.<sup>8</sup>

## Treatment

Currently, there are no specific treatments or disease-moderating therapies for CAA.<sup>6</sup> The management of CAA is determined based on the assessment findings and/or the severity of the bleed with attention to increased intracranial pressure, cerebral edema, cerebrovascular injuries, and controlling blood pressure (BP). The immediate treatments are similar to other

**TABLE 1. Modified Boston Criteria for Diagnosis of CAA<sup>5</sup>**

Tiers	Criteria
1. Definite CAA	Full postmortem examination reveals lobar, cortical, or cortical/subcortical hemorrhage and pathological evidence of severe cerebral amyloid angiopathy without other diagnostic lesions
2. Probable CAA with supporting pathological evidence	Clinical data and pathological tissue (evacuated hematoma or cortical biopsy specimen) demonstrate a hemorrhage as mentioned previously and some degree of vascular amyloid deposition
3. Probable CAA	Does not have to be postmortem Pathological confirmation not required Patients 55 years or older Appropriate clinical history MRI findings demonstrate multiple hemorrhages restricted to lobar cortical, or corticosubcortical regions (cerebellar hemorrhages allowed) of varying sizes/ages without another cause or a single lobar, cortical, or corticosubcortical hemorrhage and focal (3 or less sulci) or disseminated (more than 3 sulci) cortical superficial siderosis without another cause
4. Possible CAA	Patients 55 years or older Appropriate clinical history MRI findings demonstrate a single lobar, cortical, or corticosubcortical hemorrhage without another cause, or focal or disseminated cortical superficial siderosis without another cause

*Note.* The modified Boston criteria (2010) are based on the original Boston criteria (1995) and combine clinical, imaging, and pathological parameters. They are now divided into 4 tiers. Compared with the original criteria, they have an increase in sensitivity and confidence interval, with only a modest decrease in specificity.  
Abbreviation: CAA, cerebral amyloid angiopathy.

TIA or strokes with the exception of anticoagulant use, which may increase the risk of hemorrhagic stroke from CAA. Statin treatment also increases the risk of microhemorrhages.<sup>14,15</sup> The recurrence rate of CAA rebleeds is 24% to 40%, with the biggest risk in the first year.<sup>8</sup> Consequently, careful consideration of appropriate treatments is necessary.

Acute treatment of CAA-related stroke, like other types of stroke, should focus on urgent stabilization of cardiopulmonary systems and management of intracranial complications. Management of airway is a priority in the patient with a deteriorating level of consciousness. Increased intracranial pressure may be related to the direct effect of the bleed, the progression of cerebral edema, or the development of hydrocephalus.

Arterial hypertension is a main risk factor for stroke. Blood pressure control validated by the PROGRESS trial maintains that the patients' BP should be at the lower end of "normal" to help decrease the risk of rebleeding.<sup>14,15</sup> Blood pressure control is managed according to the American Heart Association/American Stroke Association guidelines for ICH, which are safe and effective for improving functional outcome.<sup>16</sup> Early seizures may occur in 3.4% to 41% of patients after an ICH within 30 days postbleed.<sup>17</sup> Seizures are more likely to occur with lobar hematomas.<sup>18</sup>

Hematoma evacuation of ICH may be considered.<sup>6</sup> The Surgical Trial in Lobar Intracerebral Hemorrhage trial identified that some patients with spontaneous ICH may benefit from early surgical evacuation. In this trial, early surgery did not increase the rate of death or disability at 6 months, suggesting a small survival advantage for patients with ICH who do not have intraventricular hemorrhage.<sup>19</sup>

There have also been cases where inflammation is noted on MRI.<sup>20</sup> This is known as CAA-related inflammation.<sup>21</sup> It is a subgroup of CAA that can present with lobar ICH, encephalopathy, and seizures. This type responds favorably to corticosteroids as seen by significant improvement in clinical and imaging characteristics.<sup>7</sup>

There are continuing clinical trials and studies for the treatment of CAA and its complications. One therapy on the horizon, currently in trials, is the use of passive immunotherapy to target amyloid- $\beta$ , reduce amyloid angiopathy, and improve vascular reactivity. Because CAA is characterized by the accumulation of shorter amyloid- $\beta$  isoform in the walls of the leptomeningeal and cortical arterioles, using an anti-amyloid- $\beta$ 40-selective antibody helps to reduce and neutralize the amyloid.<sup>22</sup> Some other examples of research are the Platelet Transfusion in Cerebral Hemorrhage trial, which targets the coagulation cascade.<sup>19</sup> Other trials such as the

Minimally Invasive Surgery Plus rt-PA for Intracerebral Hemorrhage Evacuation are examining the role of combining minimally invasive surgery with clot-busting drugs to improve outcomes, whereas the Clot Lysis: Evaluating Accelerated Resolution of Intraventricular Hemorrhage trial is assessing the usefulness of intraventricular thrombolysis.<sup>23</sup> Results of these trials and other research may impact future management of CAA.

### Nursing Care for Patients With CAA

The Brain Attack Coalition recommends that nurses carry out detailed assessment of neurological function, BP control, and prevention of complications.<sup>24</sup> An initial neurological assessment is needed to establish a baseline. Thereafter, assessments must be regularly performed to quickly detect subtle changes in the patient status especially related to orientation.

Nursing care includes monitoring all vital signs, specifically BP due to the risk of a rebleed. Furthermore, nurses must carry out regular and vigilant neurological examinations to reduce morbidity and mortality, looking for mass effect and signs of increased intracranial pressure. Nurses must also assess for secondary injury such as fever, hyperglycemia, and seizures that may complicate and impact the prognosis. Fever is a common occurrence after ICH and results in early neurologic deterioration, hematoma growth, and poor functional outcome.<sup>25</sup> There is clear evidence demonstrating that hyperglycemia carries a poor short- and long-term prognosis and increases early death after an ICH. Hyperglycemia is associated with hematoma expansion and worsening perihematoma edema, and therefore it is necessary to maintain a state of normoglycemia.<sup>16,26</sup>

Nurses must encourage early ambulation to prevent potential complications such as deep venous thrombosis and venous thromboembolism. Collaboration with physical/occupational therapists and/or speech-language pathologists, as appropriate, leads to improved outcomes and overall quality of life.<sup>27</sup> Nutrition is another important care consideration. Patients with a diet high in carbohydrates and sugars had a greater cerebral amyloid burden.<sup>28</sup> This suggests that diet is a potential modifiable behavior for cerebral amyloid accumulation.

Patient education is critical. Patients with CAA often have some degree of cognitive impairment affecting memory, executive function, and processing speed.<sup>10</sup> Education should include both the patient and his/her family/significant others using a variety of teaching methods to promote retention of material. Stroke education should be modified for CAA patients and their families, especially related to when to seek care regarding neurological symptoms. Unlike other strokes, patients with a known diagnosis of CAA do not always have to act “FAST” and go to the ED immediately when symptoms

occur. Instead, these patients may be instructed to wait and see whether the symptoms persist longer than an hour, and if so, then they should go to the ED to seek evaluation and possible treatment. Reassurance of patients and families is important because they can feel somewhat isolated when dealing with the uncertainties of CAA.

### Following up With Mr M

The CAA suspicions of the neurologists treating Mr M were confirmed with a gradient-echo MRI, which validated many small hemorrhages in the right post-eroparietal area, without evidence of vasculitis, encephalopathy, tumors, or arteriovenous malformations. At this time, Mr M was taken off the aspirin because anticoagulants increase the risk of hemorrhagic stroke from CAA and his BP was to be tightly controlled with systolic blood pressure to remain less than 130 mm Hg. He was also informed to use acetaminophen (Tylenol) for any pain and to not use nonsteroidal anti-inflammatory drugs. During the last year, he has had several more neurological events, very similar to the one described in the case study. All of the events resolved within approximately 5 to 10 minutes without residual effects. While initially these were quite frightening for him, his wife, family, and support system know now to stay with him, reassure him, and keep going about what they have been doing while vigilantly watching him, while at the same time not causing increased stress for him. If the symptoms are different or last longer than 1 hour, the family is aware that they must then seek expert consultation. Education has helped Mr M and his family cope with his CAA and has given them added confidence to manage this condition.

### References

1. Elliott J, Smith M. The acute management of intracerebral hemorrhage: a clinical review. *Anesth Analg*. 2010;110(5):1419–1427. doi:10.1213/ANE.0b013e3181d568e8
2. Charidimou A, Boulouis G, Gurol ME, et al. Emerging concepts in sporadic cerebral amyloid angiopathy. *Brain*. 2017;140(7):1829–1850. doi.org/10.1093/brain/awx047
3. National Institutes of Health. Cerebral amyloid angiopathy. 2017. Available at <http://medlineplus.gov/ency/article/000719.htm>. Accessed December 15, 2017.
4. Biffi A, Greenberg SM. Cerebral amyloid angiopathy: a systematic review. *J Clin Neurol*. 2011;7(1):1–9. doi:10.3988/jcn.2011.7.1.1
5. Charidimou A, Martinez-Ramirez S, Shoamanesh A, et al. Cerebral amyloid angiopathy with and without hemorrhage: evidence for different disease phenotypes. *Neurol*. 2015;84(12):1206–1212. doi:10.1212/WNL.0000000000001398
6. Yamada M. Cerebral amyloid angiopathy: emerging concepts. *J Stroke*. 2015;17(1):17–30. doi.org/10.5853/jos.2015.17.1.17
7. Rastogi V, Donnangelo LL, Asaithambi G, Bidari S, Khanna AY, Hedna VS. Recurrence of lobar hemorrhage: a red flag for cerebral amyloid angiopathy-related inflammation? *Innov Clin Neurosci*. 2015;12(5-6):20–26.

8. Menon RS. Cerebral amyloid angiopathy. *Medscape*. 2017. Available at <https://emedicine.medscape.com/article/1162720>. Accessed December 20, 2017.
9. Azmin S, Osman SS, Mukari S, Sahathevan R. Cerebral amyloid angiopathy: an important differential diagnosis of stroke in the elderly. *Malays J Med Sci*. 2015;22(1): 74–78.
10. Case NF, Charlton A, Zwiers A, et al. Cerebral amyloid angiopathy is associated with executive dysfunction and mild cognitive impairment. *Stroke*. 2016;47(8):2010–2016. doi:10.1161/STROKEAHA.116.012999
11. Wermer MJH, Greenberg SM. The growing clinical spectrum of cerebral amyloid angiopathy. *Curr Opin Neurol*. 2018; 31(1):28–35. doi:10.1097/WCO.0000000000000510
12. Zema C, Modi J, Bilston L, Shoamanesh A, Coutts SB, Smith EE. Cerebral microbleeds and cortical superficial siderosis in patients presenting with minor cerebrovascular events. *Stroke*. 2016;47(9):2236–2241. doi:10.1161/STROKEAHA.116.013418
13. Viswanathan A, Greenberg SM. Cerebral amyloid angiopathy in the elderly. *Ann Neurol*. 2011;70(6):871–880. doi:10.1002/ana.22516
14. Arima H, Tzourio C, Anderson C, et al. Effects of perindopril-based lowering of blood pressure on intracerebral hemorrhage related to amyloid angiopathy: the PROGRESS trial. *Stroke*. 2010;41(2):394–396. doi:10.1161/STROKEAHA.109.563932
15. Block F, Dafotakis M. Cerebral amyloid angiopathy in stroke medicine. *Dtsch Arztebl Int*. 2017;114(3):37–42. doi:10.3238/arztebl.2017.0037
16. Hemphill JC III, Greenberg SM, Anderson CS, et al. Guidelines for the management of spontaneous intracerebral hemorrhage: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2015;46(7):2032–2060. doi:10.1161/STR.0000000000000069
17. Cruz-Flores S, Alshekhlee A. Seizures in intracerebral hemorrhage. In: Koubeissi M, Alshekhlee A, Mehndiratta P, eds. *Seizures in Cerebrovascular Disorders*. New York, NY: Springer; 2015. doi.org/10.1007/978-1-4939-2559-9\_3
18. Koch S, Sung G. AEDs after ICH: preventing the prophylaxis. *Neurology*. 2017;88(1):15–16. doi.org/10.1212/WNL.00000000000003467
19. Morawo AO, Gilmore EJ. Critical care management of intracerebral hemorrhage. *Semin Neurol*. 2016;36(3):225–232. doi:10.1055/s-0036-1581991
20. Martucci M, Sarria S, Toledo M, et al. Cerebral amyloid angiopathy-related inflammation: imaging findings and clinical outcome. *Neuroradiology*. 2014;56(4):283–289. doi:10.1007/s00234-014-1330-6
21. Mendonça MD, Caetano A, Pinto M, Cruz e Silva V, Viana-Baptista M. Stroke-like episodes heralding a reversible encephalopathy: microbleeds as the key to the diagnosis of cerebral amyloid angiopathy-related inflammation—a case report and literature review. *J Stroke Cerebrovasc Dis*. 2015;24(9):e245–e250. doi:10.1016/j.jstrokecerebrovasdis.2015.04.042
22. Bales KR, O'Neill SM, Pozdynakov N, et al. Passive immunotherapy targeting amyloid- $\beta$  reduces cerebral amyloid angiopathy and improves vascular reactivity. *Brain*. 2016;139(2):563–577. doi:10.1093/brain/aww313
23. Nowinski WL, Qian G, Hanley DF. A CAD system for hemorrhagic stroke. *Neuroradiol J*. 2014;27(4):409–416. doi:10.15274/NRJ-2014-10080
24. Alberts MJ, Latchaw RE, Jagoda A, et al. Revised and updated recommendations for the establishment of primary stroke centers: a summary statement from the Brain Attack Coalition. *Stroke*. 2011;42(9):2651–2665. doi:10.1161/STROKEAHA.111.615336
25. Rincon F, Patel U, Schorr C, et al. Brain injury as a risk factor for fever upon admission to the intensive care unit and association with in-hospital case fatality: a matched cohort study. *J Intensive Care Med*. 2015;30(2):107–114. doi:10.1177/0885066613508266
26. Qureshi AI, Palesch YY, Martin R, et al. Association of serum glucose concentrations during acute hospitalization with hematoma expansion, perihematomal edema, and three month outcome among patients with intracerebral hemorrhage. *Neurocrit Care*. 2011;15(3):428–435. doi:10.1007/s12028-011-9541-8
27. Hillegass E, Puthoff M, Frese EM, et al. Role of physical therapists in the management of individuals at risk for or diagnosed with venous thromboembolism: evidence-based clinical practice guideline. *Phys Ther*. 2016;96(2):143–166. doi:10.2522/ptj.20150264
28. Taylor MK, Sullivan DK, Swerdlow RH, et al. A high-glycemic diet is associated with cerebral amyloid burden in cognitively normal older adults. *Am J Clin Nutr*. 2017; 106(6):1463–1470. doi:10.3945/ajcn.117.162263201712270 95912126570582

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