

*Answers to 3 questions the heart
doctor needs to know about
neurologically ill patients*

2ND ANNUAL PVHMC
CARDIOVASCULAR
SYMPOSIUM
14 MARCH 2020

Conflicts of interest

- Sometimes neurologists and cardiologists seem like they have conflicts of interest with each other, regarding:
 - Blood pressure: aim low (cardiology) vs aim high (neurology)
 - Anticoagulation: the more the better (cardiology) vs less is more (neurology)
 - Doing something (cardiology) vs doing nothing (neurology)

BLOOD PRESSURE

How high how low?

ACC/AHA BP guidelines

- Normal < 120/80 mm Hg
 - Elevated: SBP 120-129 *and* DBP < 80 mm Hg;
 - Stage 1: SBP 130-139 *or* DBP 80-89;
 - Stage 2: SBP ≥ 140 *or* DBP ≥ 90 mm Hg;
 - Hypertensive crisis: SBP > 180 and/or DBP > 120
 - GOAL < 130/80 mm Hg
-
- **But neurologists seem to always want high BP post stroke!!**

ASA ischemic stroke guidelines

3.2. Blood Pressure	COR	LOE
1. Hypotension and hypovolemia should be corrected to maintain systemic perfusion levels necessary to support organ function.	I	C-EO
<p>The blood pressure (BP) level that should be maintained in patients with AIS to ensure the best outcome is not known. Some observational studies show an association between worse outcomes and lower BPs, whereas others have not.¹¹⁶⁻¹²³ No studies have addressed the treatment of low BP in patients with stroke. In a systematic analysis of 12 studies comparing the use of IV colloids and crystalloids, the odds of death or dependence were similar. Clinically important benefits or harms could not be excluded. There are no data to guide volume and duration of parenteral fluid delivery.¹²⁴ No studies have compared different isotonic fluids.</p>		

“Blood pressure level that should be maintained in patients with AIS....is not known”

“...no data...”

Brain metabolic demand

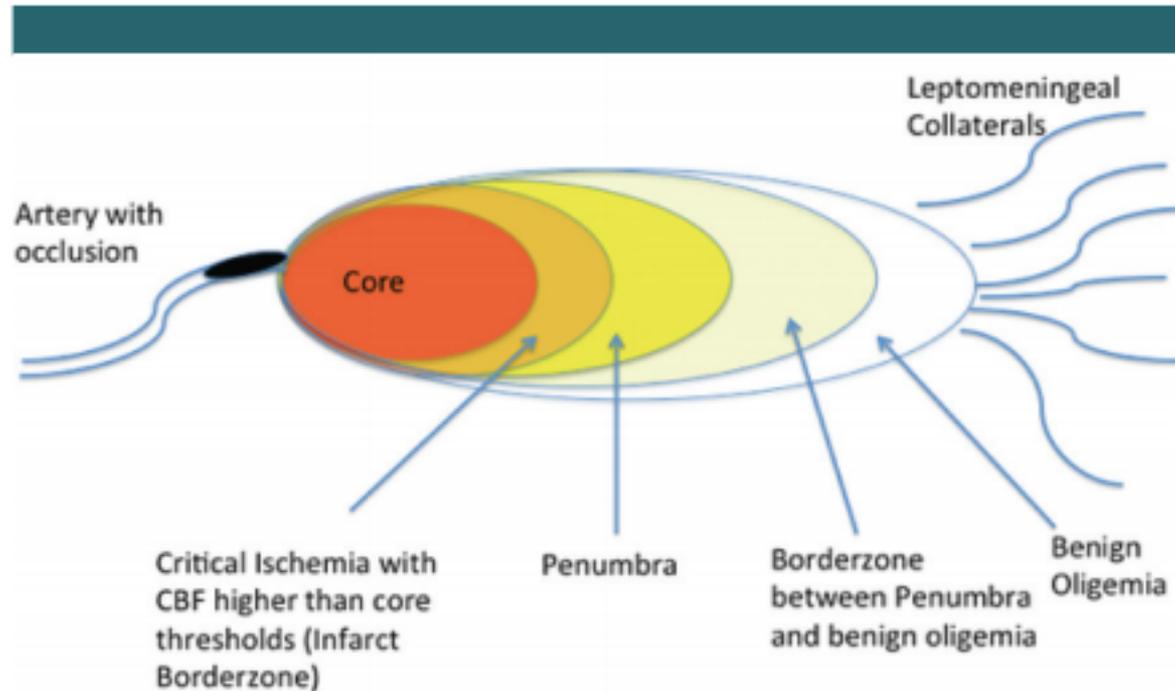
- Constant energy expenditure
- Brain has poor capacity for anaerobic metabolism, poor O₂ storing capacity

TABLE 3

Major organ and tissue masses and whole-body resting energy expenditure (REE)¹

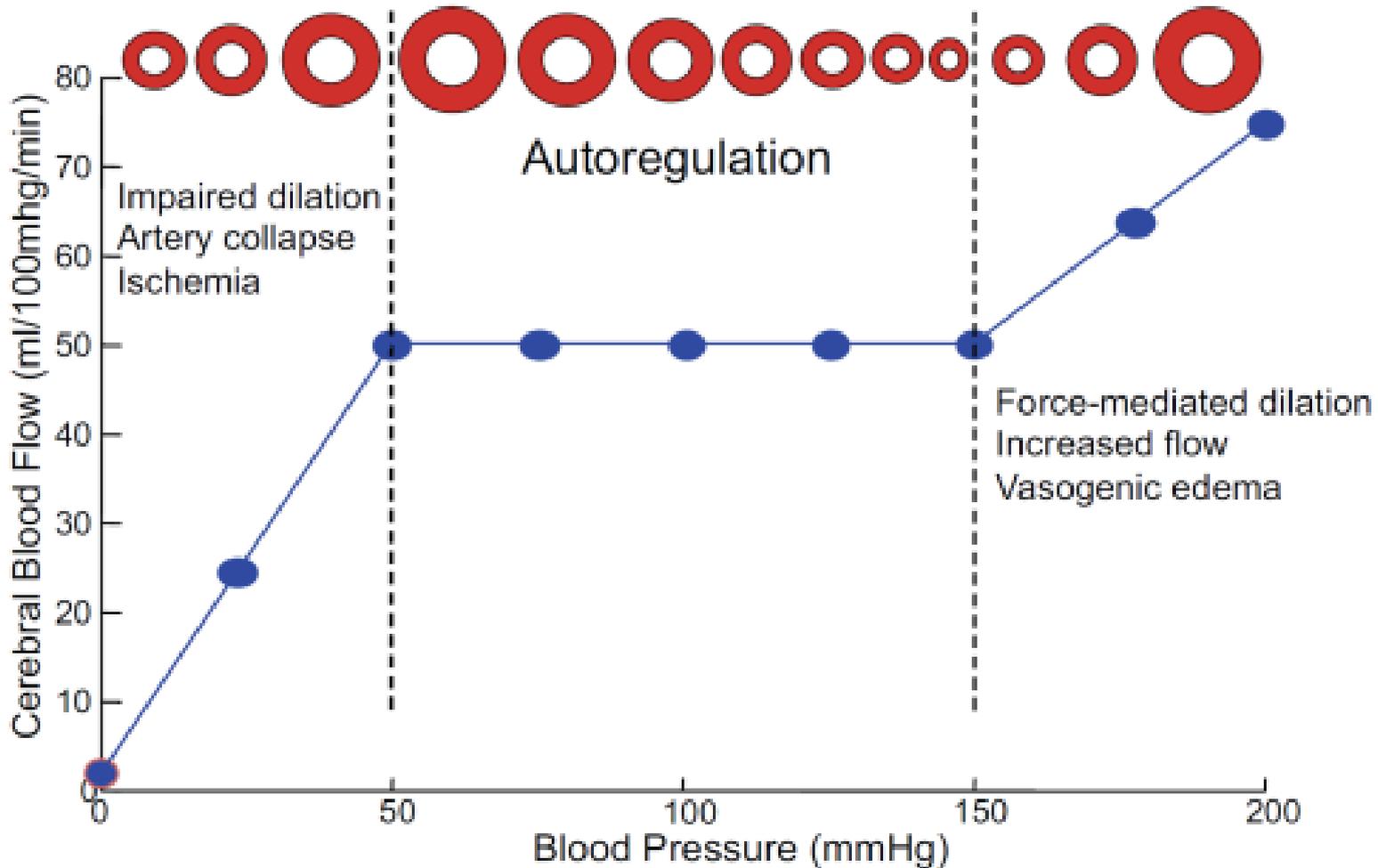
	All subjects ³	21–30 y (young)	31–50 y (middle-age)	51–73 y	<i>P</i> ²
Liver (kg)	1.39 ± 0.25	1.35 ± 0.23	1.41 ± 0.25	1.41 ± 0.28	0.513 ⁴
Brain (kg)	1.33 ± 0.11	1.33 ± 0.11	1.34 ± 0.10	1.32 ± 0.12	0.766 ⁴
Heart (kg)	0.31 ± 0.08	0.31 ± 0.09	0.30 ± 0.08	0.33 ± 0.07	0.327 ⁴
Kidneys (kg)	0.29 ± 0.06	0.28 ± 0.06	0.28 ± 0.05	0.31 ± 0.06	0.042 ⁵

Permissive hypertension and penumbra



Schematic shows regions beyond an arterial occlusion with border zones among core, penumbra, and benign oligemia. These regions may change over time owing to possible change in leptomeningeal collateral vessels and other toxic metabolic or physiologic processes, including periinfarct depolarization.

Arterioles and autoregulation



PVHMC Stroke order sets

HIE

Loc:ICU 3; E263; A

Inpatient Hospital Admit Dt: 3/6/2020 1:36:00 AM PST Disch...

Search:



Advanced Options

Type:



Folder:

Search within:

[Stroke Dysphagia Screening](#)

Stroke Education

Stroke Panel

Stroke Risk Assessment

ED Stroke TIA

NEURO Stroke Alert STAT Orders

NIH Stroke Scale

CT Head Stroke Protocol

NEURO Acute Stroke Alteplase (tPA) Administration (33068)

NEURO Admission Stroke Acute Ischemic Post tPA Admin (34481)

NEURO Admission Stroke Transient Ischemic Attack (50416)

ICU Acute Ischemic Stroke Post Intra-arterial Thrombectomy (50679)

NEURO Admission Ischemic Stroke non-tPA (34493)

NEURO Intervention STAT Acute Isc
Echocardiogram Complete Routine, F
Coumadin - Pharmacy to Dose
T;N Daily, Ischemic Stroke Target INR:
warfarin - Pharmacy to Dose
T;N Daily, Ischemic Stroke Target INR:
Do Not Initiate: VTE Pharmacologic Pr
T;N, Acute stroke/CVA
Activase
Patient weight 100 kg or LESS, 0.9 mg,
Activase
Patient weight GREATER than 100 kg,
alteplase
Patient weight 100 kg or LESS, 0.9 mg,

Ischemic Stroke Non TPA

If SBP Greater than 220 mmHg and/or DBP Greater than 120 mmHg, begin IV antihypertensive therapy. Maintain goal SBP 160 mmHg. Select ONLY one choice from below.

labetalol (Trandate)	10 mg, IV Push, Injection, Once-daily If SBP greater than 220 mmHg and/or DBP greater than 120 mmHg
labetalol (Trandate)	20 mg, IV Push, Injection, Q20min If SBP 180-220 mmHg and/or DBP 120-130 mmHg
OR (For use in ED or Critical Care ONLY)	
niCARdipine (Cardene) 25 mg/250 mL Sodium Chloride 0.9%	Total Volume (mL): 250, IV Conc: 0.1 mg/mL. Start: 5 mg/hr
OR (For use in ED or Critical Care ONLY)	
clevipidine (Cleviprex) 50 mg/100 mL IV	Total Volume (mL): 100, IV Start: 1 mg/hr. Double the dose if SBP > 180 mmHg

Ischemic stroke pre/post TPA

Pre TPA

Antihypertensives

  labetalol (Trandate)	10 mg, IV Push, Injection, Once-Unscheduled for 1 doses, hypertension If SBP GREATER than 185 mmHg or DBP GREATER than 110 mmHg. Give ...
  labetalol (Trandate)	20 mg, IV Push, Injection, Q20min for 2 doses, PRN hypertension If SBP LESS than 185 mmHg and/or DBP LESS than 110 mmHg not reached...
 OR (For use in ED or Critical Care ONLY)	
  clevidipine (Cleviprex) 50 mg/100 mL IV	Total Volume (mL): 100, IV Conc: 0.5 mg/mL. Start: 1 mg/hr. Double the dose q90sec until SBP within...
 OR use niCARDipine (Cardene) if clevidipine (Cleviprex) is unavailable or contraindicated (For use in ED or Critical Care ONLY).	
  niCARDipine (Cardene) 25 mg/250 mL Sodium Chloride 0.9%	Total Volume (mL): 250, IV Conc: 0.1 mg/mL. Start: 5 mg/hr. Titrate: 2.5 mg/hr Q5min until SBP LESS ...

Post TPA

 If SBP Greater than 180 mmHg and/or DBP Greater than 105 mmHg, begin IV antihypertensive therapy. Maintain goal SBP 120-180 mmHg and DBP 70-105 mmHg. Select ONLY one choice from below.	
  labetalol (Trandate)	10 mg, IV Push, Injection, Once-Unscheduled for 1 doses, hyperten... If SBP greater than 180 mmHg and/or DBP greater than 105 mmHg....
  labetalol (Trandate)	20 mg, IV Push, Injection, Q20min for 2 doses, PRN hypertension If SBP 120-180 mmHg and/or DBP 70-105 mmHg not reached after ...
 OR (For use in ED or Critical Care ONLY)	
  niCARDipine (Cardene) 25 mg/250 mL Sodium Chloride 0.9%	Total Volume (mL): 250, IV Conc: 0.1 mg/mL. Start: 1 mg/hr. Titrate: 2.5 mg/hr Q5min until SB...
 OR (For use in ED or Critical Care ONLY)	
  clevidipine (Cleviprex) 50 mg/100 mL IV	Total Volume (mL): 100, IV Conc: 0.5 mg/mL. Start: 1 mg/hr. Double the dose q90sec until SBP ...

Ischemic stroke post thrombectomy

 For Re-canalized patients, maintain SBP 100-160 mmHg AND DBP 50-90 mmHg	
 clevidipine (Cleviprex) 50 mg/100 mL IV	Total Volume (mL): 100, IV Conc: 0.5 mg/mL. Start: 1 mg/hr. Double the dose q90sec until SBP ...
 OR	
 niCARDipine (Cardene) 25 mg/250 mL Sodium Chloride 0.9%	Total Volume (mL): 250, IV Conc: 0.1 mg/mL. Start: 5 mg/hr. Titrate: 2.5 mg/hr Q5min until SB...
 OR	
 labetalol (Trandate)	10 mg, IV Push, Injection, Once-Unscheduled for 1 doses, hyperten... If SBP greater than 160 mmHg AND DBP greater than 90 mmHg. Gi...
 labetalol (Trandate)	20 mg, IV Push, Injection, Q20min for 2 doses, PRN hypertension If SBP 100-160 mmHg AND DBP 50-90 mmHg not reached after the...
 For Non-Re-canalized patients, maintain SBP 100-200 mmHg AND DBP 70-105 mmHg	
 clevidipine (Cleviprex) 50 mg/100 mL IV	Total Volume (mL): 100, IV Start: 1 mg/hr. Double the dose q90sec until SBP within 10 mmHg ...
 OR	
 niCARDipine (Cardene) 25 mg/250 mL Sodium Chloride 0.9%	Total Volume (mL): 250, IV Conc: 0.1 mg/mL. Start: 5 mg/hr. Titrate: 2.5 mg/hr Q5min until SB...
 OR	
 labetalol (Trandate)	10 mg, IV Push, Injection, Once-Unscheduled for 1 doses, hyperten... If SBP greater than 200 mmHg AND DBP greater than 105 mmHg. G...
 labetalol (Trandate)	20 mg, IV Push, Injection, Q20min for 2 doses, PRN hypertension If SBP 100-200 mmHg AND DBP 70-105 mmHg not reached after th...

SAH unsecured protocol

Antihypertensives

 **To maintain SBP LESS than 140 mmHg AND MAP LESS than 100 mmHg**

Total Volume (mL): 100, IV
Conc: 0.5 mg/mL. Start: 1 mg/hr. Double the dose q90sec until S...

 OR

 niCARDipine (Cardene) 25 mg/250 mL Sodium Chloride 0.9%

Total Volume (mL): 250, IV
Conc: 0.1 mg/mL. Start: 5 mg/hr. Titrate: 2.5 mg/hr Q5min until ...

 OR

  labetalol (Trandate)

10 mg, IV Push, Injection, Once-Unscheduled for 1 doses, hypert...
If SBP greater than 140 mmHg AND MAP greater than 100 mmH...

  labetalol (Trandate)

20 mg, IV Push, Injection, Q20min for 2 doses, PRN hypertension
If SBP less than 140 mmHg AND MAP less than 100 mmHg not r...

 **To maintain SBP LESS than 160 mmHg AND MAP LESS than 110 mmHg**

 clevidipine (Cleviprex) 50 mg/100 mL IV

Total Volume (mL): 100, IV
Start: 1 mg/hr. Double the dose q90sec until SBP within 10 mm...

 OR

 niCARDipine (Cardene) 25 mg/250 mL Sodium Chloride 0.9%

Total Volume (mL): 250, IV
Conc: 0.1 mg/mL. Start: 5 mg/hr. Titrate: 2.5 mg/hr Q5min until ...

 OR

  labetalol (Trandate)

10 mg, IV Push, Injection, Once-Unscheduled for 1 doses, hypert...
If SBP greater than 160 mmHg AND MAP greater than 110 mmH...

  labetalol (Trandate)

20 mg, IV Push, Injection, Q20min for 2 doses, PRN hypertension
If SBP less than 160 mmHg AND MAP less than 110 mmHg not r...

 **To maintain CPP between 60-80 mmHg**

 clevidipine (Cleviprex) 50 mg/100 mL IV

Total Volume (mL): 100, IV
Start: 1 mg/hr. Double the dose q90sec until CPP within 10 mm...

 OR

 niCARDipine (Cardene) 25 mg/250 mL Sodium Chloride 0.9%

Total Volume (mL): 250, IV
Conc: 0.1 mg/mL. Start: 5 mg/hr. Titrate: 2.5 mg/hr Q5min until ...

 OR

  labetalol (Trandate)

10 mg, IV Push, Injection, Once-Unscheduled for 1 doses, hypert...
If SBP greater than 140 mmHg. Give each 10 mg over 1 minute. ...

  labetalol (Trandate)

20 mg, IV Push, Injection, Q20min for 2 doses, PRN hypertension
If SBP less than 140 mmHg not reached after the 10 mg dose. Gi...

SAH secured aneurysm and/or clinical vasospasm

Vasoactive agents

 norepinephrine (Levophed) 8 mg/250 mL Sodium Chloride 0.9% IV

Total Volume (mL): 250, IV

Goal: SBP 120-220 mmHg. Conc: 32 mCg/mL. Start: 3 mCg/min.

 phenylephrine (Neo-Synephrine) 40 mg/250 mL Sodium Chloride 0.9% IV

IV

Goal: SBP 120-220 mmHg. Conc: 160 mCg/mL. Start: 40 mCg/m

Antihypertensive therapy

 clevidipine (Cleviprex) 50 mg/100 mL IV

Total Volume (mL): 100, IV

Conc: 0.5 mg/mL. Goal: SBP 120-220 mmHg. Start: 1 mg/hr. Do.

 OR

 niCARDipine (Cardene) 25 mg/250 mL Sodium Chloride 0.9%

Total Volume (mL): 250, IV

Conc: 0.1 mg/mL. Goal: SBP 120-220 mmHg. Conc: 0.1 mg/mL.

Vasospasm after SAH

- Develops 3-10 days following SAH
- theories: OxyHb stimulates endothelin 1
- → vasoconstrictor
- inhibits the vasodilator nitric oxide

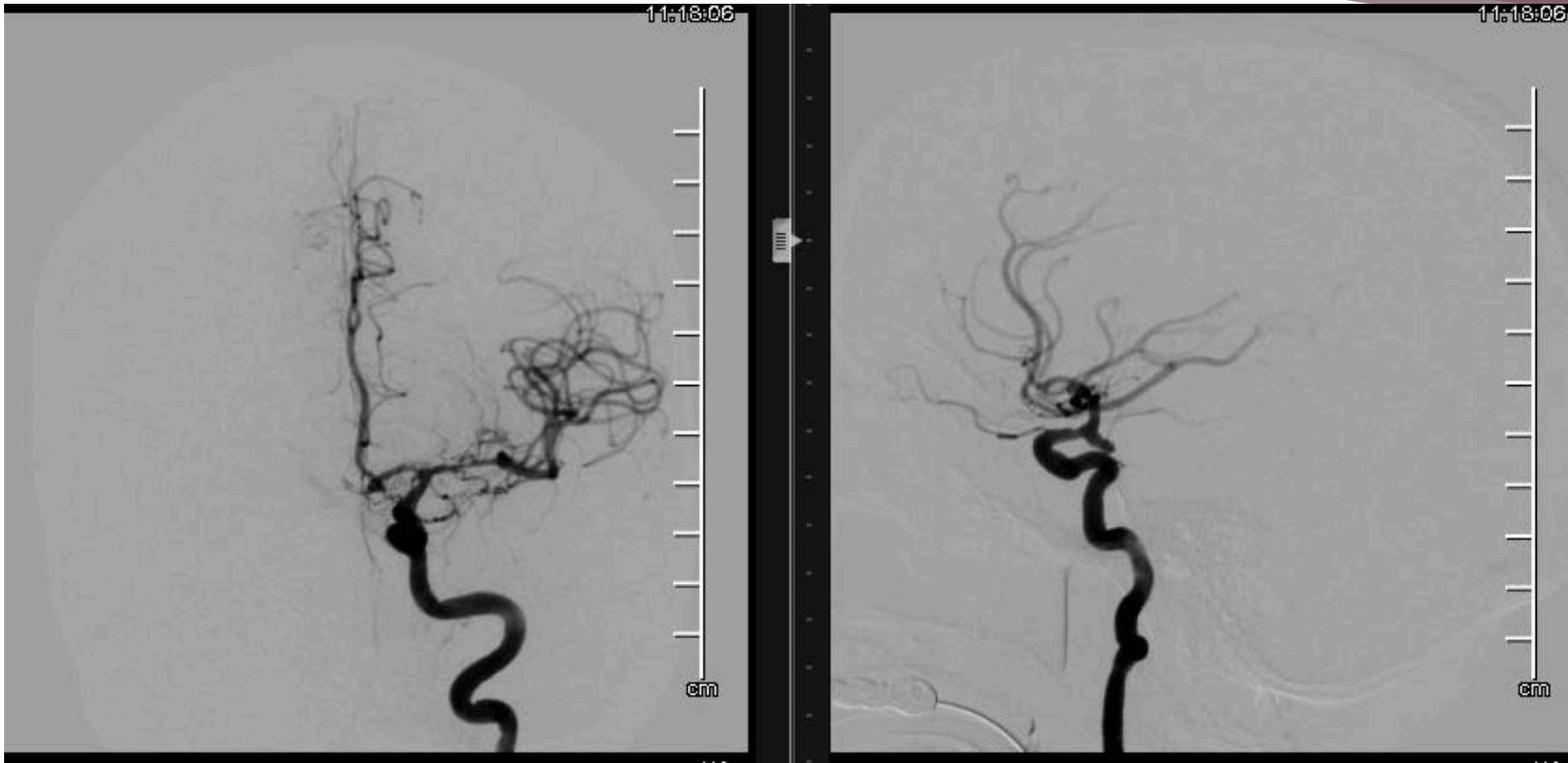
- Tx of SAH: nimodipine, L type Ca channel blocker

Case: 67 F, H/A x 3 days, SAH, lethargy

- Found to have L ICA aneurysm
- Hosp day 1, embo of L PCOM aneurysm
- VSP
- Induced HTN



LEFT ICA ANGIOGRAM



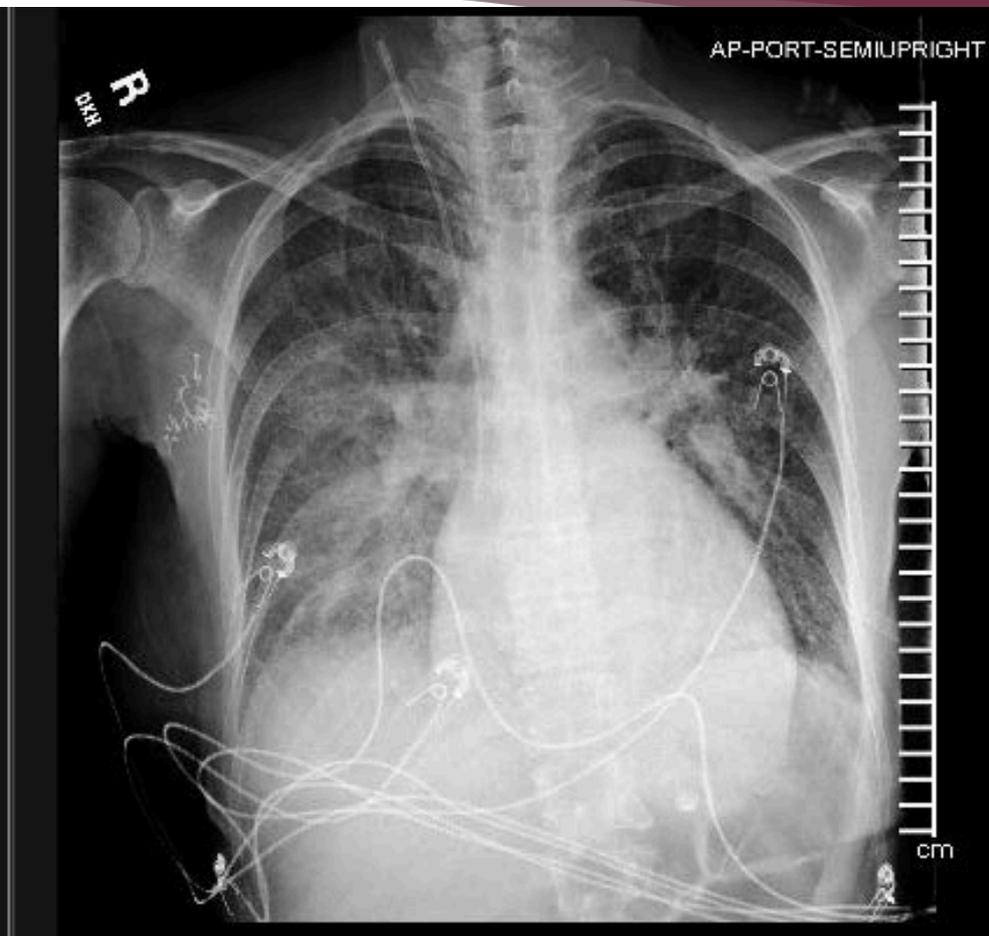
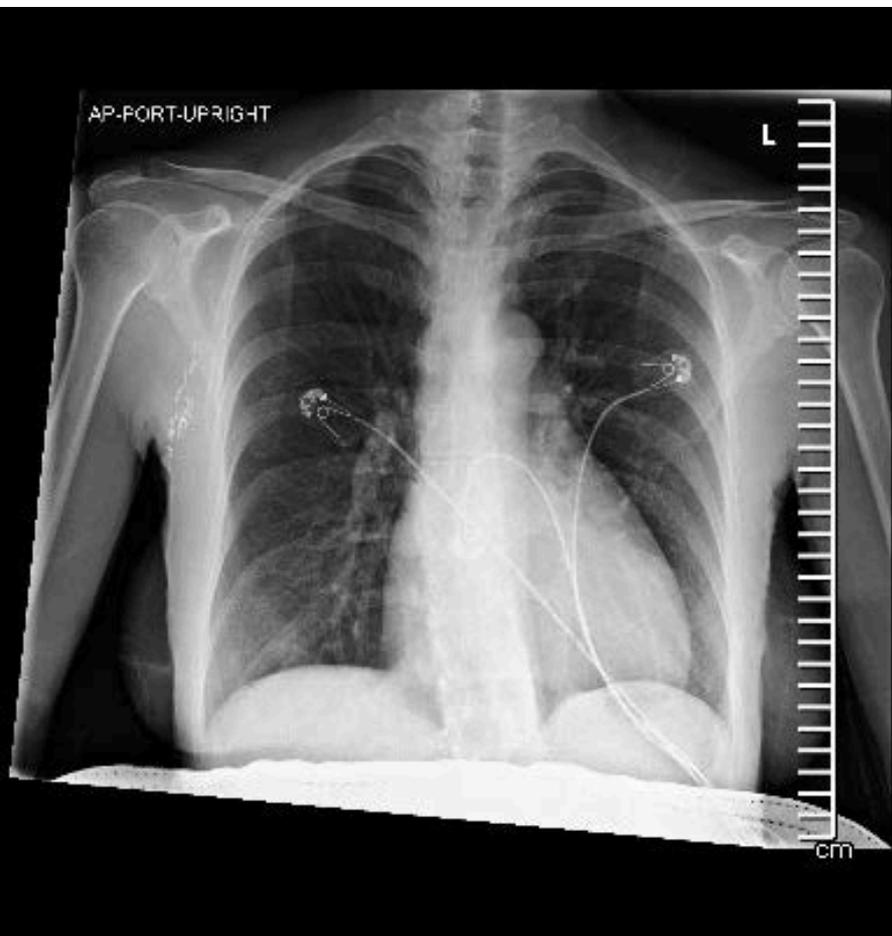
Case, BP trends

12/27/2019 02:00 PST	Systolic Blood Pressure Invasive	154 (H)	(90 - 139)
12/27/2019 01:45 PST	Systolic Blood Pressure Invasive	147 (H)	(90 - 139)
12/27/2019 01:30 PST	Systolic Blood Pressure Invasive	137	(90 - 139)
12/27/2019 01:15 PST	Systolic Blood Pressure Invasive	141 (H)	(90 - 139)
12/27/2019 01:00 PST	Systolic Blood Pressure Invasive	136	(90 - 139)

Diastolic Blood Pressure Invasive	70	(60 - 89)
Diastolic Blood Pressure Invasive	61	(60 - 89)
Diastolic Blood Pressure Invasive	56 (L)	(60 - 89)
Diastolic Blood Pressure Invasive	58 (L)	(60 - 89)
Diastolic Blood Pressure Invasive	56 (L)	(60 - 89)
Mean Arterial Pressure, Invasive	101	(65 - 140)
Mean Arterial Pressure, Invasive	92	(65 - 140)
Mean Arterial Pressure, Invasive	85	(65 - 140)
Mean Arterial Pressure, Invasive	88	(65 - 140)
Mean Arterial Pressure, Invasive	85	(65 - 140)



Chest X ray hospital day 1 and 5



Neurogenic stunned myocardium and pulmonary edema

- Related to catecholamine surges
- Globalized vs regional hypokinesis
- Takotsubo cardiomyopathy
 - **Echocardiography in patient:**
 - **12/27/19, EF 60-65%**
 - **12/30/19, < 20%**
 - 1/7/20, 40-45%, small pericardial effusion
 - 1/21/20, EF 60-65%, small ant, mod post peri. eff.
- Pulmonary edema: rapid changes on CXR

Case, BP trends

12/27/2019 02:00 PST	Systolic Blood Pressure Invasive	154 (H)	(90 -	Diastolic Blood Pressure Invasive	70
12/27/2019 01:45 PST	Systolic Blood Pressure Invasive	147 (H)	(90 -	Diastolic Blood Pressure Invasive	61
12/27/2019 01:30 PST	Systolic Blood Pressure Invasive	137	(90 -	Diastolic Blood Pressure Invasive	56 (L)
12/27/2019 01:15 PST	Systolic Blood Pressure Invasive	141 (H)	(90 -	Diastolic Blood Pressure Invasive	58 (L)
12/27/2019 01:00 PST	Systolic Blood Pressure Invasive	136	(90 -	Diastolic Blood Pressure Invasive	56 (L)

Mean Arterial Pressure, Invasive	101	(65 - 140)
Mean Arterial Pressure, Invasive	92	(65 - 140)
Mean Arterial Pressure, Invasive	85	(65 - 140)
Mean Arterial Pressure, Invasive	88	(65 - 140)
Mean Arterial Pressure, Invasive	85	(65 - 140)

01/01/2020 14:45 PST	Systolic Blood Pressure	113	Diastolic Blood Pressure	66	(60 - 140)
01/01/2020 14:30 PST	Systolic Blood Pressure	107	Diastolic Blood Pressure	64	(60 - 140)
01/01/2020 14:15 PST	Systolic Blood Pressure	99	Diastolic Blood Pressure	58 (L)	(60 - 140)
01/01/2020 14:00 PST	Systolic Blood Pressure	104	Diastolic Blood Pressure	55 (L)	(60 - 140)
01/01/2020 13:45 PST	Systolic Blood Pressure	115	Diastolic Blood Pressure	67	(60 - 140)

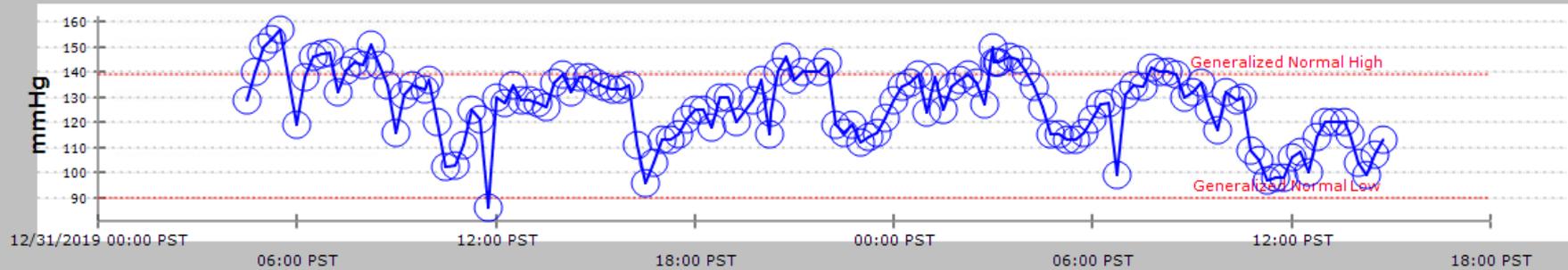
Mean Arterial Pressure, Cuff	79	(65 - 140)
Mean Arterial Pressure, Cuff	76	(65 - 140)
Mean Arterial Pressure, Cuff	71	(65 - 140)
Mean Arterial Pressure, Cuff	69	(65 - 140)
Mean Arterial Pressure, Cuff	81	(65 - 140)

Cardiac output and cerebral perfusion

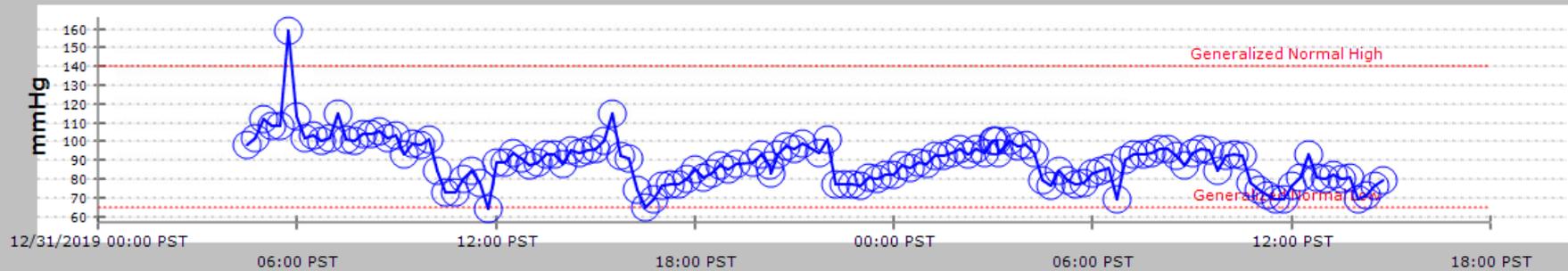
- 15-20% CO directed to brain
- 750 mL/min at rest
- Cerebral perfusion pressure= mean arterial pressure-intracranial pressure
- $CPP = MAP - ICP$

SBP, MAP, CPP trends

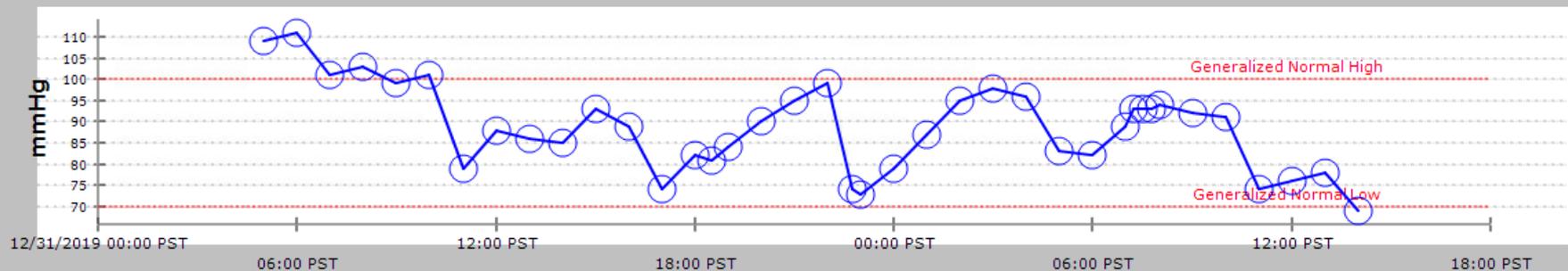
Systolic Blood Pressure



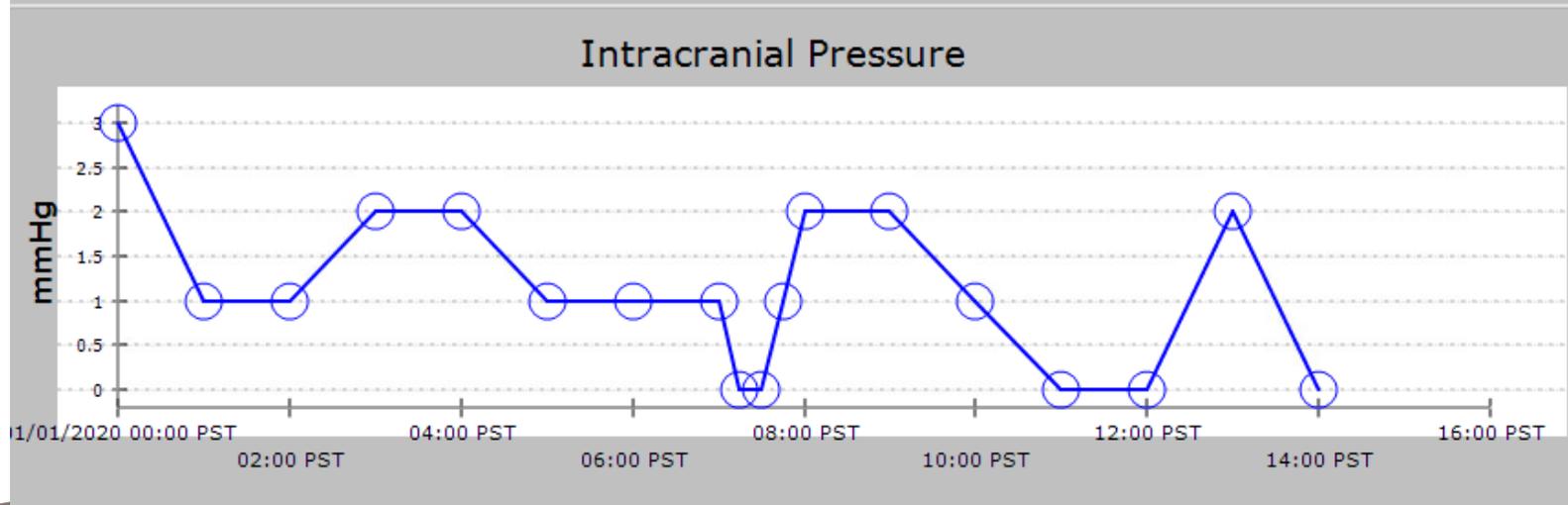
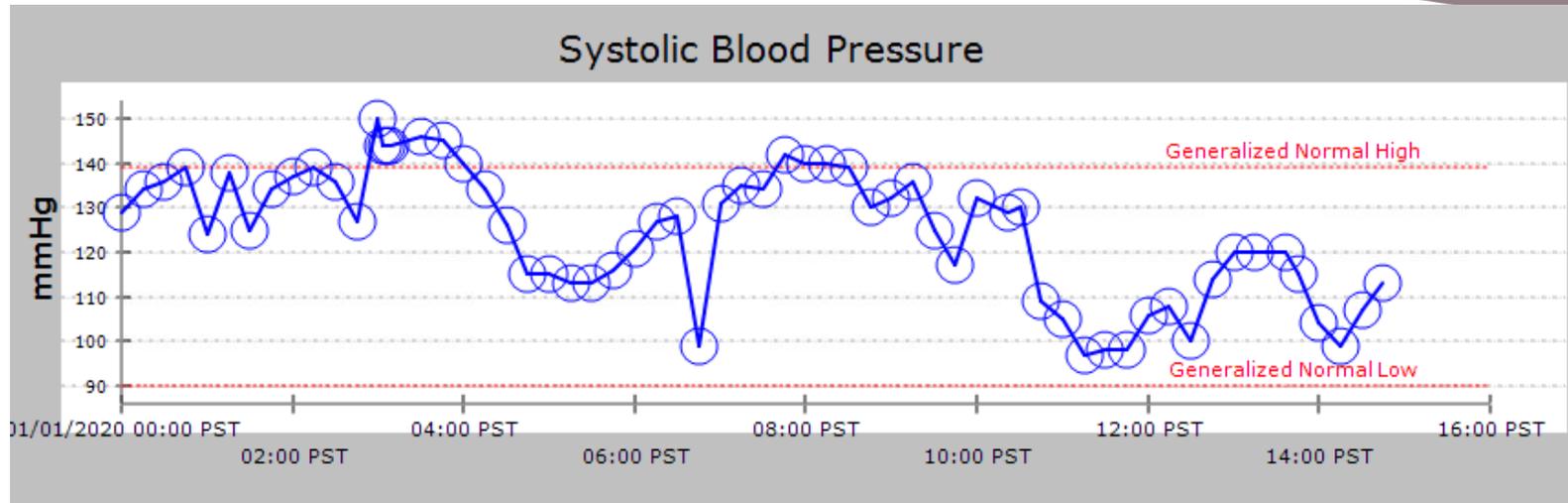
Mean Arterial Pressure, Cuff



Cerebral Perfusion Pressure



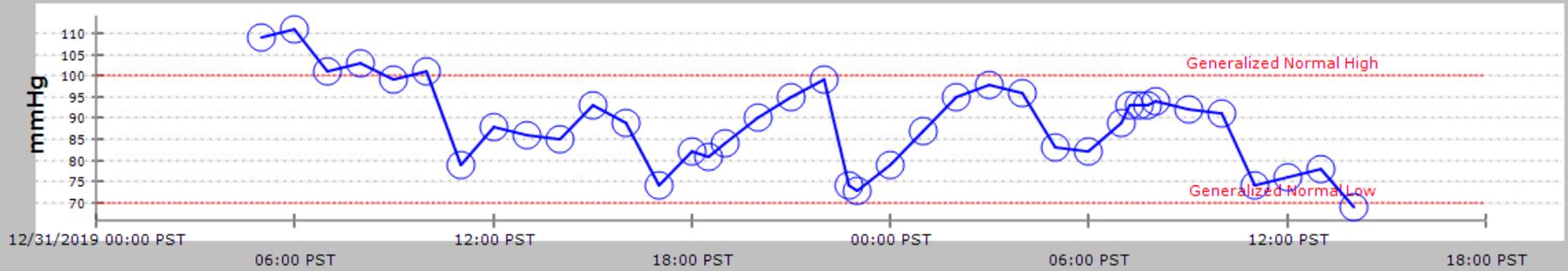
SBP, ICP trends (fx of ICP modulation) day 6



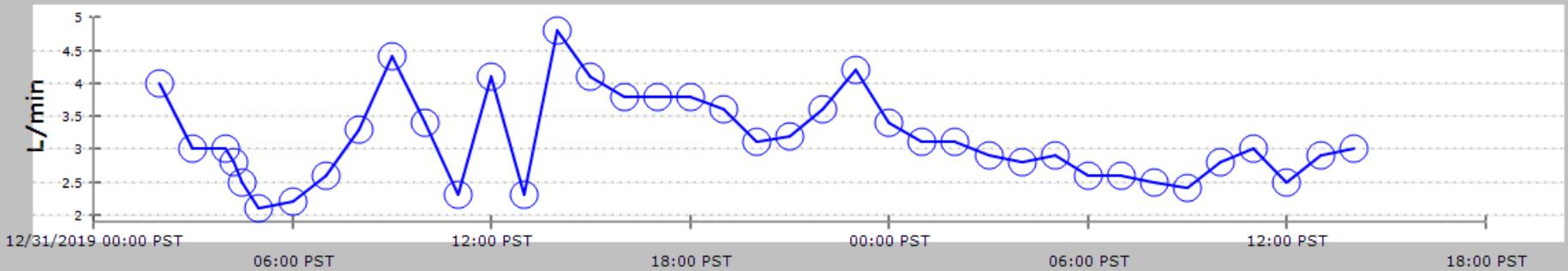
POMONA VALLEY HOSPITAL
MEDICAL CENTER

CPP, CO, CI trends

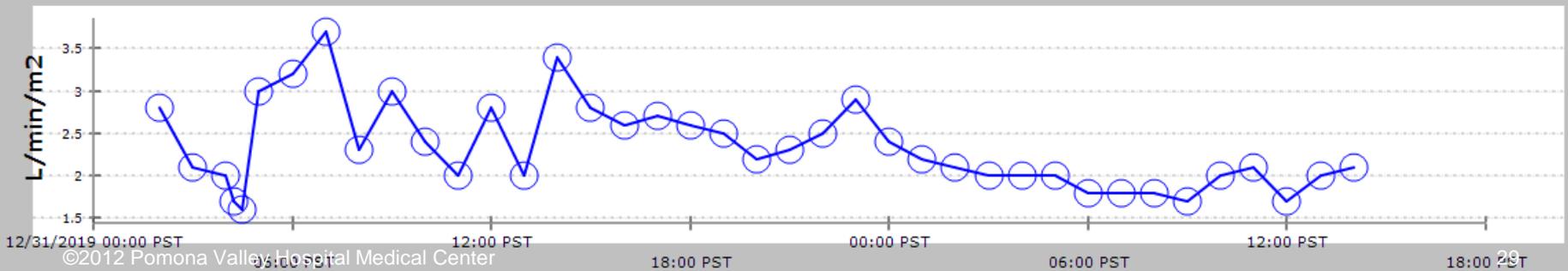
Cerebral Perfusion Pressure



Cardiac Output

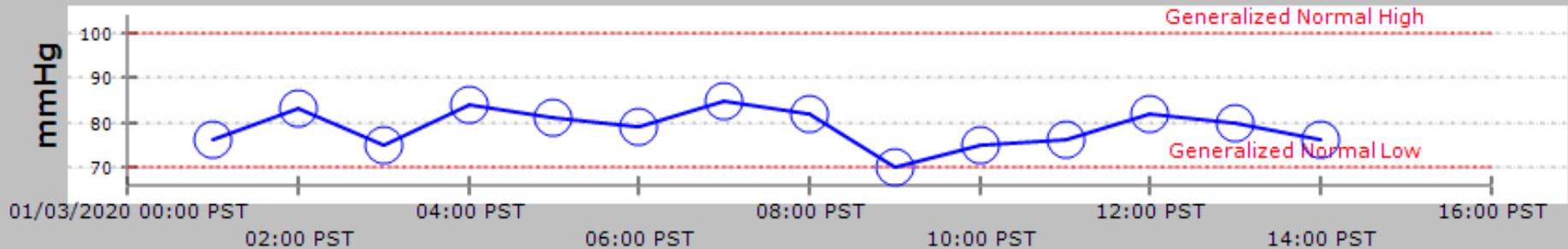


Cardiac Index

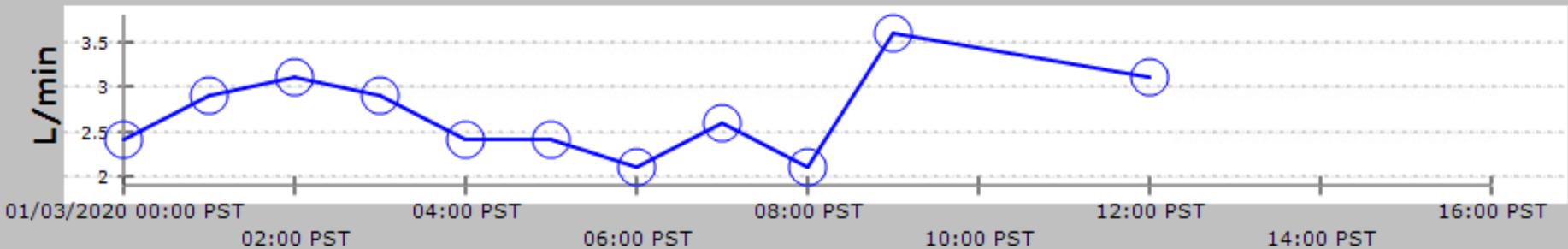


CPP, CO, CI trends, day 8

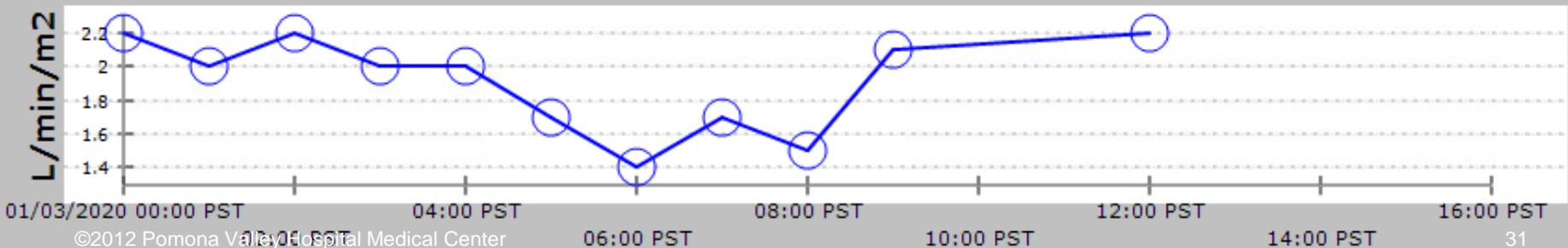
Cerebral Perfusion Pressure



Cardiac Output



Cardiac Index

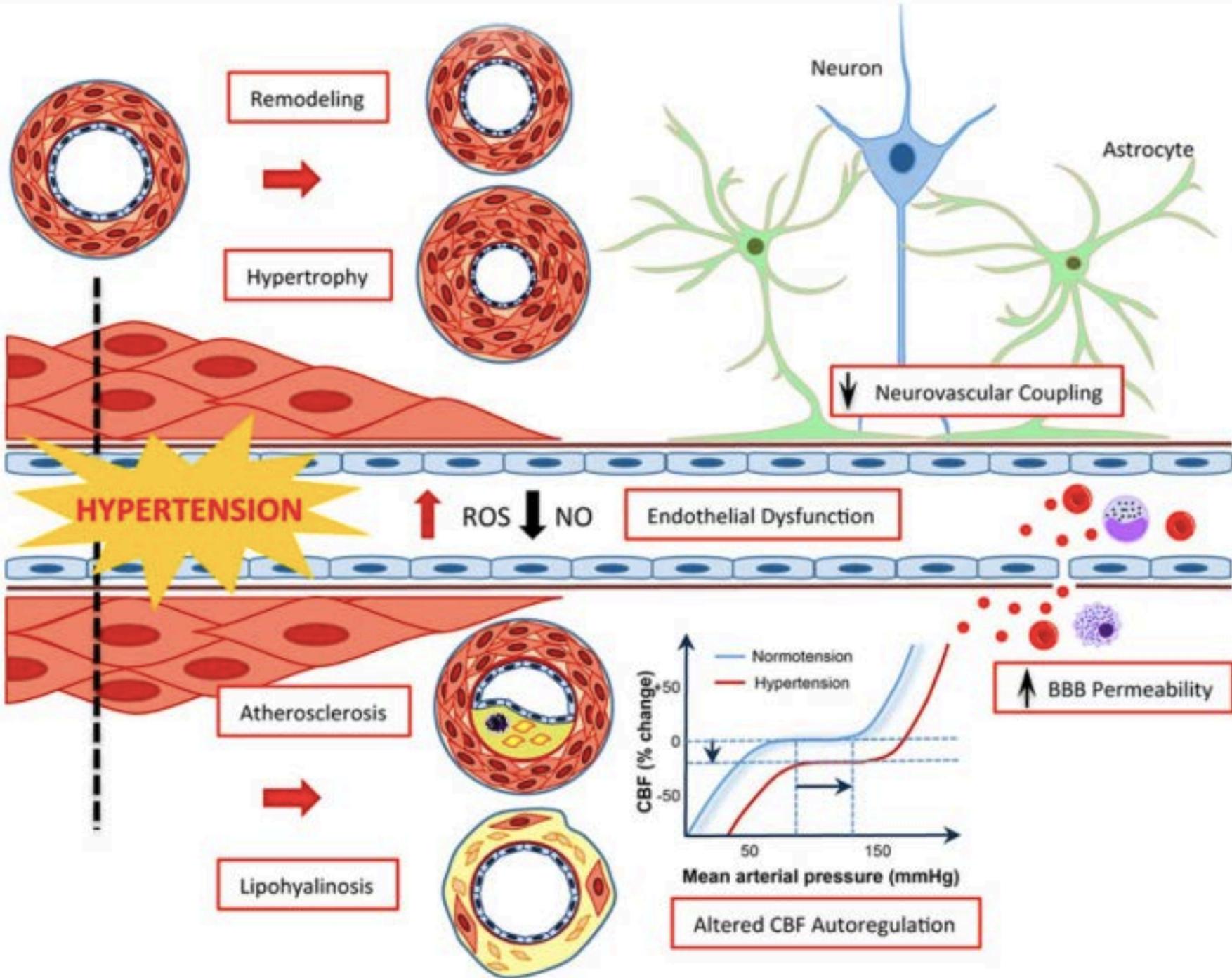


Further course

- extubated
- Vasospasm improved
- Echocardiography
 - 12/27/19, EF 60-65%
 - 12/30/19, < 20%
 - 1/7/20, 40-45%, small pericardial effusion
 - 1/21/20, EF 60-65%, small ant, mod post peri. eff.

HTN and cerebrovascular remodeling

- increase vascular resistance
- Decreased lumen
- Greater wall to lumen ratio
- ?capillary pruning



SAMMPRIS trial secondary risk factor mgt

- Stenting vs aggressive Medical Management in Prevention of Recurrent Ischemic Stroke
- Goal blood pressure < 140/90 mm Hg (< 130/80 if diabetic)

BLOOD THINNERS

WHEN AND WHAT TO START

Anticoagulants

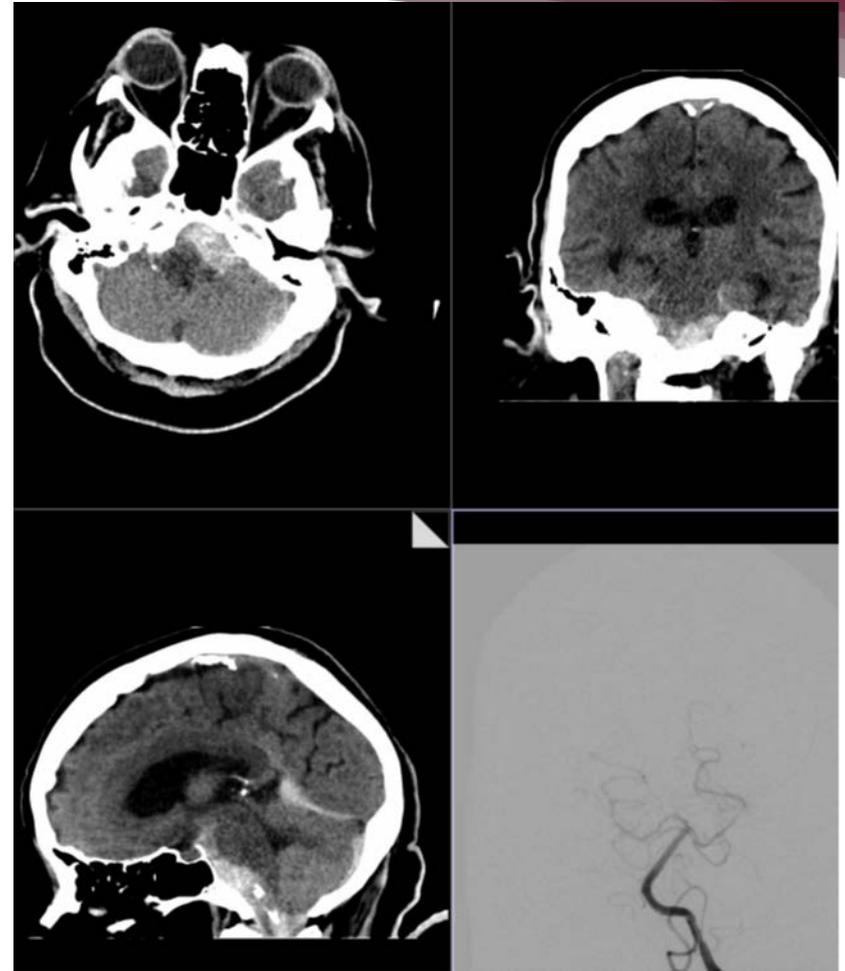
- The results of several clinical trials demonstrate an increased risk of bleeding complications with early administration of either UFH or LMWH
- Early administration of UFH or LMWH does not lower the risk of early recurrent stroke, including among persons with cardioembolic sources.
- The role of anticoagulants as an adjunct in addition to mechanical or pharmacological fibrinolysis has not been established.
- The PREVAIL study gives the strongest evidence of the superiority of LMWH in prevention of venous thromboembolism following ischemic stroke.

Clinical Scenarios

- Hemorrhagic stroke and cardiac history (CAD or AFIB)
 - Unknown source,
 - Known source treated
 - Known source untreated
- Ischemic stroke and cardiac history as above
 - Recanalized
 - Non recanalized
 - Large stroke
 - Small or moderate sized stroke

76 year old woman, w/SAH

- 1 month prior, PCI for NSTEMI. Mid LAD DES
- Moderate stenosis of the distal left circumflex artery of 60 to 70%
- Chronic total occlusion of the right coronary artery
- On aspirin and ticagrelor



Unclear source of hemorrhage

- Unable to initiate antiplatelets
- Worsening renal failure, unable to do standard protocol repeat catheter angio at SAH day 7-10
- Repeat MRA brain planned, if negative, may consider starting single antiplatelet therapy
- Ultimately may have initiated antiplatelets but she expired (renal failure and complications of that)

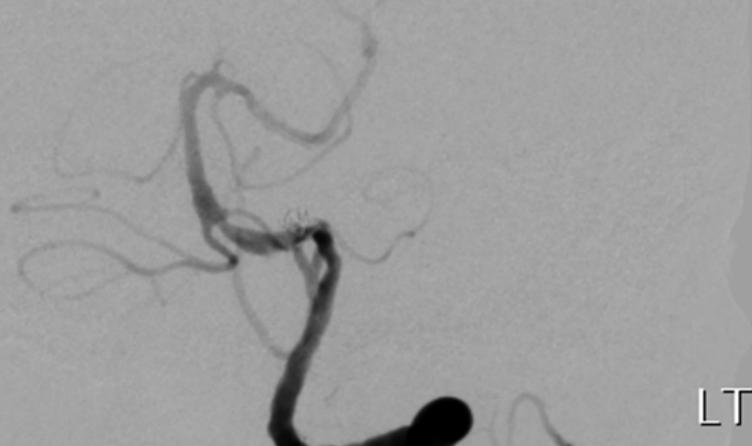
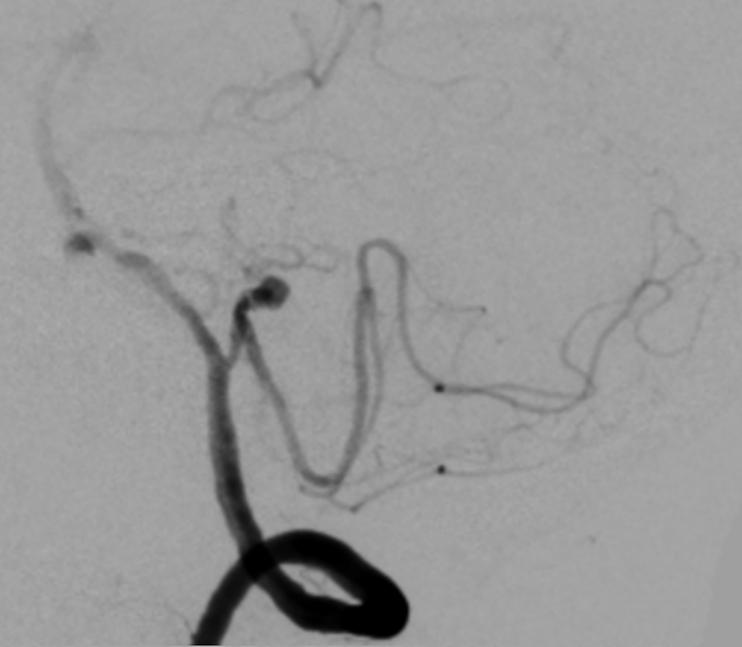
82 F, SAH, h/o AFIB, on warfarin



Left vertebral artery



LT



LT



LT

Hospital course

- L PICA aneurysm coiling hospital day 1
- d/c on aspirin
- In clinic 1 month post bleed, started on warfarin

38 M, AFIB, intracranial R ICA occlusion

- 3rd stroke
 - 1 few years ago L MCA
 - 1 in December R MCA
- On warfarin->dabigatran->riveroxaban (current). Planned for LAA closure but last TEE showed thrombus
- Successful recan, no enlargement start aspirin immediately
- d/c on warfarin (hosp day 2)

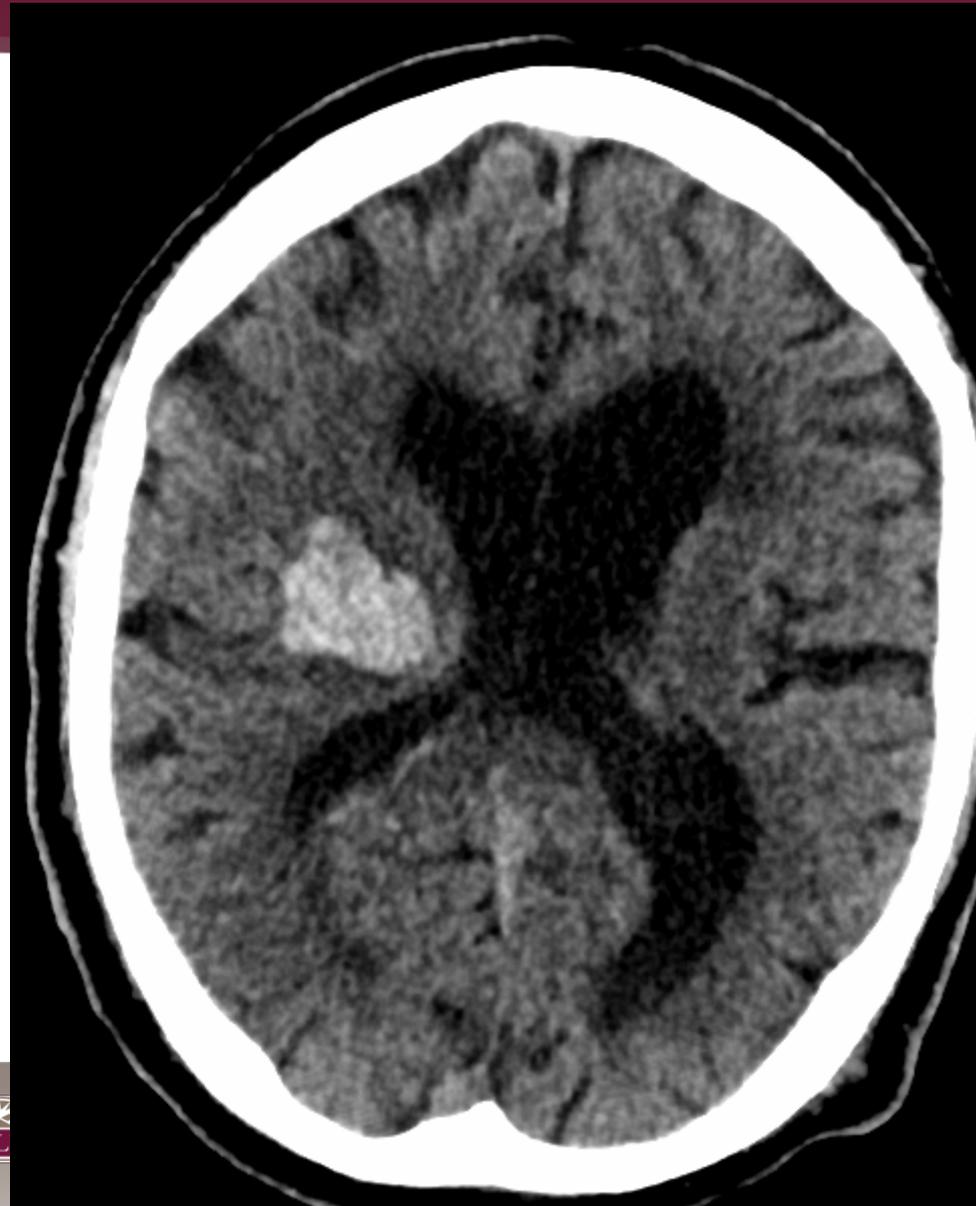


Other scenarios

- Ischemic stroke, no AFIB, no hemorrhagic conversion, small to moderate size: start antiplatelets soon
- Small/mod isch. stroke + AFIB: NOAC or warfarin-bridge w/aspirin, SQ UH or LMWH VTE proph. Dose)
- Ischemic stroke, + AFIB (or no AFIB), large stroke or hemorrhagic conversion, ? Wait 1-2 weeks for anticoag. Start antiplatelet sooner if feasible

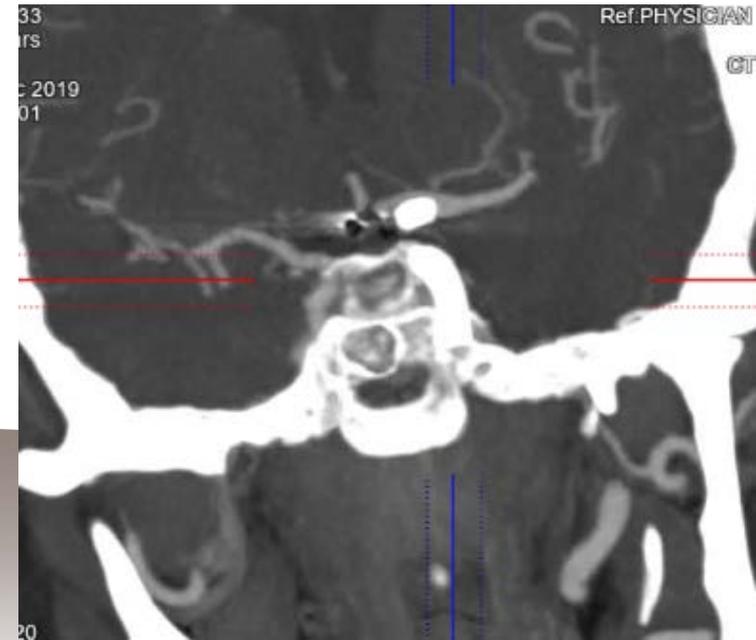
Hypertensive ICH with cardiac hx or AFIB

- 70 F, R BG ICH, AFIB on rivaroxaban
- European stroke initiative rec. starting AC 10-14 days post bleed
- CHADSVASC2 vs HASBLED score
- High TE risk, start early 2 wks, high ICH risk start late 4 weeks



Intracranial stent

- Tx of symptomatic intracranial atherosclerotic disease causing recurrent stroke despite maximal medical therapy
- Including with aneurysm, may need dual antiplatelet therapy for 6-12 months (single antiplatelet therapy indef.)
- Flow diverter for aneurysm, similar antiplatelet strategy



Post cardiac cath stroke

**We're right here, why can't we
open the vessel**

Post cath lab

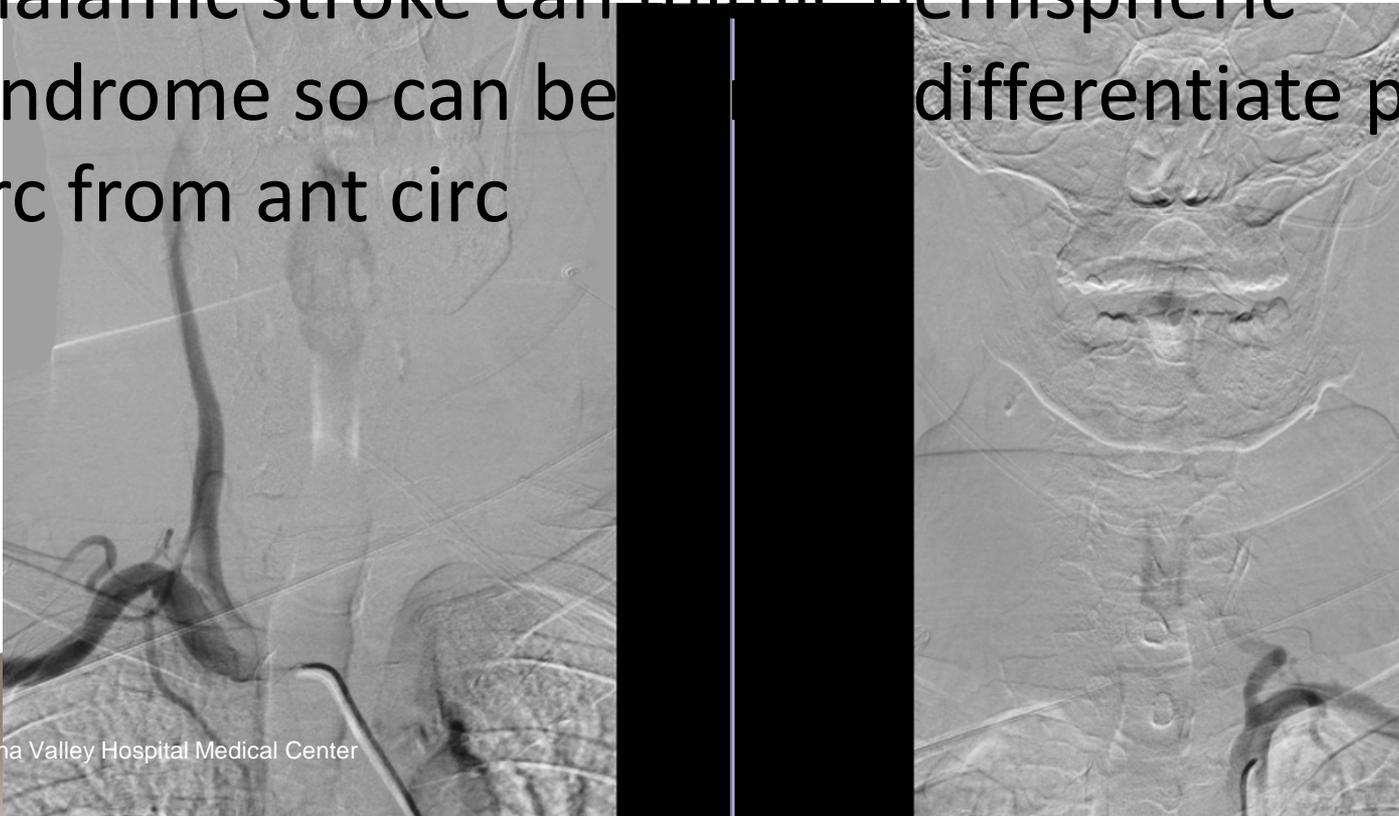
- Causes of stroke
- Small plaque dislodgement causing small stroke
- Ostial injury
- Usually detected in the cath lab recovery area
- TPA time window 3 hours, broad pool of patients, 4.5 hours up to 80 years/more selective criteria
- Thrombectomy (for large vessel occlusion only, not lacunar stroke) up to 24 hours

Management

- TPA depends on any anticoagulation received during procedure (if heparin given, need to document normal PTT, similarly with other anticoagulants)
- If anticoagulation given during procedure, may need to rule out intracranial hemorrhage with head CT
- Acute ICH may cause sudden confusion, agitation, increased BP (Cushing reaction)n

Causes of stroke during cardiac cath

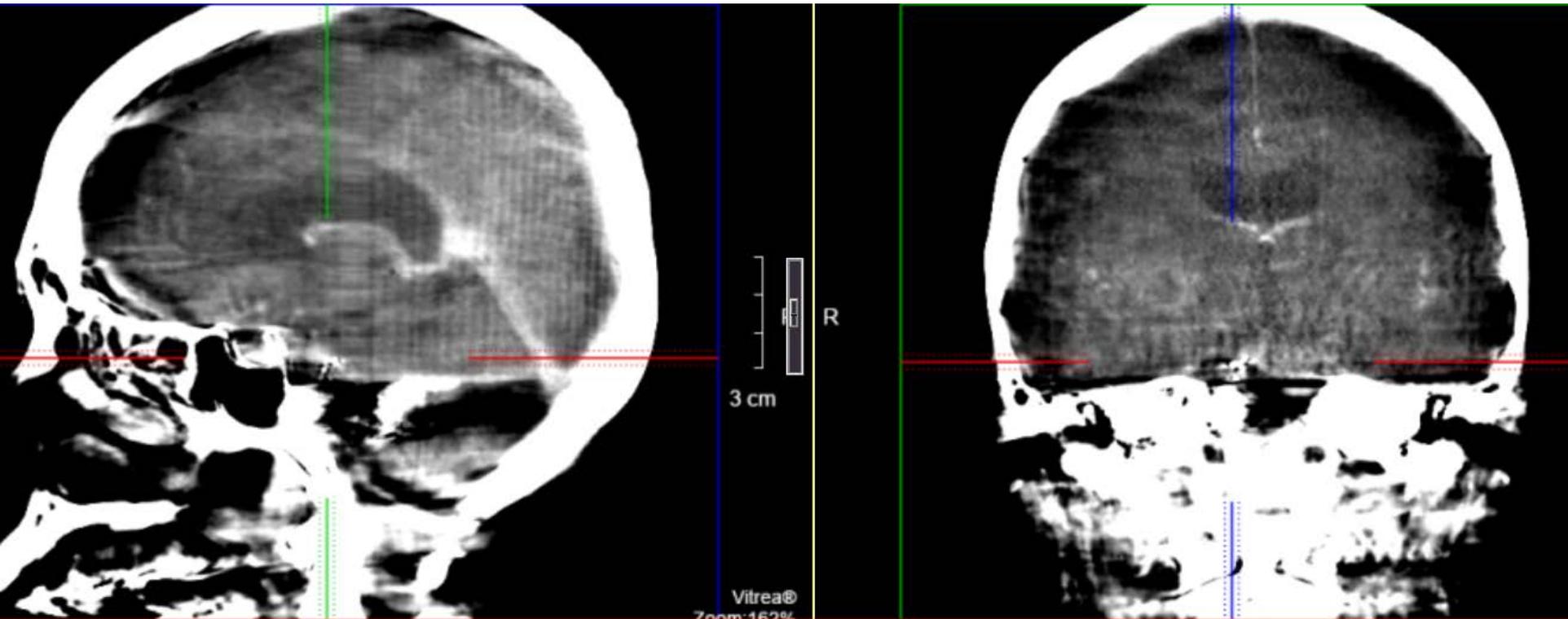
- Internal thoracic artery opposite vertebral artery origin. May injure that
- Vertebral artery is post circ. Supplies thalamus
- Thalamic stroke can mimic hemispheric syndrome so can be difficult to differentiate post circ from ant circ



options

- If ICH suspected, need brain parenchymal imaging
- 3D software
- Lci protocol
- Vascular imaging

LCI Protocol, fluoroscopy equipment



Conclusion

- One patient, one physiological system
- Optimize all organ systems for best performance

