# Blood pressure management in stroke

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# Outline

# Epidemiology

# Effects and treatment

- Ischemic stroke
- Hemorrhagic stroke
- Subarachnoid hemorrhage
- Anti-hypertensive medications
- Primary prevention
- Future trends

# AHA Stroke Statistics 2016

Approximately 77% of those who had first stroke have BP >140/90 mmHg (ARIC, CHS, and FHS Cohort and Offspring studies)

- For each 10 mm Hg increase in levels of SBP, the increased stroke risk in whites is ≈8%; however, a similar 10 mm Hg increase in SBP in African Americans is associated with a 24% increase in stroke risk, an impact 3 times greater than in whites.
- Diabetic subjects with BP <120/80 mm Hg have appx half the lifetime risk of stroke of subjects with hypertension.
- Large accelerated reductions in stroke mortality due to Median SBP decline (16 mmHg) between 1959 and 2010 for different age groups
- Average 41% reduction in stroke incidence with SBP reductions of 10 mm Hg with anti-HTN therapy

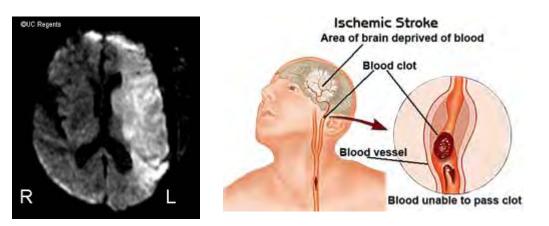
# AHA Stroke Statistics 2016

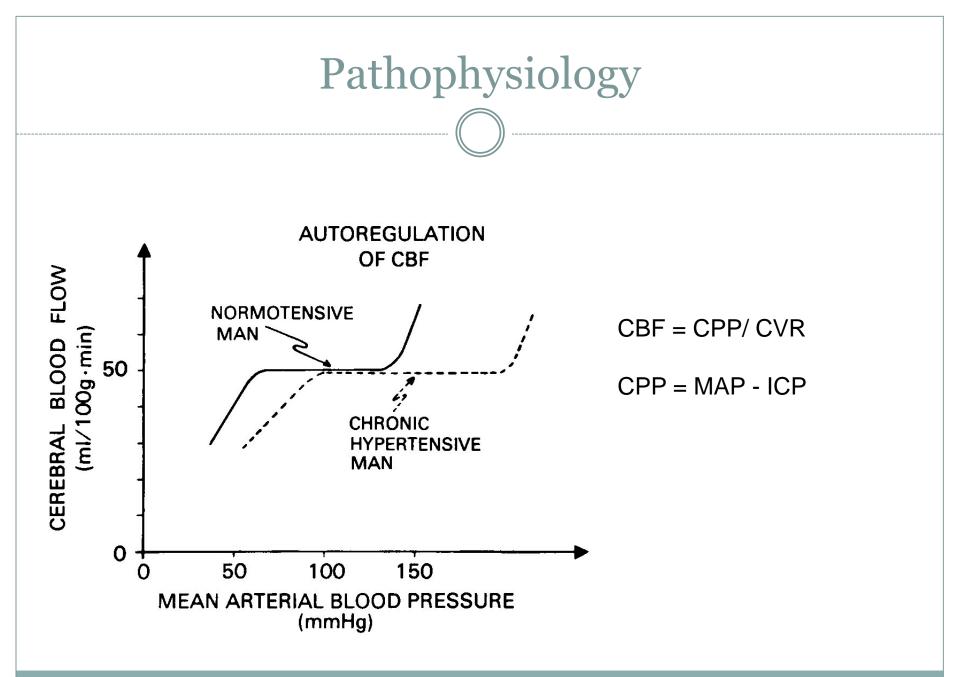
- Several studies have shown significantly lower rates of recurrent stroke with lower BPs.
  - Most recently, the BP- reduction component of the SPS3 trial showed that targeting an SBP <130 mmHg was likely to reduce recurrent stroke by ≈20% (P=0.08) and significantly reduced ICH by two thirds.</li>

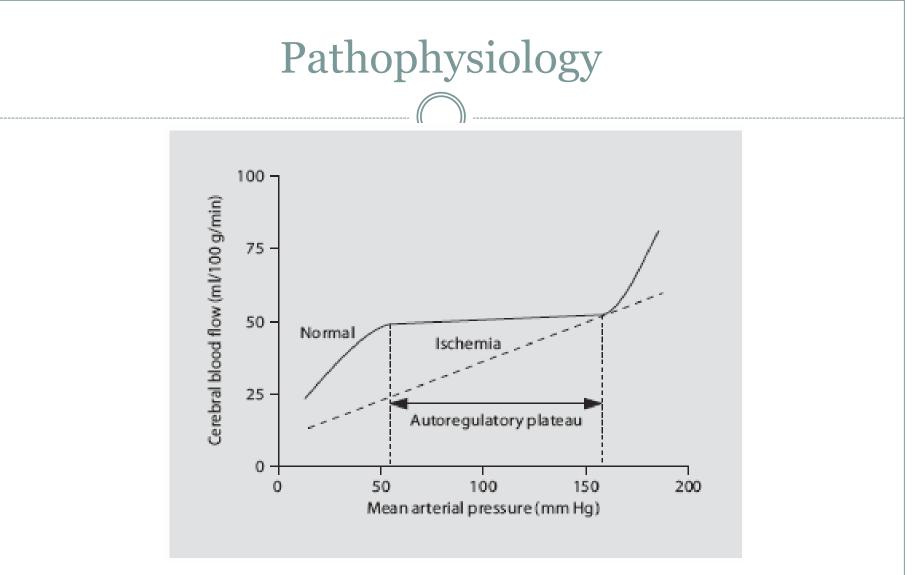
# Effects of BP

- Extreme arterial hypertension leads to encephalopathy, cardiac complications, and renal insufficiency
- Extreme arterial hypotension decreases perfusion to multiple organs, especially the ischemic brain, exacerbating the ischemic injury

# Ischemic stroke







Relationship between cerebral blood flow and mean arterial pressure under normal conditions and in ischemia.

# BP and its effect on ischemic stroke

- Moderate arterial hypertension during acute ischemic stroke might be advantageous by improving cerebral perfusion of the ischemic tissue, or it might be detrimental by exacerbating edema and hemorrhagic transformation of the ischemic tissue
- U-shaped relation between the admission blood pressure and favorable clinical outcomes, with an optimal systolic blood pressure ranging from 121 to 200 mmHg and diastolic blood pressure ranging from 81 to 110 mmHg
- However, elevated in-hospital blood pressure during acute ischemic stroke has been associated with worse clinical outcomes in a more linear fashion



# BP management during ischemic stroke

- BP for ischemic stroke eligible for IV tpa
- BP for ischemic stroke eligible for IV tpa + IAT
- BP for ischemic stroke for only IAT
- BP for ischemic stroke not a candidate for thrombolysis
- BP for ischemic stroke in sub-acute period
- Based on intracranial pathology

# BP during acute ischemic stroke eligible for alteplase

- Earlier thrombolytic treatment of patients with AIS is not only associated with more frequent independent ambulation at discharge and discharge to home, but is also associated with reduced mortality and symptomatic intracerebral hemorrhage (sICH)
- Elevated BP can affect thrombolytic eligibility and has been associated with delay in administration of IV tissue plasminogen activator (IV tPA)
- One factor that has been associated with delays in treatment times is the need for prethrombolytic BP goal of < 185/110 mm Hg a target extrapolated from prior studies of thrombolysis in acute myocardial infarction.

# BP during acute ischemic stroke eligible for alteplase

- In cases where such a target is not achieved, tPA may even be withheld, given the association of elevated BP and risk of sICH leading to poor clinical outcomes.
- Withholding tPA based solely on persistently uncontrolled BP, however, can lead to as many as 10% of otherwise eligible patients not receiving tPA.
- This is a significant number considering that ,10% of patients meet the current eligibility criteria for the use of IV tPA within 4.5 hours.
- Thus, a proficient attempt must be made to reduce BP to the thrombolytic range, even if it involves using multiple BP agents or continuous infusions.

# Table 9. Potential Approaches to Arterial Hypertension inAcute Ischemic Stroke Patients Who Are Candidates for AcuteReperfusion Therapy

Patient otherwise eligible for acute reperfusion therapy except that BP is >185/110 mm Hg:

Labetalol 10-20 mg IV over 1-2 minutes, may repeat 1 time; or

Nicardipine 5 mg/h IV, titrate up by 2.5 mg/h every 5–15 minutes, maximum 15 mg/h; when desired BP reached, adjust to maintain proper BP limits; or

Other agents (hydralazine, enalaprilat, etc) may be considered when appropriate

If BP is not maintained at or below 185/110 mm Hg, do not administer rtPA

Management of BP during and after rtPA or other acute reperfusion therapy to maintain BP at or below 180/105 mm Hg:

Monitor BP every 15 minutes for 2 hours from the start of rtPA therapy, then every 30 minutes for 6 hours, and then every hour for 16 hours

If systolic BP >180-230 mm Hg or diastolic BP >105-120 mm Hg:

Labetalol 10 mg IV followed by continuous IV infusion 2-8 mg/min; or

Nicardipine 5 mg/h IV, titrate up to desired effect by 2.5 mg/h every 5–15 minutes, maximum 15 mg/h

If BP not controlled or diastolic BP >140 mm Hg, consider IV sodium nitroprusside

BP indicates blood pressure; IV, intravenously; and rtPA, recombinant tissuetype plasminogen activator.

# Current BP guidelines for acute ischemic stroke

A single optimal medication to lower the blood pressure in all patients with acute stroke has not been determined, and an individualized approach is best.

• When should BP treatment start?

# Thrombolysis with intrarterial thrombectomy

#### • Prior to the procedure

- With IV tPA: BP < 180/105 mm Hg</p>
- Only IA: Target BP within 10%–20% of the admission BP is a reasonable goal if IA recanalization is used as monotherapy

#### During the procedure:

- Extreme caution should be taken to avoid relative hypotension during the procedure, especially when general anesthesia is used
- In addition, systolic BP > 140 mm Hg is generally targeted during the procedure, as BP below this threshold has been shown to be independently predictive of poor neurologic outcomes after endovascular treatment.

#### • Post-procedure:

- Postprocedure, BP can be titrated according to the degree of arterial recanalization and the patient's neurologic examination. If complete recanalization is achieved, then goal BP may be lowered to a SBP of 120–140 mm Hg to lower the risk of reperfusion hemorrhage.
- In cases of partial recanalization, it is reasonable to maintain SBP up to 185 mm Hg for 24–48 hours in order to augment collateral blood flow and clear emboli from distal vasculature, unless the patient has received IV tPA.
- BP must ultimately be optimized to minimize the rate of sICH and reperfusion injury and to promote adequate cerebral perfusion

# When thrombolysis is not an option

- Uncertainty surrounding the optimal management of BP in the acute setting
- Must take into consideration the potential of compromising collateral blood flow and hastening the interval to infarction (range 6–18 hours after large vessel ischemic stroke), vs the potential for adverse systemic effects as a result of persistently elevated BP.
- Best to observe current guidelines, which recommend a 15% reduction within the first 24 hours of ischemic stroke only in cases where BP exceeds 220/120 mm Hg

# When thrombolysis not an option

- However when to normalize BP and how fast?
- Given the limitations in studies and until more definitive evidence is available, our practice is to gently normalize BP during hospitalization
- Regardless of when BP medication is resumed, a management strategy must ensure a patient's neurologic stability prior to BP control and minimize BP variability, given the association of wide BP fluctuations and poor outcomes at 1 and 3 months.

# Current guidelines- TIA and sub-acute stroke

Hypertension

Initiation of BP therapy is indicated for previously untreated patients with ischemic stroke or TIA who, after the first several days, have an established BP ≥140 mm Hg systolic or ≥90 mm Hg diastolic (*Class I; Level of Evidence B*). Initiation of therapy for patients with BP <140 mm Hg systolic and <90 mm Hg diastolic is of uncertain benefit (*Class IIb; Level of Evidence C*).

Resumption of BP therapy is indicated for previously treated patients with known hypertension for both prevention of recurrent stroke and prevention of other vascular events in those who have had an ischemic stroke or TIA and are beyond the first several days (Class I; Level of Evidence A).

Goals for target BP level or reduction from pretreatment baseline are uncertain and should be individualized, but it is reasonable to achieve a systolic pressure <140 mm Hg and a diastolic pressure <90 mm Hg (*Class IIa; Level of Evidence B*). For patients with a recent lacunar stroke, it might be reasonable to target a systolic BP of <130 mm Hg (*Class IIb; Level of Evidence B*).

# Specific conditions

- Small vessel disease
- Intracranial atherosclerosis (70-99% intracranial stenosis)

# BP targets in patients with recent lacunar strokes: SPS3

#### Summary

Background Lowering of blood pressure prevents stroke but optimum target levels to prevent recurrent stroke are unknown. We investigated the effects of different blood-pressure targets on the rate of recurrent stroke in patients with recent lacunar stroke.

Methods In this randomised open-label trial, eligible patients lived in North America, Latin America, and Spain and had recent, MRI-defined symptomatic lacunar infarctions. Patients were recruited between March, 2003, and April, 2011, and randomly assigned, according to a two-by-two multifactorial design, to a systolic-blood-pressure target of 130–149 mm Hg or less than 130 mm Hg. The primary endpoint was reduction in all stroke (including ischaemic strokes and intracranial haemorrhages). Analysis was done by intention to treat. This study is registered with ClinicalTrials.gov, number NCT 00059306.

Findings 3020 enrolled patients, 1519 in the higher-target group and 1501 in the lower-target group, were followed up for a mean of  $3 \cdot 7$  (SD  $2 \cdot 0$ ) years. Mean age was 63 (SD 11) years. After 1 year, mean systolic blood pressure was 138 mm Hg (95% CI 137–139) in the higher-target group and 127 mm Hg (95% CI 126–128) in the lower-target group. Non-significant rate reductions were seen for all stroke (hazard ratio  $0 \cdot 81$ , 95% CI  $0 \cdot 64-1 \cdot 03$ , p= $0 \cdot 08$ ), disabling or fatal stroke ( $0 \cdot 81$ ,  $0 \cdot 53-1 \cdot 23$ , p= $0 \cdot 32$ ), and the composite outcome of myocardial infarction or vascular death ( $0 \cdot 84$ ,  $0 \cdot 68-1 \cdot 04$ , p= $0 \cdot 32$ ) with the lower target. The rate of intracerebral haemorrhage was reduced significantly ( $0 \cdot 37$ ,  $0 \cdot 15-0 \cdot 95$ , p= $0 \cdot 03$ ). Treatment-related serious adverse events were infrequent.

Interpretation Although the reduction in stroke was not significant, our results support that in patients with recent lacunar stroke, the use of a systolic-blood-pressure target of less than 130 mm Hg is likely to be beneficial.

# SAMMPRIS

#### BACKGROUND

Atherosclerotic intracranial arterial stenosis is an important cause of stroke that is increasingly being treated with percutaneous transluminal angioplasty and stenting (PTAS) to prevent recurrent stroke. However, PTAS has not been compared with medical management in a randomized trial.

#### METHODS

We randomly assigned patients who had a recent transient ischemic attack or stroke attributed to stenosis of 70 to 99% of the diameter of a major intracranial artery to aggressive medical management alone or aggressive medical management plus PTAS with the use of the Wingspan stent system. The primary end point was stroke or death within 30 days after enrollment or after a revascularization procedure for the

#### CONCLUSIONS

In patients with intracranial arterial stenosis, aggressive medical management was superior to PTAS with the use of the Wingspan stent system, both because the risk of early stroke after PTAS was high and because the risk of stroke with aggressive medical therapy alone was lower than expected. (Funded by the National Institute of Neurological Disorders and Stroke and others; SAMMPRIS ClinicalTrials.gov number, NCT00576693.)

#### Aggressive medical management:

- Aspirin 325 daily + plavix 75 mg daily for 90 days
- SBP < 140 or < 130 in diabetics
- LDL < 70</li>
- Exercise, lifestyle modification

# BP during inter hospital transfer

- Acute vs sub-acute setting
- Parameters largely based on exam and vessel imaging if available
- For post IV tPA: per guidelines < 180/105
  - Also important to follow the exam during infusion
  - IV tPA for thrombolysis: < 180/105 however > 140 to preserve the penumbra and collaterals
- Sub-acute > 8hrs: treat only if BP > 220/110 until vascular status is established

schemic stroke and TIA <sup>8,26,28,29,e18</sup>	
Acute setting	
Patients eligible for acute reperfusion	For BP >185/110 mm Hg: administer labetalol 10-20 mg over 1-2 minutes, may repeat 1 time; or start nicardipine 5 mg/h IV, titrate up by 2.5 mg/h every 5-15 minutes for maximum 15 mg/h; or add other agents (hydralazine, enalaprilat)
During and after reperfusion therapy	BP goal ≤180/105 mm Hg
Patients not eligible for acute reperfusion therapy	For SBP >220 mm Hg or DBP 121-140 mm Hg, administer labetalol IV or nicardipine as IV infusion, aiming for a 10%-15% reduction of BP
	If DBP >140 mm Hg, give sodium nitroprusside as IV infusion, titrating the dose for a 10%-15% reduction of BP
Subacute setting	
Previously untreated patients with SBP ≥140 mm Hg or DBP ≥90 mm Hg	Initiate BP therapy (Class I; Level of evidence B)
Patients with SBP <140 mm Hg and DBP <90 mm Hg	Initiation of BP therapy is of uncertain benefit (Class IIb; Level of evidence C)
Previously treated patients with known hypertension	Resume BP therapy (Class I; Level of evidence A)
	Reasonable to achieve BP <140/90 mm Hg as a target if patients do not have specific indications as below (Class IIa; Level of evidence B)

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#### Specific indications

Recent lacunar stroke

Intracranial atherosclerosis (50%-99% stenosis of a major intracranial artery)

SBP <130 mm Hg (Class IIb; Level of evidence B)

Target SBP <140 mm Hg (Class I; Level of evidence B)



#### Hemodynamic stroke

• During stroke and prior to CEA: to maintain the CPP and collaterals, SBP 150-170

#### • Post CEA BP parameters for severe stenosis

 < 120/80 in order to prevent hyperperfusion injury for stenosis > 80%, prior h/o HTN and poor collaterals

# Hypotension

- Arterial hypotension is rare during acute ischemic stroke and suggests another cause, such as cardiac arrhythmia or ischemia, aortic dissection, or shock.
- In a study of 930 patients with acute ischemic stroke, the admission systolic blood pressure was <100 mmHg in only 2.5% of the patients, and this was associated with ischemic heart disease.
- The brain is especially vulnerable to arterial hypotension during acute ischemic stroke because of impaired cerebral autoregulation.

# Hypotension

- Arterial hypotension on admission in acute ischemic stroke patients has been associated with poor outcomes in multiple studies.
- The exact definition of arterial hypotension needs to be individualized. In a given patient, a blood pressure that is lower during acute ischemic stroke than the premorbid pressure could be considered hypotension.
- Urgent evaluation, diagnosis, and correction of the cause of arterial hypotension are needed to minimize the extent of brain damage. If the arterial hypotension cannot be corrected rapidly by other means, use of vasopressor agents is reasonable.

### Induced Hypertension for the Management of Acute Ischemic Stroke

- In exceptional cases with systemic hypotension producing neurological sequelae, a physician may prescribe vasopressors to improve cerebral blood flow. If drug-induced hypertension is used, close neurological and cardiac monitoring is recommended (Class I; Level of Evidence C).
- The administration of high-dose albumin is not well established as a treatment for most patients with acute ischemic stroke until further definitive evidence regarding efficacy becomes available (*Class IIb; Level of Evidence B*).
- At present, use of devices to augment cerebral blood flow for the treatment of patients with acute ischemic stroke is not well established (*Class IIb; Level of Evidence B*). These devices should be used in the setting of clinical trials.

## Induced Hypertension for the Management of Acute Ischemic Stroke

- The usefulness of drug-induced hypertension in patients with acute ischemic stroke is not well established (*Class IIb; Level of Evidence B*).
- Hemodilution by volume expansion is not recommended for treatment of patients with acute ischemic stroke (Class III; Level of Evidence A). (Revised from the previous guideline13)
- The administration of vasodilatory agents, such as pentoxifylline, is not recommended for treatment of patients with acute ischemic stroke (*Class III; Level of Evidence A*). (Unchanged from the previous guideline13)

# Intracranial hemorrhage



- Nontraumatic intracerebral hemorrhage most commonly results from hypertensive damage to blood vessel walls (eg, hypertension, eclampsia)
- Autoregulatory dysfunction with excessive cerebral blood flow (eg, reperfusion injury, hemorrhagic transformation)
- Chronic hypertension produces a small vessel vasculopathy characterized by lipohyalinosis, fibrinoid necrosis, and development of Charcot-Bouchard aneurysms, affecting penetrating arteries throughout the brain including lenticulostriates, thalamoperforators, paramedian branches of the basilar artery, superior cerebellar arteries, and anterior inferior cerebellar arteries.
- Intraventricular hemorrhage occurs in one third of intracerebral hemorrhage cases from extension of thalamic ganglionic bleeding into the ventricular space.

# Effect of BP on ICH

- ICH is a medical emergency. Rapid diagnosis and attentive management of patients with ICH is crucial, because early deterioration is common in the first few hours after ICH onset.
- More than 20% of patients will experience a decrease in the Glasgow Coma Scale (GCS) of 2 or more points between the prehospital emergency medical services (EMS) assessment and the initial evaluation in the emergency department (ED)
- The risk for early neurological deterioration and the high rate of poor long-term outcomes underscore the need for aggressive early management.
- ICH consists of three distinct phases: (1) initial hemorrhage,(2) hematoma expansion and (3) peri-hematoma edema

# Effect of BP on ICH

- The high rate of early neurological deterioration after ICH is related in part to active bleeding that may proceed for hours after symptom onset
- Hematoma expansion tends to occur early after ICH and increases risk of poor functional outcome and death
- Among patients undergoing head CT within 3 hours of ICH onset, 28% to 38% have hematoma expansion of greater than one third of the initial hematoma volume on follow-up CT
- Elevated BP is very common in acute ICH because of a variety of factors, including stress, pain, increased ICP, and premorbid acute or persistent elevations in BP
- High SBP is associated with greater hematoma expansion, neurological deterioration, and death and dependency after ICH

# Rapid Blood-Pressure Lowering in Patients with Acute Intracerebral Hemorrhage

#### METHODS

We randomly assigned 2839 patients who had had a spontaneous intracerebral hemorrhage within the previous 6 hours and who had elevated systolic blood pressure to receive intensive treatment to lower their blood pressure (with a target systolic level of <140 mm Hg within 1 hour) or guideline-recommended treatment (with a target systolic level of <180 mm Hg) with the use of agents of the physician's choosing.

#### CONCLUSIONS

In patients with intracerebral hemorrhage, intensive lowering of blood pressure did not result in a significant reduction in the rate of the primary outcome of death or severe disability. An ordinal analysis of modified Rankin scores indicated improved functional outcomes with intensive lowering of blood pressure. (Funded by the National Health and Medical Research Council of Australia; INTERACT2 ClinicalTrials.gov number, NCT00716079.)

# ICH guidelines- BP

 For ICH patients presenting with SBP between 150 and 220 mm Hg and without contraindication to acute BP treatment, acute lowering of SBP to 140 mm Hg is safe (Class I; Level of Evidence A) and can be effective for improving functional outcome (Class IIa; Level of Evidence B

 BP should be controlled in all ICH patients (Class I; Level of Evidence A). (Revised from the previous guideline) Measures to control BP should begin immediately after ICH onset (Class I; Level of Evidence A). (New recommendation) A long-term goal of BP <130 mmHg systolic and 80 mmHg diastolic is reasonable (Class IIa; Level of Evidence B). (New recommendation)

# Intensive Blood-Pressure Lowering in Patients with Acute Cerebral Hemorrhage

#### METHODS

We randomly assigned eligible participants with intracerebral hemorrhage (volume, <60 cm<sup>3</sup>) and a Glasgow Coma Scale (GCS) score of 5 or more (on a scale from 3 to 15, with lower scores indicating worse condition) to a systolic blood-pressure target of 110 to 139 mm Hg (intensive treatment) or a target of 140 to 179 mm Hg (standard treatment) in order to test the superiority of intensive reduction of systolic blood pressure to standard reduction; intravenous nicardipine to lower blood pressure was administered within 4.5 hours after symptom onset. The primary outcome was death

#### CONCLUSIONS

The treatment of participants with intracerebral hemorrhage to achieve a target systolic blood pressure of 110 to 139 mm Hg did not result in a lower rate of death or disability than standard reduction to a target of 140 to 179 mm Hg. (Funded by the

### ICH guidelines- BP

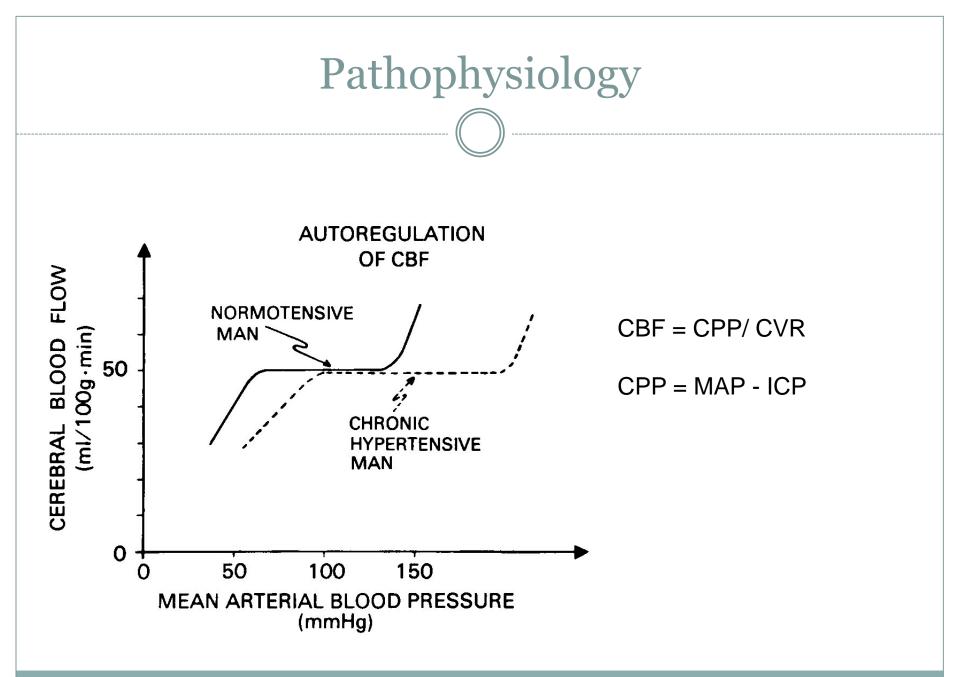
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# Sub arachnoid hemorrhage



- 2003 Nationwide Inpatient Sample provided an annual estimate of 14.5 discharges for aSAH per 100 000 adults
- Because death resulting from aSAH often occurs before hospital admission (an estimated 12% to 15% of cases) the true incidence of aSAH might be even higher
- Although the case fatality of aSAH remains high worldwide,5 mortality rates from aSAH appear to have declined
- The risk of early aneurysm rebleeding is high, and rebleeding is associated with very poor outcomes. Therefore, urgent evaluation and treatment of patients with suspected aSAH is recommended (Class I; Level of Evidence B)
- More than one third of rebleeds occur within 3 hours and nearly half within 6 hours of symptom onset
- One of the causes of rebleeding is though to be SBP > 160 apart from longer time secure the aneurysm
- Complications: rebleeding, raised ICP, hydrocephalus, vasospasm, delayed cerebral ischemic (DCI)



### aSAH guidelines

- Hypertension should be treated, and such treatment may reduce the risk of aSAH (Class I; Level of Evidence B).
- Between the time of aSAH symptom onset and aneurysm obliteration, blood pressure should be controlled with a titratable agent to balance the risk of stroke, hypertension-related re-bleeding, and maintenance of cerebral perfusion pressure
- Maintenance of euvolemia and normal circulating blood volume is recommended to prevent Delayed Cerebral Ischemia (DCI).
- Induction of hypertension is recommended for patients with DCI unless blood pressure is elevated at baseline or cardiac status precludes it.
- The magnitude of blood pressure control to reduce the risk of rebleeding has not been established, but a decrease in systolic blood pressure to 160 mm Hg is reasonable.

## aSAH guidelines

- When DCI is diagnosed, the initial treatment is the induction of hemodynamic augmentation to improve cerebral perfusion.
- No randomized trials of this intervention have been performed, but the rapid improvement of many patients with this therapy and their worsening when it is stopped prematurely are convincing proof of efficacy.
- In some patients, increased mean arterial pressures may increase cerebral blood flow in the setting of autoregulatory dysfunction.
- Traditionally, hemodynamic augmentation has consisted of hemodilution (a common occurrence in this population), hypervolemia, and hypertensive therapy. Accumulating literature has shifted the focus from this triple-H therapy to the maintenance of euvolemia and induced hypertension.

## Inter-hospital transfer

- If ICH, start lowering BP < 140 after consulting with the physician at the accepting facility
- For aSAH with unsecured aneurysm SBP <160 again after physician consulation

### Antihypertensive agents in stroke

- Rapid BP control in both AIS and ICH often requires IV agents
- Such agents should be rapidly acting, be easy to titrate, and have few side effects and short half-lives
- Some of the commonly used IV medications are nicardipine, labetalol, sodium nitroprusside, nitroglycerine, enalaprilat, and hydralazine

#### Antihypertensive agents in stroke

- Recently, new data have been published investigating the use of different BP medications in the acute stroke setting.
- To compare the therapeutic response and tolerability of labetalol boluses vs IV nicardipine infusion, Liu-DeRyke et al. conducted a small pseudorandomized trial in the acute stroke setting (n= 54; 19 ischemic stroke, 29 ICH, 6 subarachnoid hemorrhage). Their findings demonstrated that a higher proportion of patients in the nicardipine group achieved goal BP within 60 minutes of treatment initiation (100% vs 61%) and spent a greater amount of time in the goal BP range compared to the labetalol group. In addition, the number of dose adjustments required to reach goal BP was also lower (0 vs 2, p, 0.001) in the nicardipine group, indicating a reliable dose response.
- While there are several limitations to this small, single-center trial, it is one of the first

#### Antihypertensive agents in stroke

- Owing to its rapid onset of action, short half-life, and selective arterial vasodilator effect, clevidipine, a new calcium channel antagonist, is being increasingly studied in the critical care setting.
- The Evaluation of Patients with Acute Hypertension and Intracerebral Hemorrhage with Intravenous Clevidipine Treatment study tested the efficacy and safety of clevidipine in a multicenter, single-arm, open-label design that included spontaneous ICH patients presenting to the emergency department within 6 or 12 hours of symptom onset and with SBP 160 mm Hg.
- Target BP was achieved in 96.9% of patients in a median time of 5.5 minutes. While the results of this study do not warrant a change in current clinical practice given that this was this was a pilot study involving a small cohort of patients, the ability to rapidly control high BP is notable and merits further study to determine whether this type of medication should be incorporated into the routine management of hypertension in the acute setting of stroke.

• While IV agents are the mainstay of proficient BP management in the hyperacute stroke setting, oral agents are the cornerstone of BP control in the outpatient setting.

Medication	Dose	Onset of action	Duration of action	Side effects
Labetalol	10-20 mg IV bolus over 1-2 min or 0.5-2.0 mg/min infusion; may repeat at 10 min	5 min	8-12 h	Bradycardia, bronchospasm
Nicardipine	5-15 mg/h as IV infusion, increasing the rate 2.5 mg/h every 5 min( max dose 15 mg/h)	1-5 min	15-120 min	hypotension
Hydralazine	10-20 mg as IV bolus or intramuscularl y; repeat every 4-6 h ( max dose 40 mg)	10-20 min	3-8 h	Reflex tachycardia, myocardial injury

Medication	Dose	Onset of action	Duration of action	Side effect
Nitroglycerine	5- 100 mg/min as IV infusion	2-5 min	5-10 min	Venous dilation can cause preload reduction
Sodium Nitroprusside	0.25-10 μ/kg/min as IV infusion; maximum dose for 10 min only	Seconds tp 2 min after initiation of infusion	1-3 min	Raised ICP
Enalaprilat	1 mg as IV bolus followed in 30 min by 10 mg	15 min	12-24 h	Onset of action and duration of action makes titration difficult, hypotension
Esmolol	500 μg/kg as IV bolus over 1 min, followed by maintenance infusion of 50 μg/kg/min for 4 min (max dose: 300μg/kg/min)	2-10 min	10-30 min	Hypotension

Primary prevention- JNC 8 guidelines				
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Age ≥ 60 y	Goal BP < 150/90 mm Hg			
Age ≤ 60 y	Goal BP < 140/90 mm Hg			
Diabetes	Goal BP < 140/90 mm Hg Initial drug option: thiazine, ACEI, ARB or CCB			
Age > 18 y and chronic kidney disease	BP < 140/90 mm Hg; Initial drug option: ACEI or ARB			
Non-black population	Thiazide diuretic, CCB, ACEI or ARB			
Black population	Thiazide diuretic or CCB			

### **Future directions**

- Pre-hospital blood pressure management
- BP management upon arrival to the ED
- BP management after reperfusion
- When and how fast to normalize BP after stroke
- Inter hospital transfer
- ENCHANTED trial
  - Intensive lowering of blood pressure (130-140) improve outcome compared to current guidelines
  - Does of addition of intensive BP lowering to thrombolysis reduce chances of ICH
- 6 trials recruiting patient to study BP in stroke

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  - Subarachnoid hemorrhage
- Anti-hypertensive medications
- Primary prevention
- Future trends



Not a cookbook approach

Individualized approach based on type of stroke, comorbidities, intracranial pathology, and comorbidities

## References

- JNC 8 guidelines
- Stroke statistics 2016
- AHA stroke guidelines for AIS, TIA, SAH, ICH
- 5 new things in stroke: BP management in stroke

# Thank you