



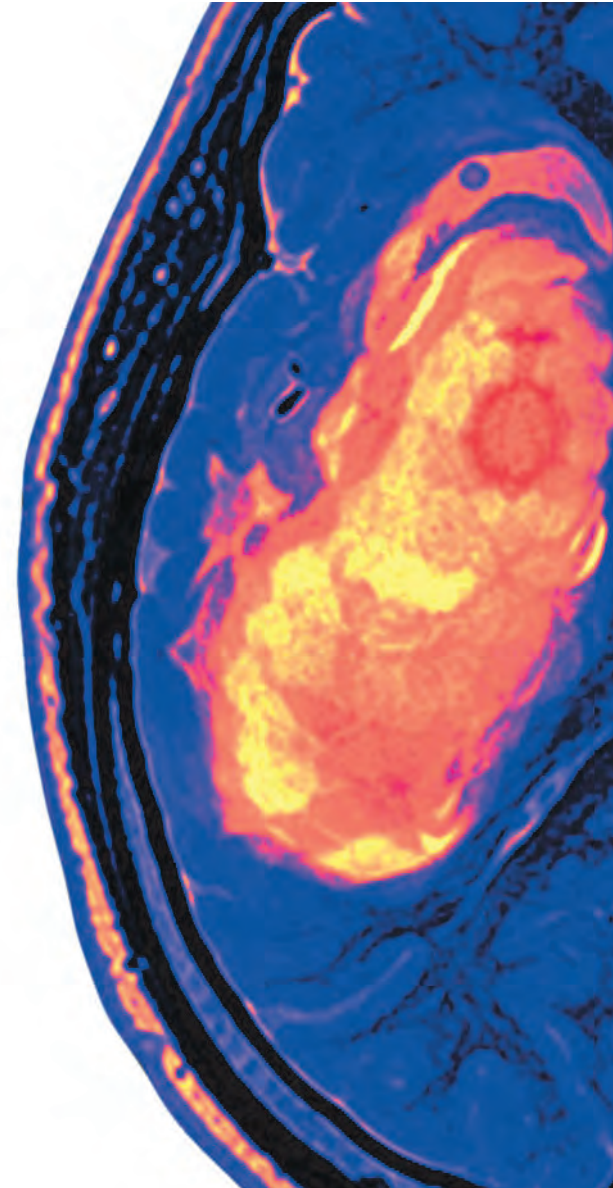
RUTGERS HEALTH
Robert Wood Johnson
Medical School
Department of Neurology

The Bleeding Edge

EARLY MANAGEMENT OF SPONTANEOUS INTRACEREBRAL HEMORRHAGE

Igor Rybinnik

Rutgers Robert Wood Johnson Medical School
Department of Neurology



DISCLOSURES

**No relevant
financial
conflicts to
disclose**

**Case was
modified for
teaching
purposes**

OBJECTIVES

Case

Man with a headache

Diagnosis

IMPORTANCE OF VASCULAR IMAGING

Preventing Hematoma Expansion

AND SECONDARY INJURY

Preventing Secondary Injury:

Surgical Management

SELECTION CRITERIA FOR MINIMALLY INVASIVE EVALUATION

Same Problem, Different Approach

NEEDLEWOUND DISCOVERIES ON IMAGING

Summary

THE 10% OF THIS TALK YOU SHOULD REMEMBER

Case

Man with a headache

HISTORY



DEMOGRAPHICS

38-year-old man, left-handed, high functioning



PAST MEDICAL HISTORY, MEDICATIONS

Hypertension, diabetes, alcohol use (last drink unknown)
Taking aspirin, lisinopril, metformin



SYMPTOMS

Garbled speech, left hemiparesis and right gaze preference



TIME FROM LAST KNOWN WELL

1 hour 50 min

VITALS



174/68 mmHg



111 bpm



14 /min



98.6 °F

NIH STROKE SCALE

20

LEVEL OF CONSCIOUSNESS

Lethargic, awakens to voice

ORIENTATION

Disoriented to month

COMMANDS

Following commands

LANGUAGE

Word finding difficulties

EXTINCTION/INATTENTION

Severe neglect on left

VISUAL FIELDS

Left homonymous hemianopia

BEST GAZE

Right gaze, crossing midline

DYSARTHRIA

Mild but intelligible

FACIAL PALSY

Left UMN facial droop

MOTOR STRENGTH

Dense flaccid left hemiparesis

LIMB ATAXIA

Absent

SENSORY

No response to noxious on left

VITALS



174/68 mmHg



111 bpm



14 /min



98.6 °F

NIH STROKE SCALE

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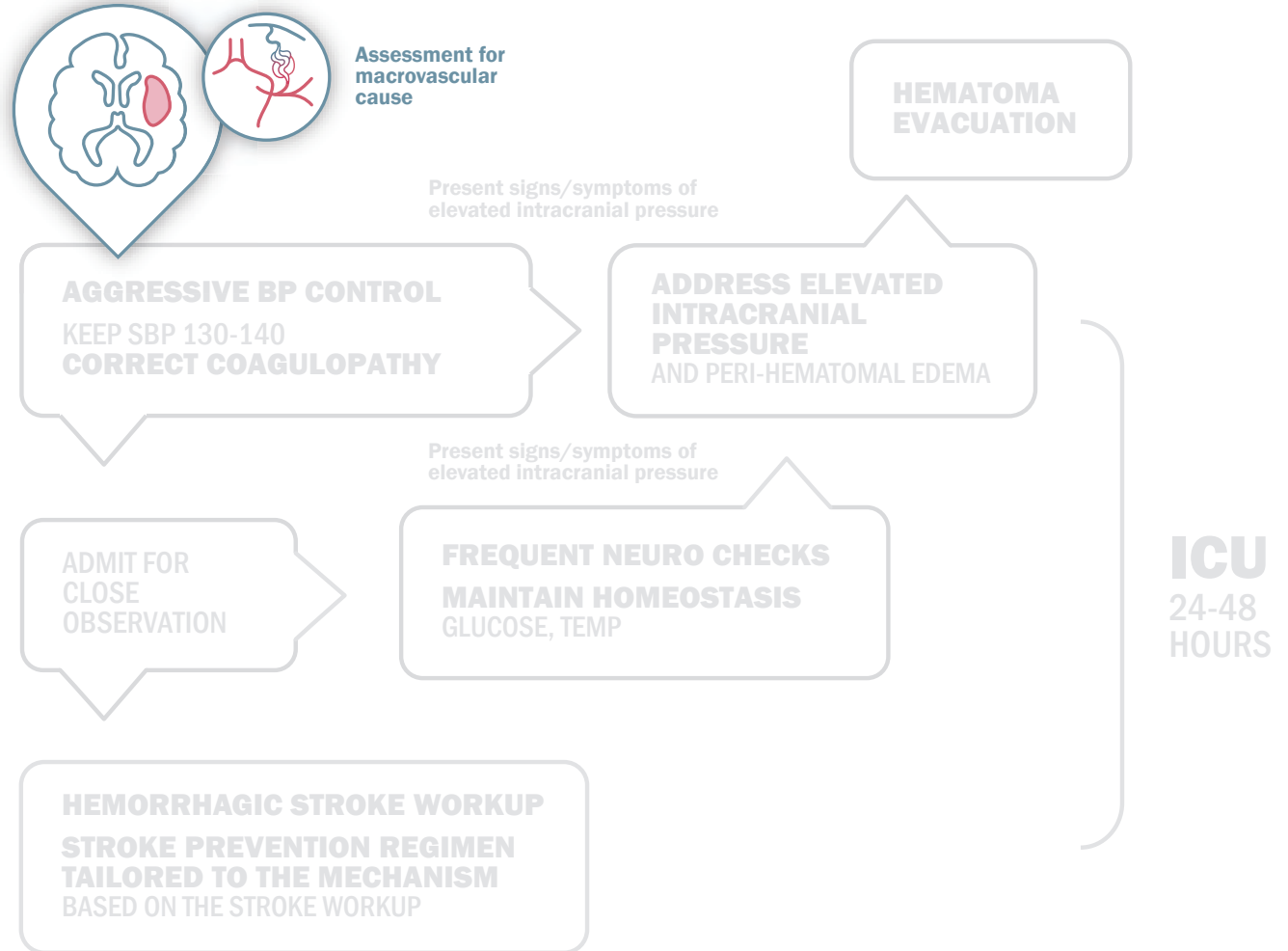
SENSORY

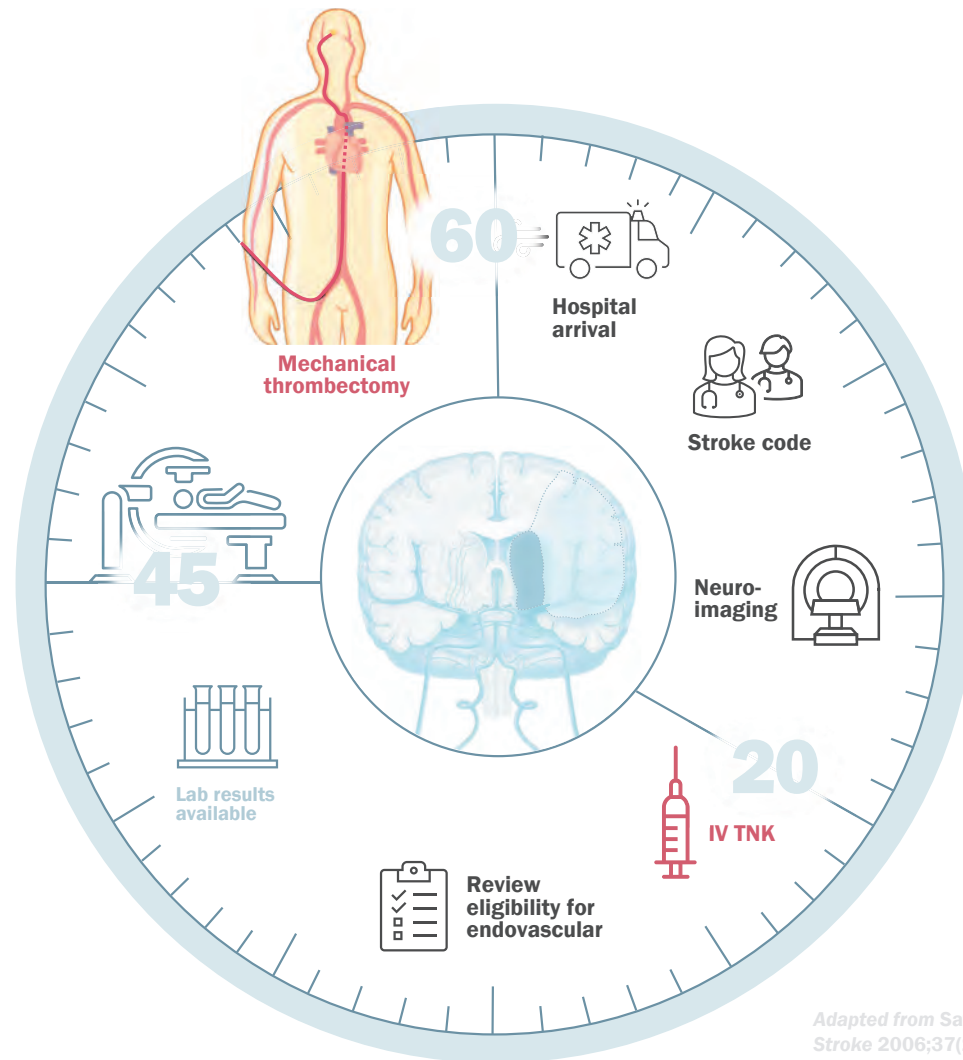
No response to noxious on left

1 DIAGNOSE

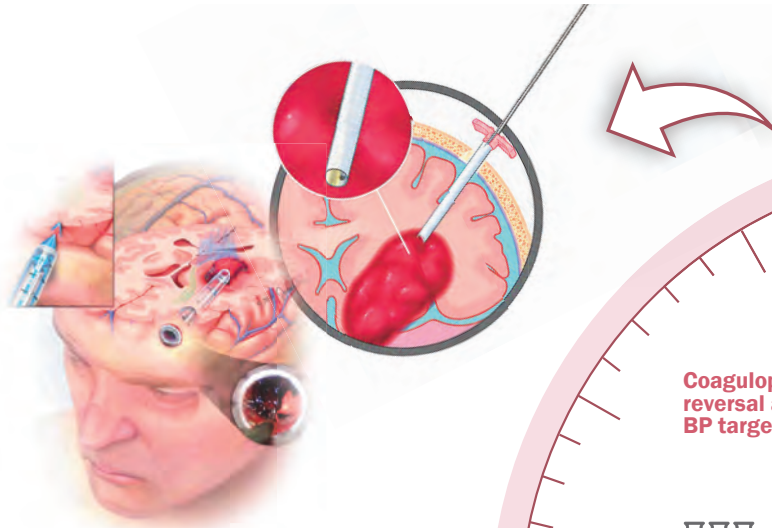
2 PREVENT HEMATOMA EXPANSION AND SECONDARY INJURY

3 PREVENT RECURRENCE



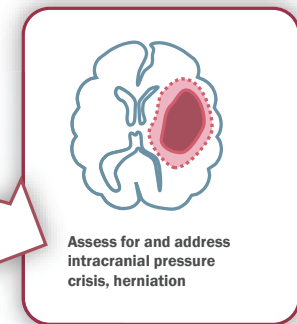
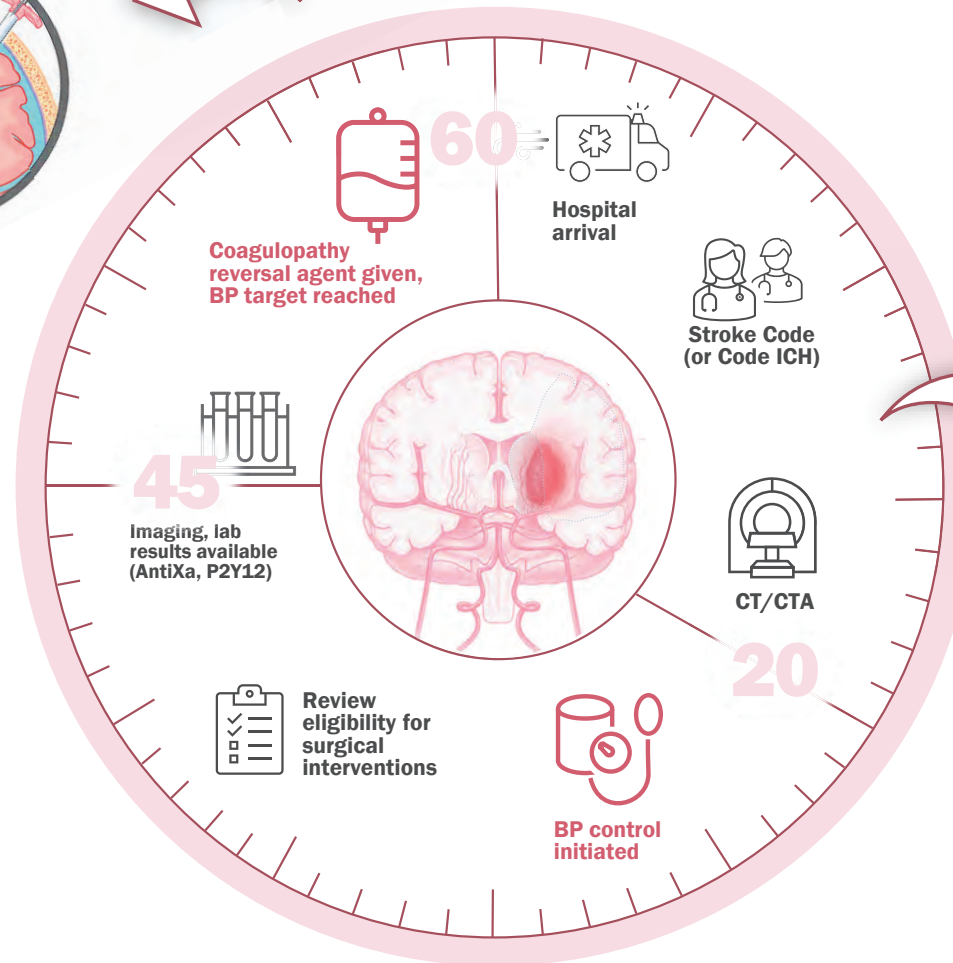


Adapted from Saver JL.
Stroke 2006;37(1):263



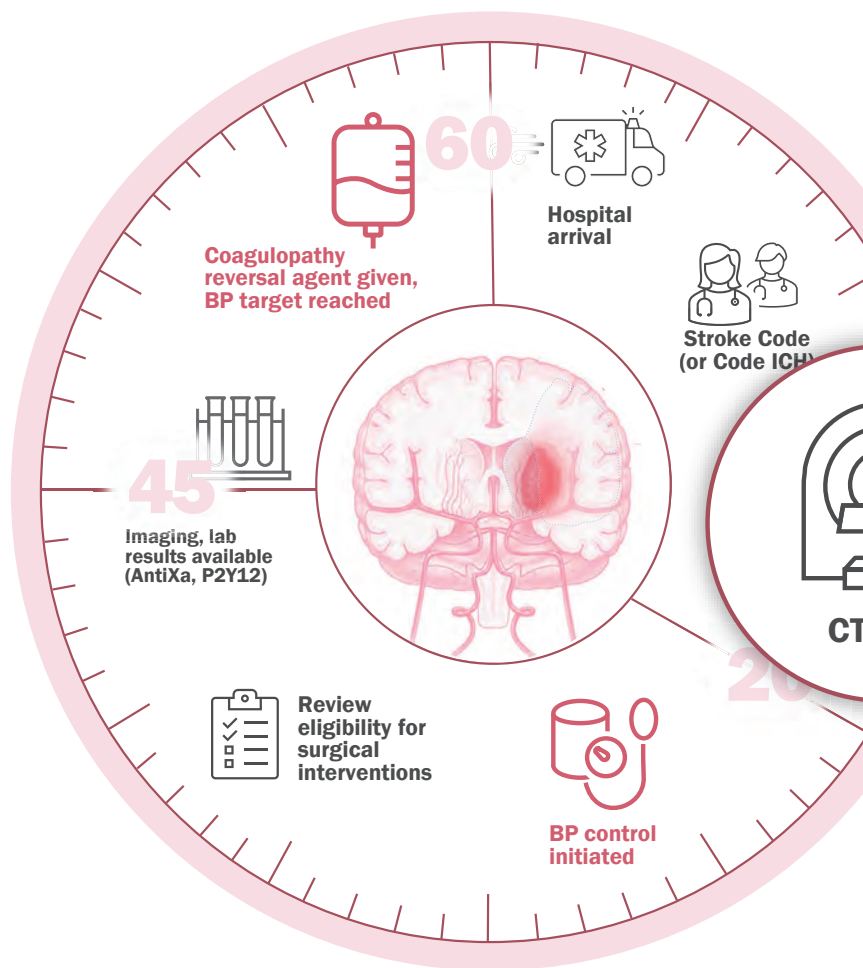
WITHIN 24 HOURS IN
ELIGIBLE PATIENTS

FIRST HOUR

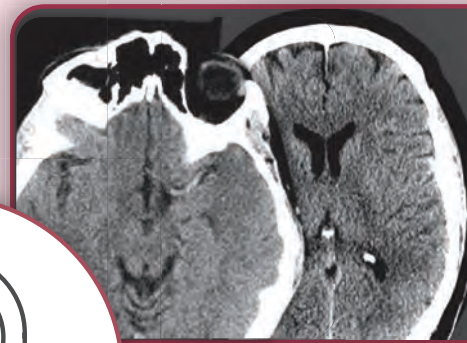


Diagnosis

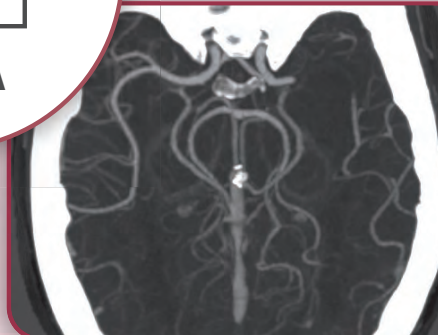
IMPORTANCE OF VASCULAR IMAGING



BASIC IMAGING



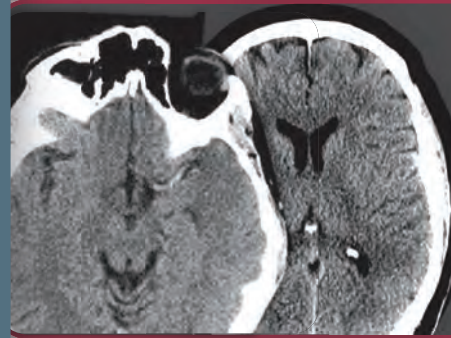
Non-contrast head CT



CT Angio head, neck with contrast

WHY IS URGENT CTA NECESSARY?

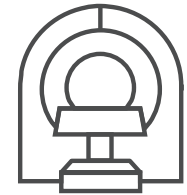
BASIC IMAGING



Non-contrast
head CT



CT Angio
head, neck
with contrast



CT, CTA



CTA DETECTS MACROVASCULAR CAUSES

Josephson CB, et al. *Cochrane Database Syst Rev* 2014;(9):CD009372.
van Asch CJ, et al. *BMJ* 2015;351:h5762

SENSITIVITY

72-80%

SPECIFICITY

92%



100 patients with intraparenchymal hemorrhage



CTA DETECTS MACROVASCULAR CAUSES

Josephson CB, et al. *Cochrane Database Syst Rev* 2014;(9):CD009372.
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SENSITIVITY
72-80%

SPECIFICITY
92%



100 patients with intraparenchymal hemorrhage



CTA DETECTS SPOT SIGNS

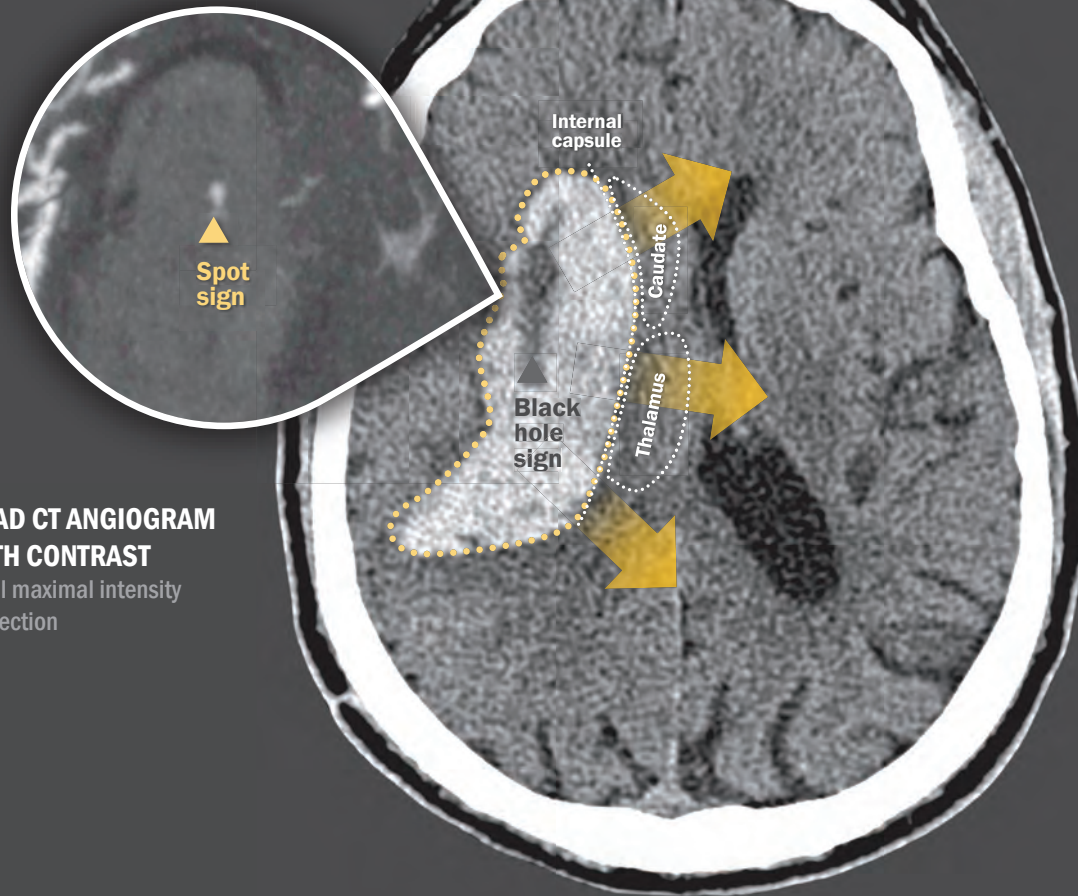
Phan TG, et al.
Stroke 2019;50(8):2030-2036

SENSITIVITY
55-60%

SPECIFICITY
88%

NON-CONTRAST HEAD CT

Axial cut through the basal ganglia

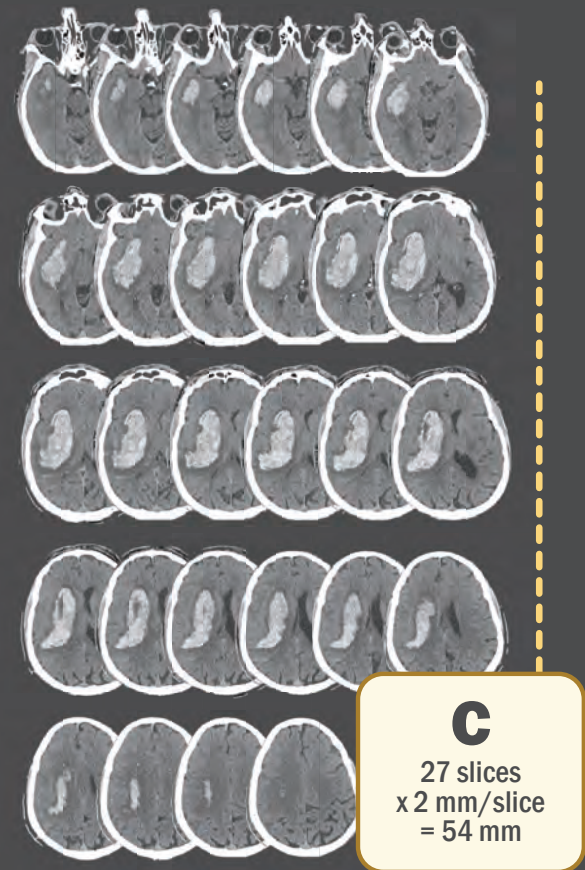
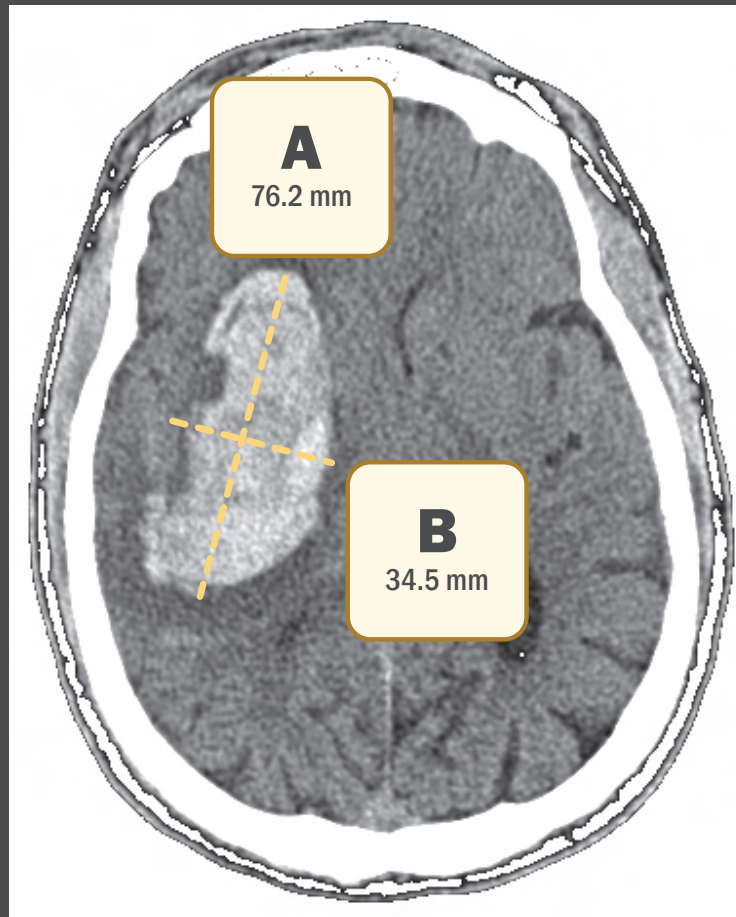


HEAD CT ANGIOGRAM WITH CONTRAST

Axial maximal intensity projection

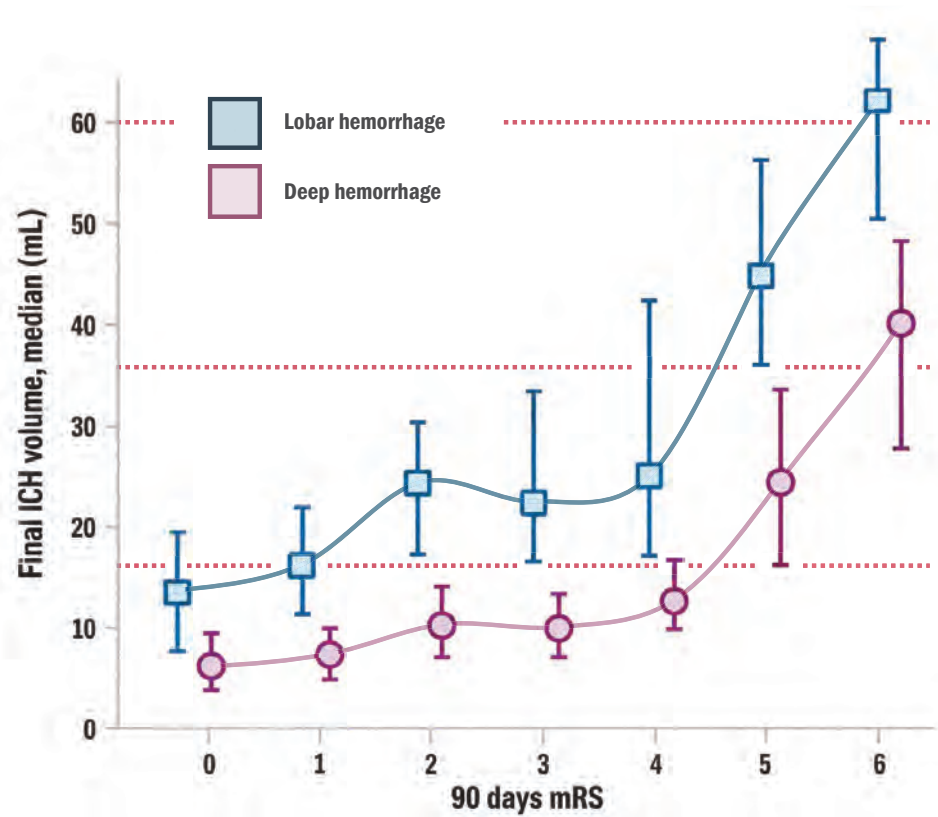
ESTIMATING HEMATOMA VOLUME

$A \times B \times C / 2$
71cc



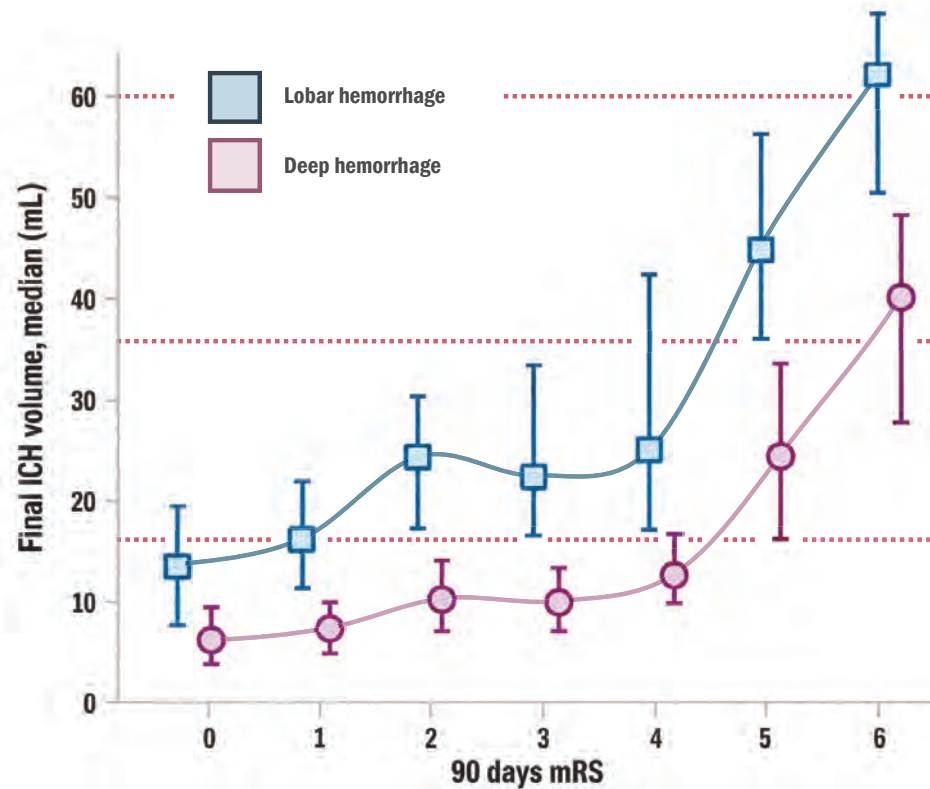
HEMATOMA VOLUME PREDICTS OUTCOMES

Adapted from Morotti A, et al. *Stroke* 2025;56(5):1224–1231



HEMATOMA VOLUME PREDICTS OUTCOMES

Adapted from Morotti A, et al. *Stroke* 2025;56(5):1224–1231

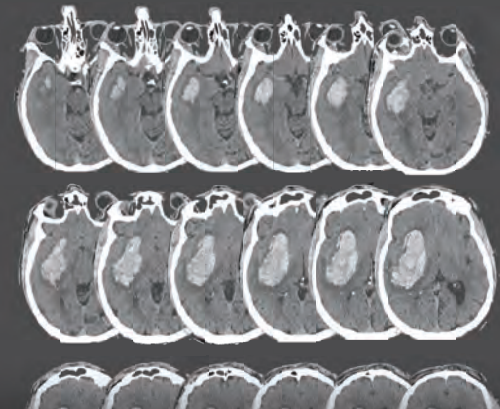
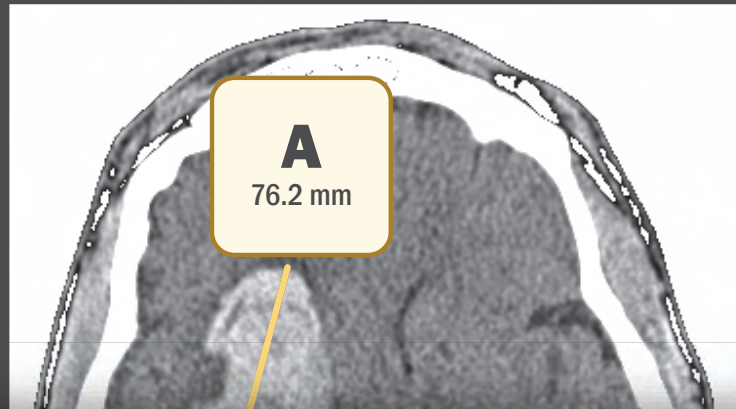


+1 mL

Increase over baseline ICH volume associated with worse mRS (OR 0.94)

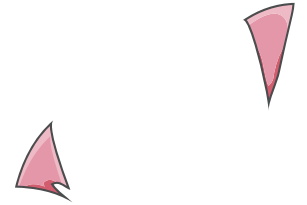
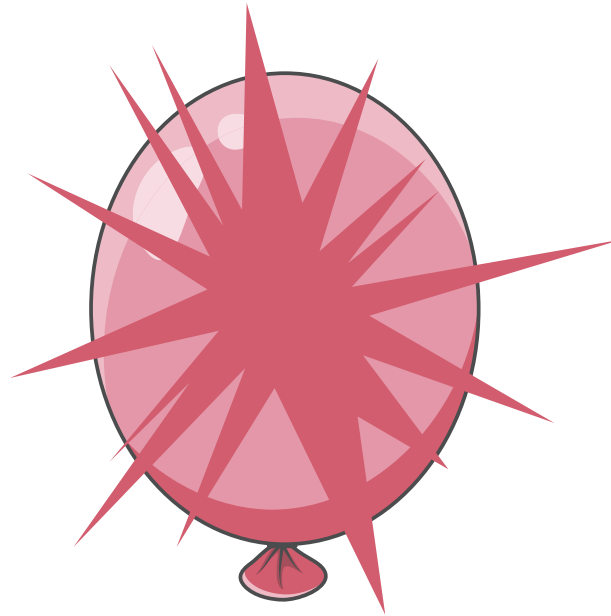
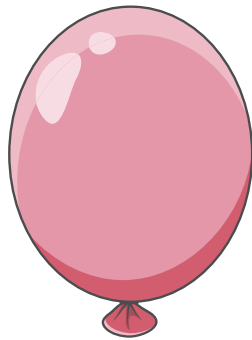
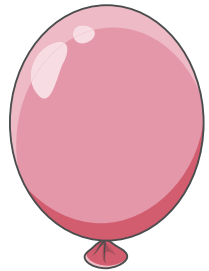
Davis SM, et al. *Neurology* 2006;66(8):1175–1181

ESTIMATING HEMATOMA VOLUME



WHAT IS THE **PRIMARY GOAL**
OF ACUTE HEMORRHAGIC
STROKE MANAGEMENT?

PREVENT EXPANSION



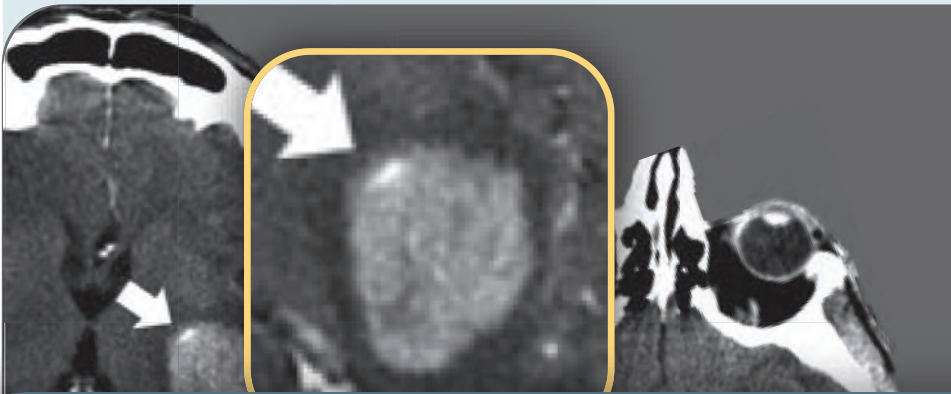
Preventing Hematoma Expansion

AND SECONDARY INJURY

MECHANISMS OF HEMATOMA EXPANSION

Explosion

Continuous bleeding from single ruptured vessel



Avalanche

Secondary shearing of adjacent vessels

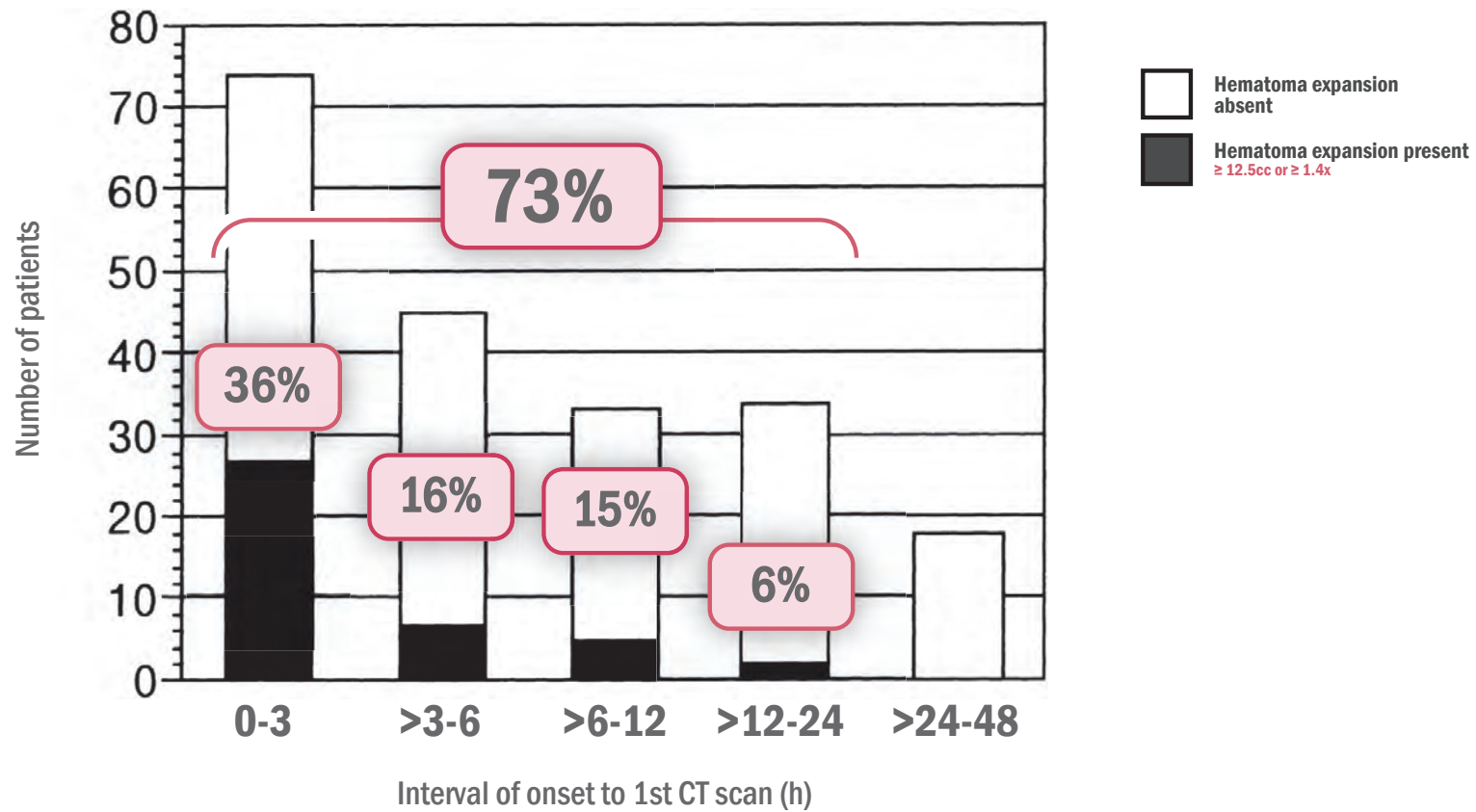


WHAT IS THE **TIME WINDOW** FOR HEMATOMA EXPANSION?

HEMATOMAS EXPAND EARLY

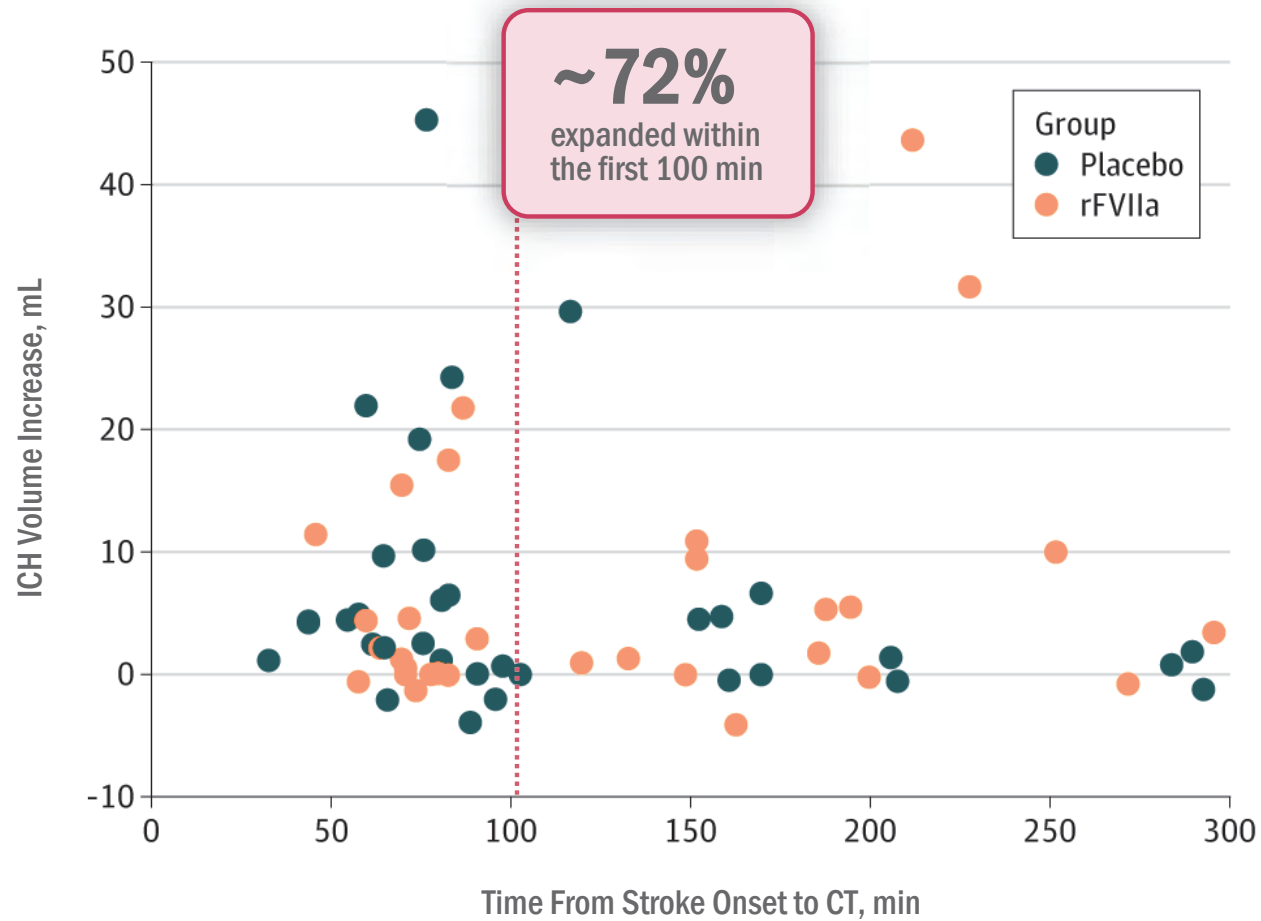
Adapted from Kazui, et al, *Stroke* 1996;27:1783-1787

Al-Shahi Salman R, et al. *Lancet Neurol* 2018;17(10):885-894



HEMATOMAS EXPAND **VERY** EARLY

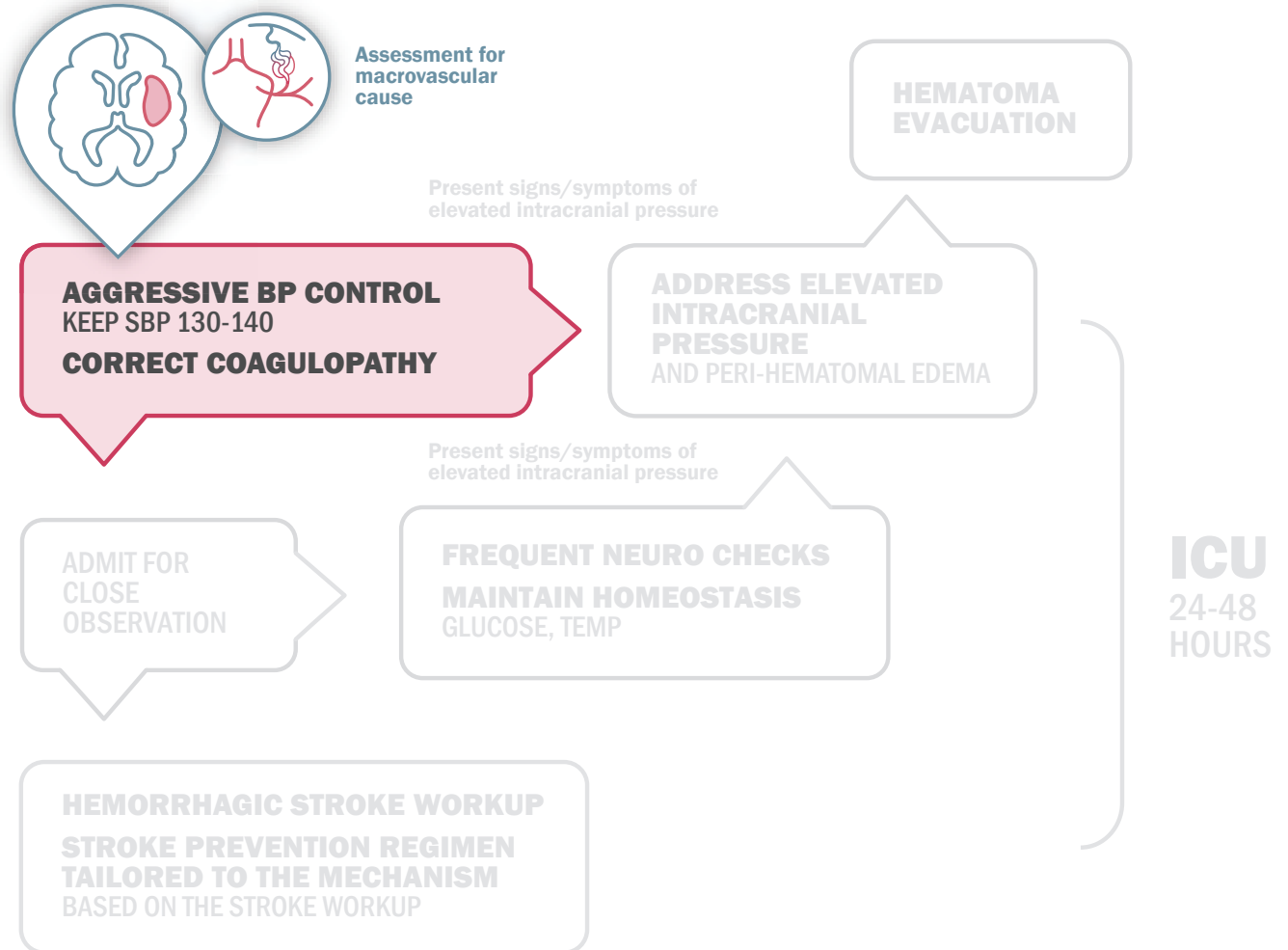
Gladstone DJ, et al. *JAMA Neurol* 2019; 76(12):1493-1501



1 DIAGNOSE

2 PREVENT HEMATOMA EXPANSION AND SECONDARY INJURY

3 PREVENT RECURRENCE



PREVENTING HEMATOMA EXPANSION:

Blood Pressure

INTERACT AND ATACH

**ACUTE ISCHEMIC
STROKE**

$\leq 220/110$ mmHg

**ACUTE ISCHEMIC
STROKE RECEIVING
INTRAVENOUS
FIBRINOLYSIS**

$\leq 180/105$ mmHg

**ACUTE ISCHEMIC
STROKE POST
SUCCESSFUL
REPERFUSION**

**SBP
140-180 mmHg**

**ACUTE
HEMORRHAGIC
STROKE**

130-140 mmHg

**LONG TERM BLOOD
PRESSURE GOAL
FOR SECONDARY
STROKE
PREVENTION**

$\leq 130/80$ mmHg



**PREVENTING
SECONDARY INJURY:
BLOOD PRESSURE IN
ACUTE STROKE**

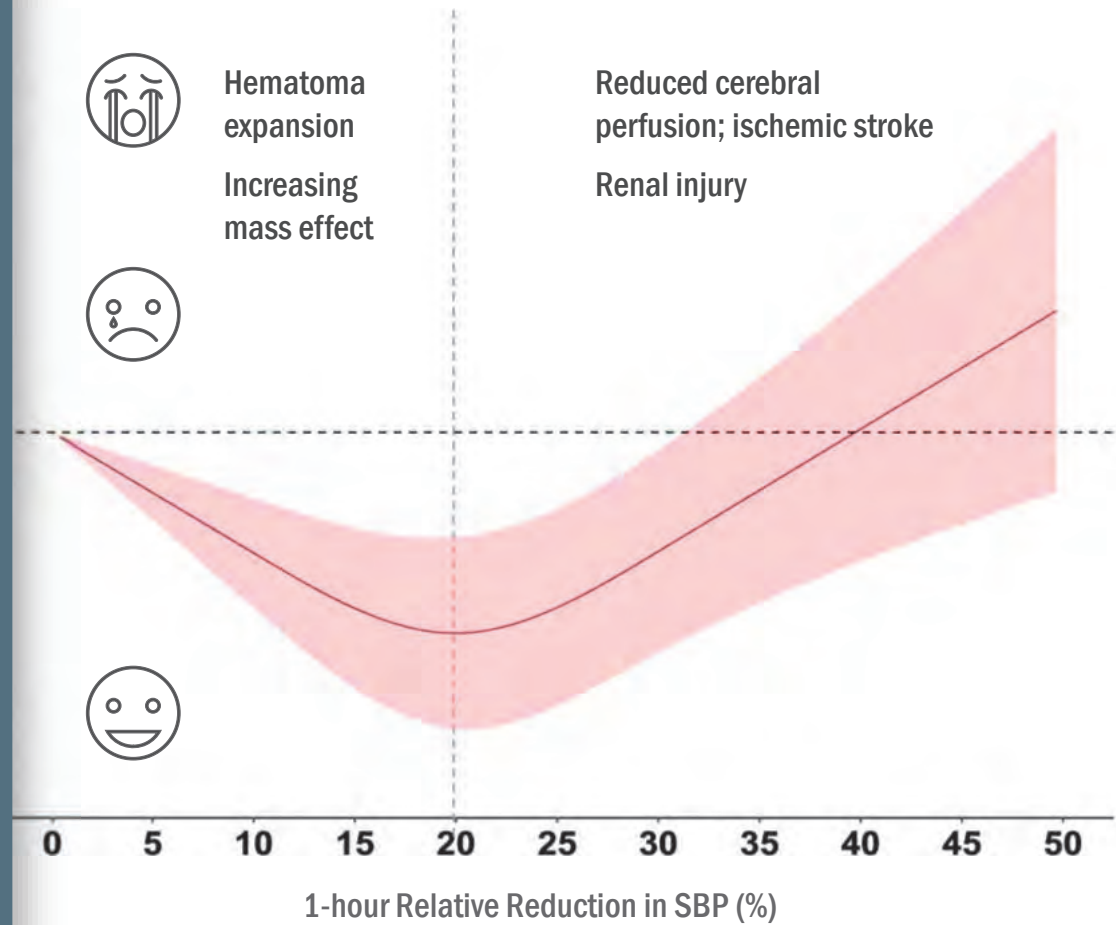
Greenberg SM, et al. *Stroke* 2022;53(7):e282-e361

Morris NA, Jindal G, Chaturvedi S. *Stroke* 2023;54(5):1457-61

Jones DW, et al. *Circulation* 2025;152(11):e114-e218

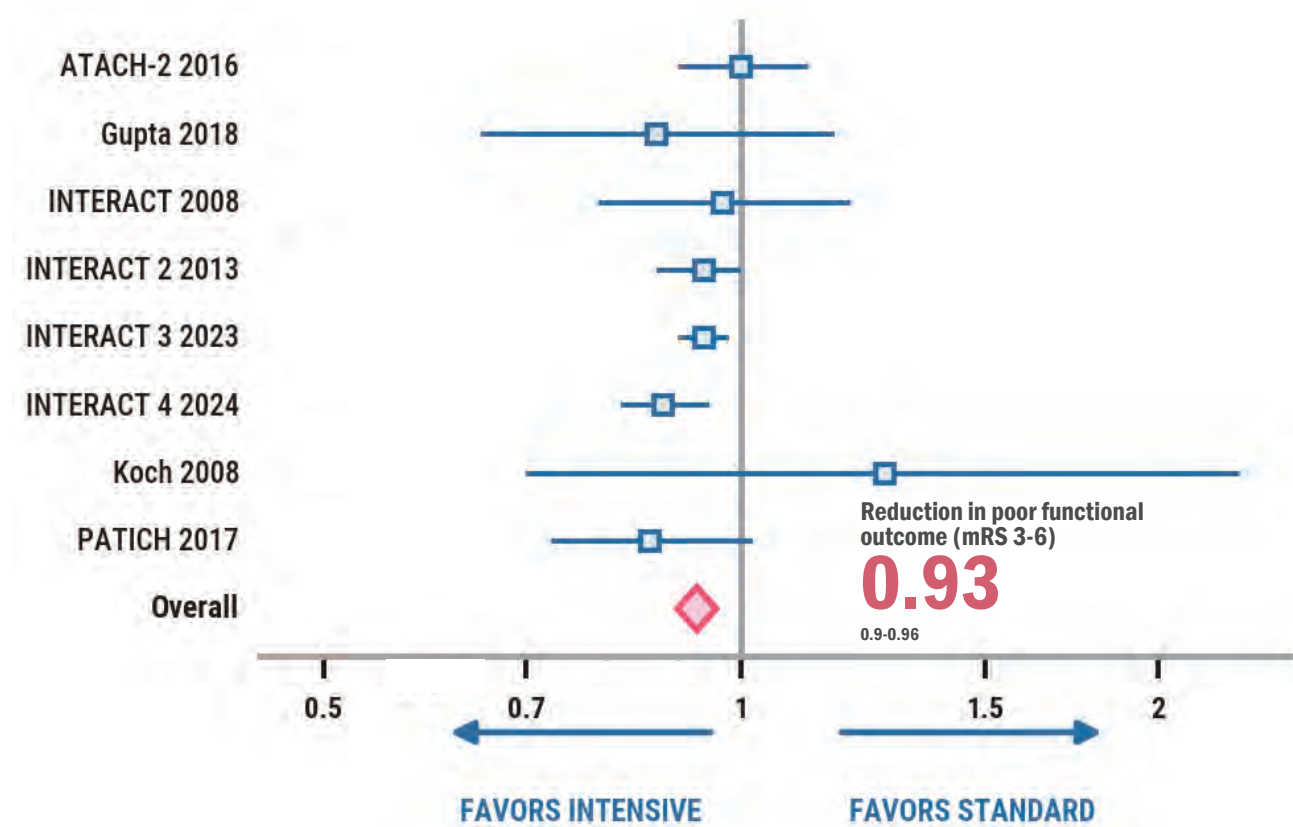
Prabhakaran S, et al. *Stroke* 2026;57

DOES BP REDUCTION IMPROVE OUTCOMES?



OUTCOMES AFTER INTENSIVE BP REDUCTION

Adapted from
Reginato PH, et al. *Neurocrit
Care* 2025;43:864–875.



38M with multiple vascular risk factors on aspirin who developed acute 71cc left putaminal ICH. CTA showed a spot sign. He is currently 2 hours after symptom onset.

Clevidipine drip started with SBP now 131/65 mmHg.

PT 11.4, INR 1.06, PTT 28, Platelets 112

Last dose of aspirin was on the day of presentation.

HOW DO WE MANAGE HIS COAGULOPATHY?

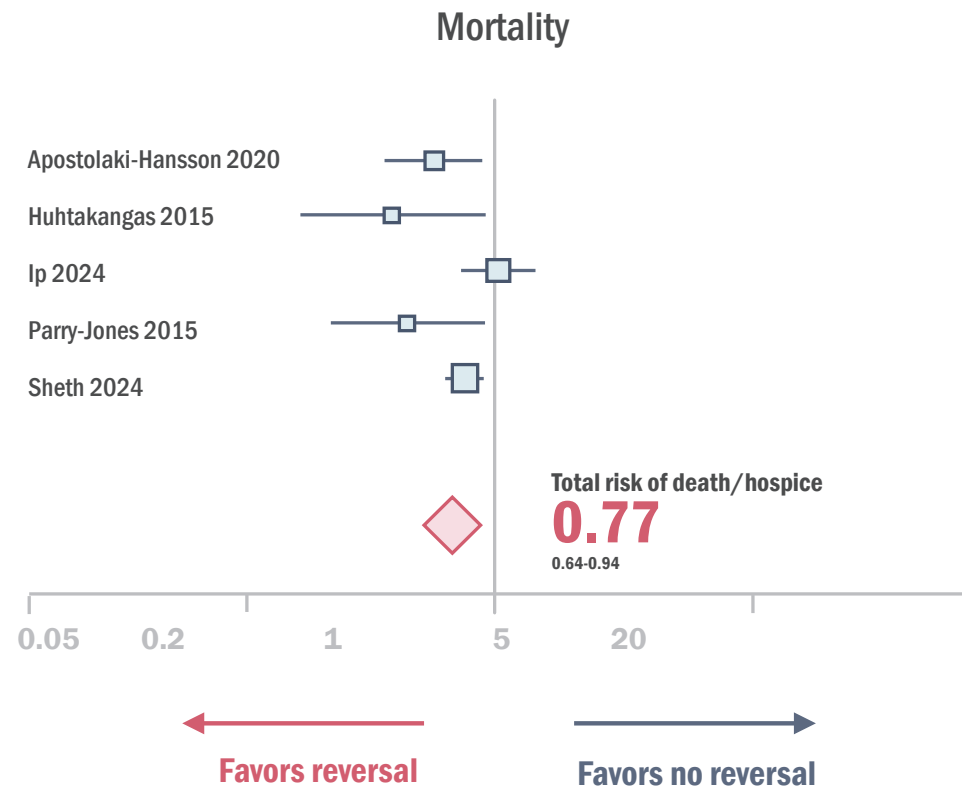
PREVENTING HEMATOMA EXPANSION:

Reversal of Coagulopathy, Hemostasis

PCC, DDAVP, rFVIIa

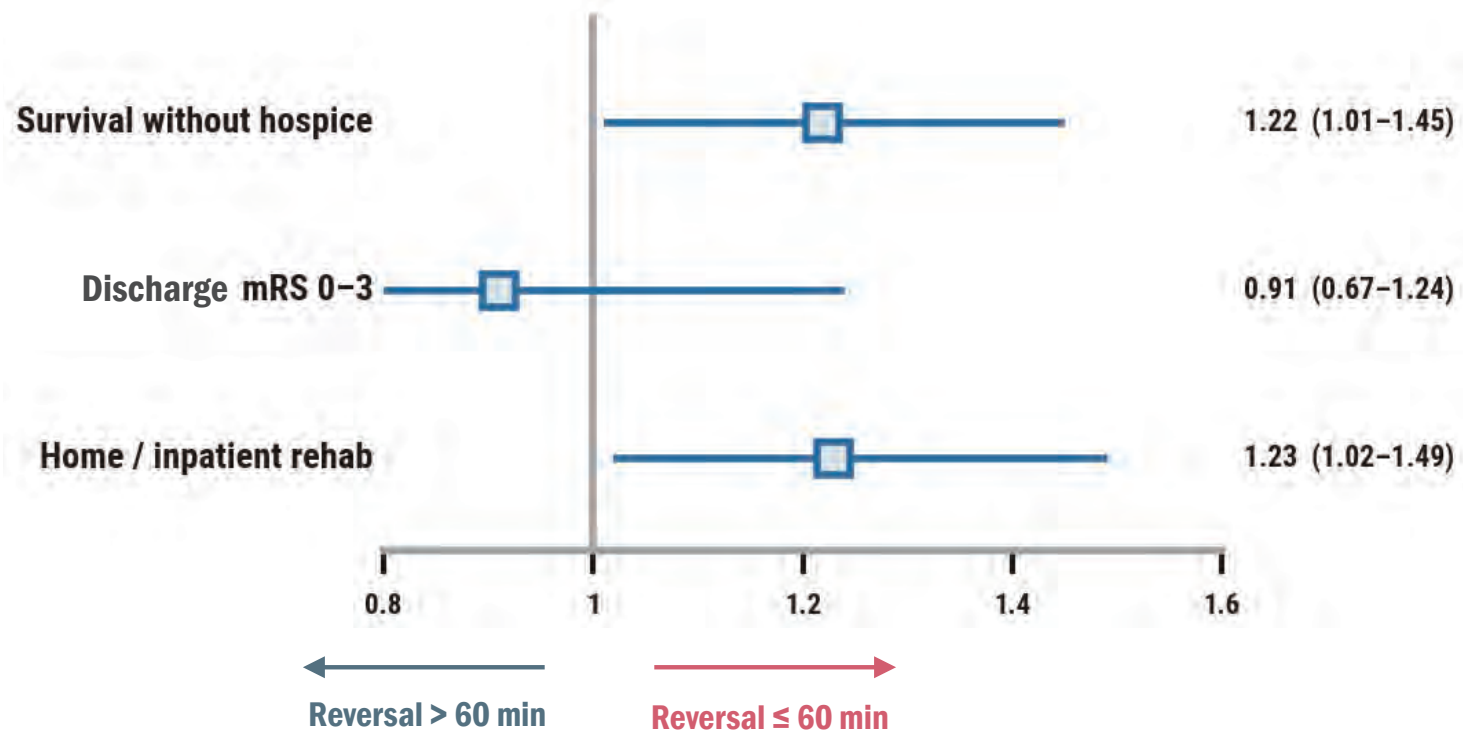
ANTICOAGULATION REVERSAL IS ASSOCIATED WITH REDUCED MORTALITY

Adapted from Tallroth et al. Neurocrit Care 2026.



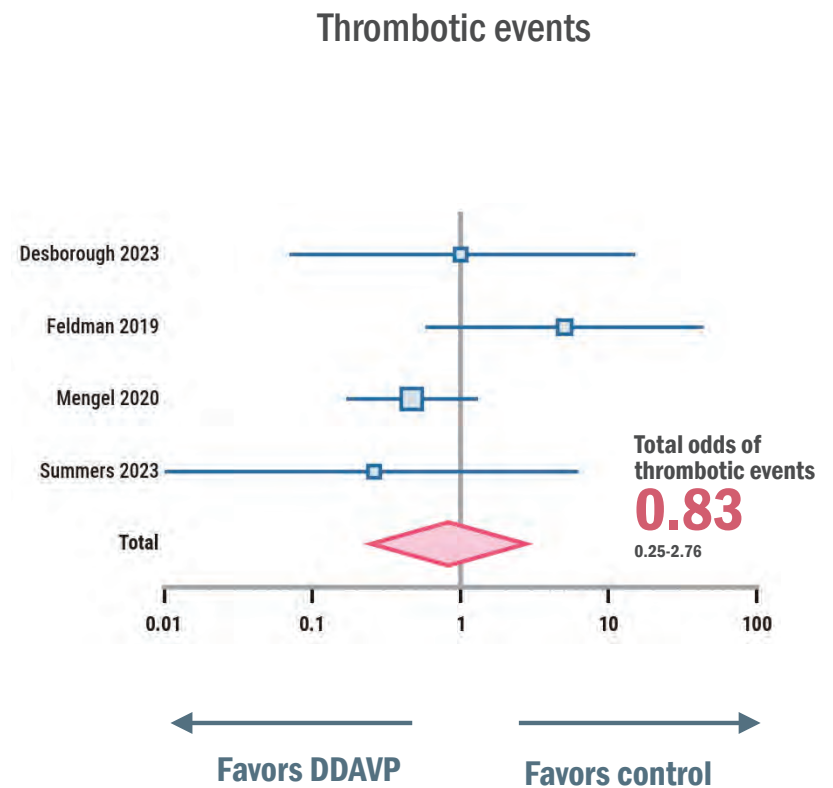
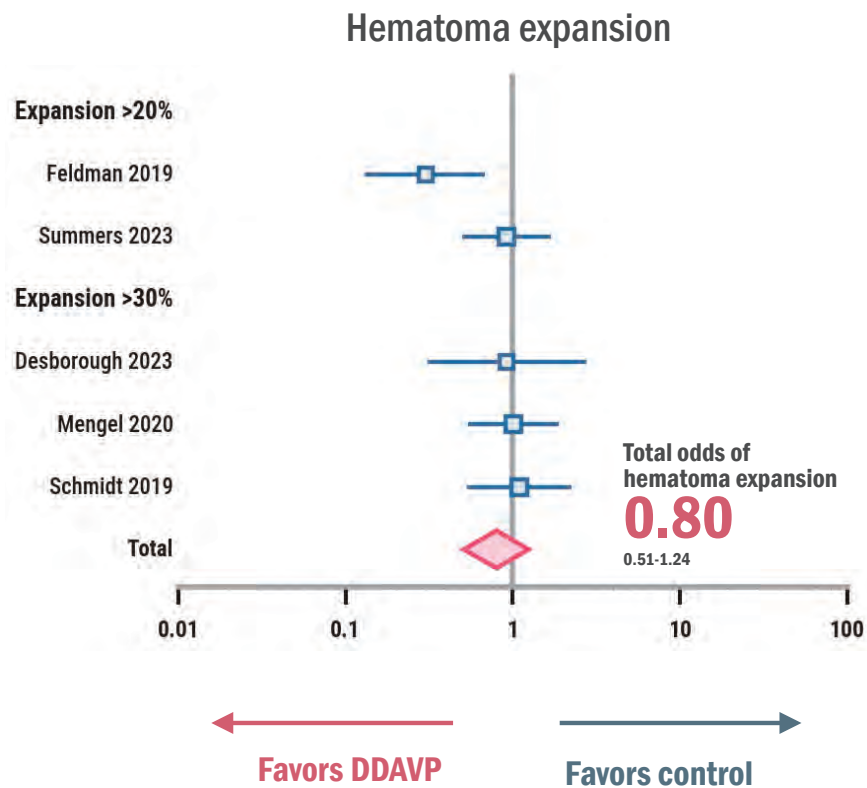
REVERSAL SHOULD HAPPEN QUICKLY

Adapted from Sheth KN, et al. *JAMA Neurol* 2024;81;(4):363-372.



DDAVP MAY REDUCE HEMATOMA EXPANSION

Adapted from Shahzad F, et al. *Brain Behav* 2024;14:e3540



38M with multiple vascular risk factors on aspirin who developed acute 71cc left putaminal ICH. CTA showed a spot sign. He is currently 3 hours after symptom onset.

Blood pressure was controlled.

DDAVP was administered

CTA showed spot sign.

**SHOULD WE ADMINISTER
RECOMBINANT FVIIA?**

RECOMBINANT FVIIA

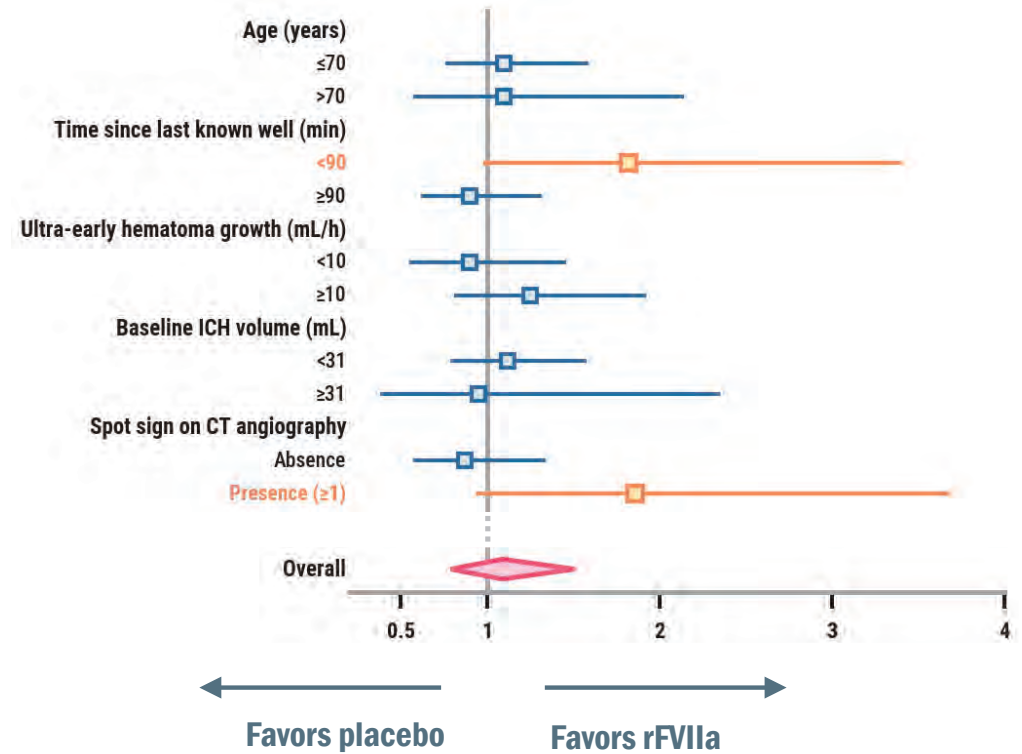
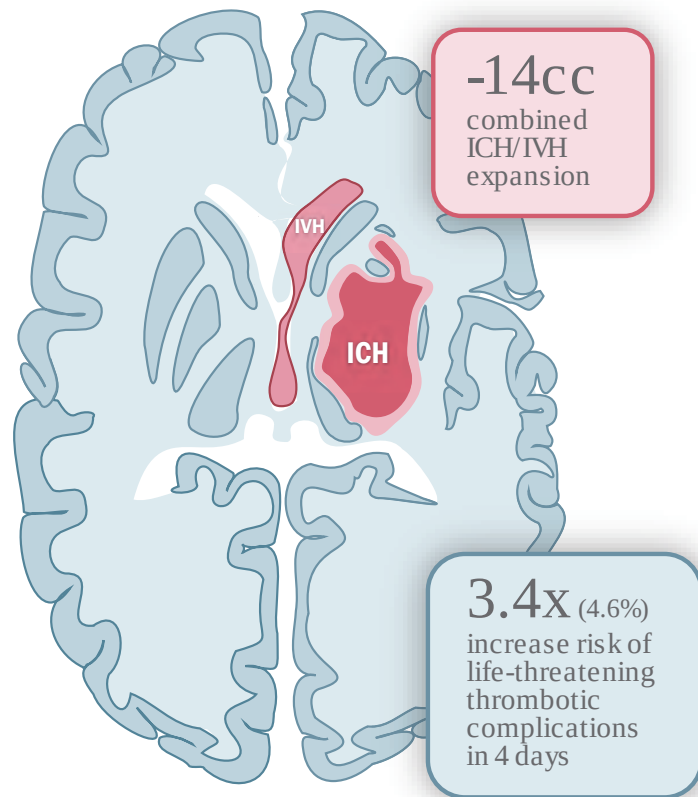
Broderick JP, et al. *Lancet* 2026;407:773-83



Generated
with AI

RECOMBINANT FVIIa IMPROVES HEMOSTASIS, **BUT NOT OUTCOMES**

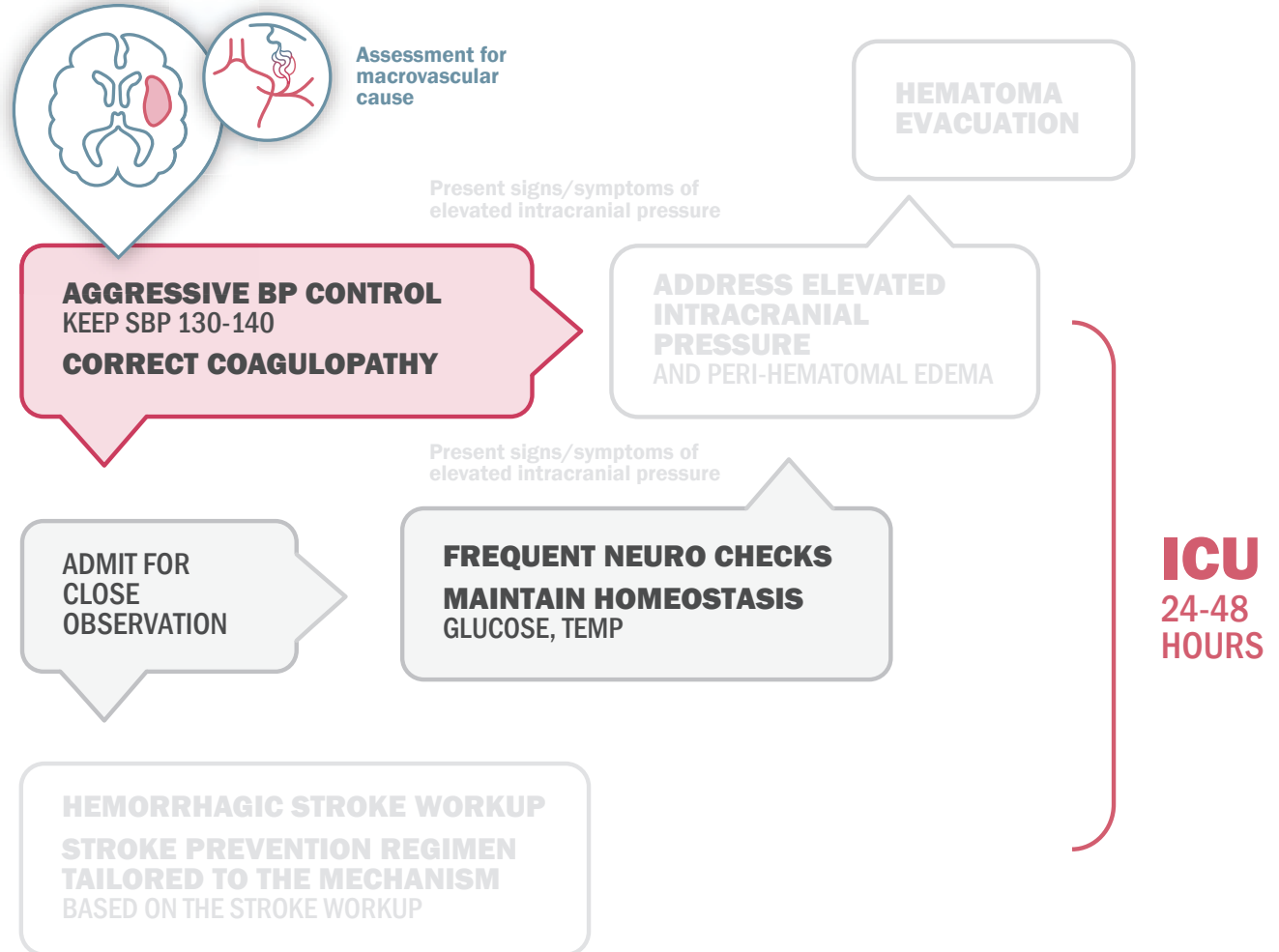
Adapted from Broderick JP, et al. *Lancet* 2026;407:773-83



1 DIAGNOSE

2 PREVENT HEMATOMA EXPANSION AND SECONDARY INJURY

3 PREVENT RECURRENCE



PREVENTING SECONDARY INJURY:

The Bundle

ADDRESSING HYPERTENSION, HYPERGLYCEMIA, PYREXIA, COAGULOPATHY



BUNDLING INTERVENTIONS IMPROVES OUTCOMES

Ma L, et al. *Lancet* 2023;402:27-40

BLOOD PRESSURE

SBP 130-140 mmHg
within 1 hour of starting treatment

HYPERGLYCEMIA

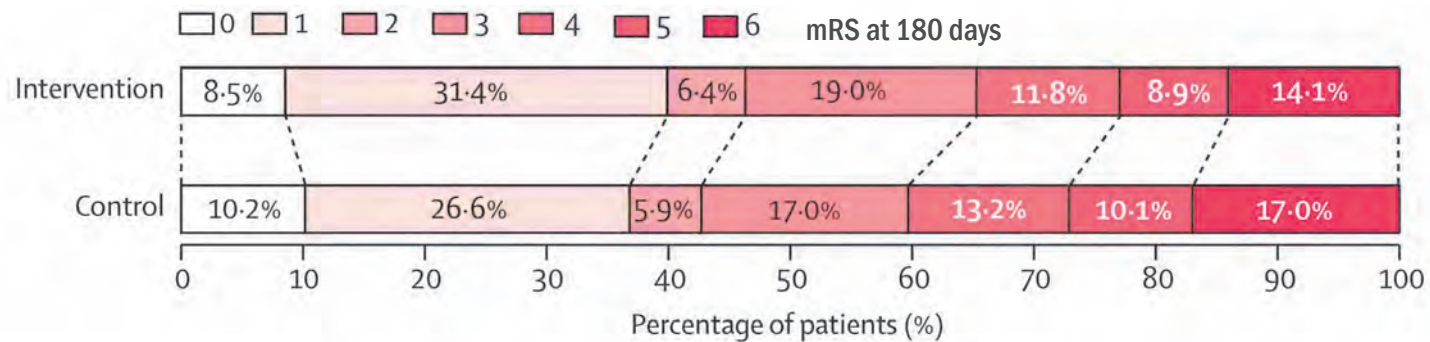
110-180 mg/dL
110-140 for non-diabetics
140-180 for diabetics

PYREXIA

<37.5°C
Within 1 hour

COAGULOPATHY

PCC
For coagulopathy reversal
(INR <1.5 within 1 hour)



38M with multiple vascular risk factors on aspirin who developed acute 71cc left putaminal ICH. CTA showed a spot sign. He is currently 6 hours after symptom onset.

BP is now 135/68 mmHg | Glucose 110-140 mg/dL

DDAVP administered

Patient is neurologically stable; repeat CT stable

**SHOULD WE CALL
NEUROSURGERY?**

Preventing Secondary Injury:

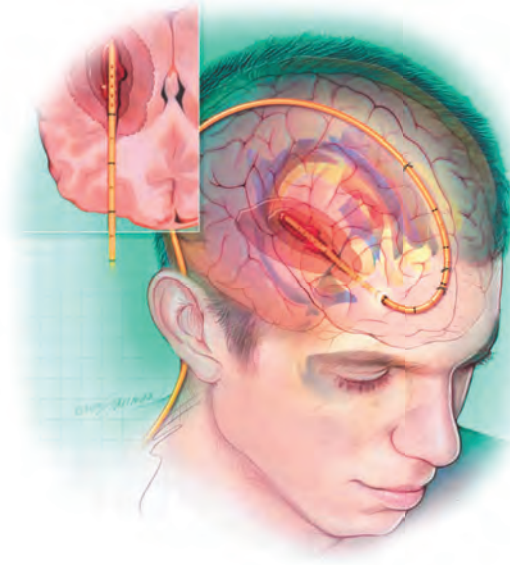
Surgical Management

SELECTING PATIENTS FOR MINIMALLY INVASIVE EVACUATION

4.8
mm

MISTIE: MINIMALLY INVASIVE
SURGERY WITH THROMBOLYSIS
IN INTRACEREBRAL
HEMORRHAGE EVACUATION

Hanley DF, et al. *Lancet*
2019;393(10175): 1021-32



13.5 mm

ENRICH: ENDOPORT-
MEDIATED EVACUATION

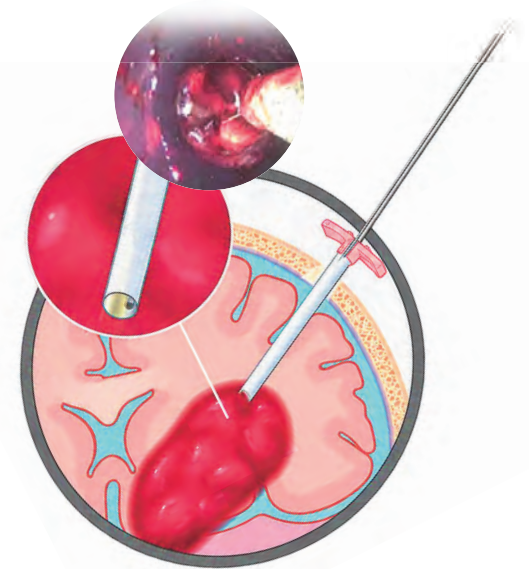
Pradilla G, et al. *NEJM*
2024;390:1277-89



6.3
mm

MIND: ENDOSCOPIC-
ASSISTED ASPIRATION

Arthur AS, et al. *JAMA Neurol*
2025;82(11):1113-1121.



4.8
mm

MISTIE: MINIMALLY INVASIVE SURGERY WITH THROMBOLYSIS IN INTRACEREBRAL HEMORRHAGE EVACUATION

Hanley DF, et al. *Lancet* 2019;393(10175): 1021-32

13.5 mm

ENRICH: ENDOPORT-MEDIATED EVACUATION

Pradilla G, et al. *NEJM* 2024;390:1277-89

6.3
mm

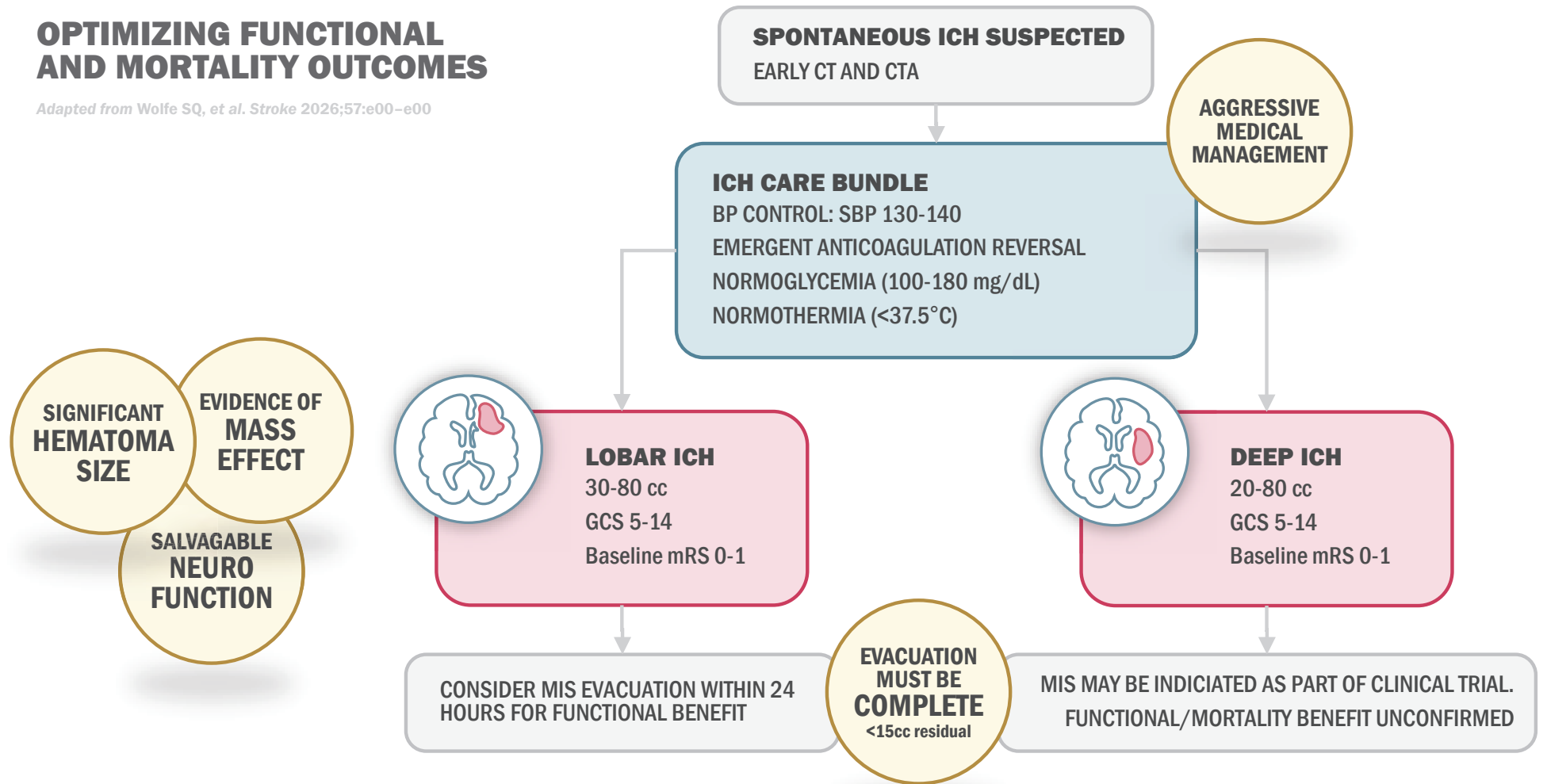
MIND: ENDOSCOPIC-ASSISTED ASPIRATION

Arthur AS, et al. *JAMA Neurol* 2025;82(11):1113-1121.

ICH VOLUME	≥30 mL	30–80 mL	20–80 mL
TIMING	12–72 h; relatively delayed	≤24 h	≤72 h; median ~28 h
POPULATION	Deep + lobar	Ultimately lobar-enriched	~70% deep
CLOT REMOVAL	Variable; ~59% ≤15 mL	Rapid, substantial	Excellent; ~79% ≤15 mL
PRIMARY FUNCTIONAL ENDPOINT	Neutral; mortality benefit	Positive	Neutral
KEY LESSON	Degree of evacuation matters	Early evacuation benefit appears concentrated in lobar ICH	Adequate evacuation alone isn't sufficient

OPTIMIZING FUNCTIONAL AND MORTALITY OUTCOMES

Adapted from Wolfe SQ, et al. Stroke 2026;57:e00–e00



ULTRA EARLY BASAL GANGLIA HEMATOMA EVACUATION: **MINUTE TRIAL**

NCT07260916. NIH StrokeNet/NINDS.

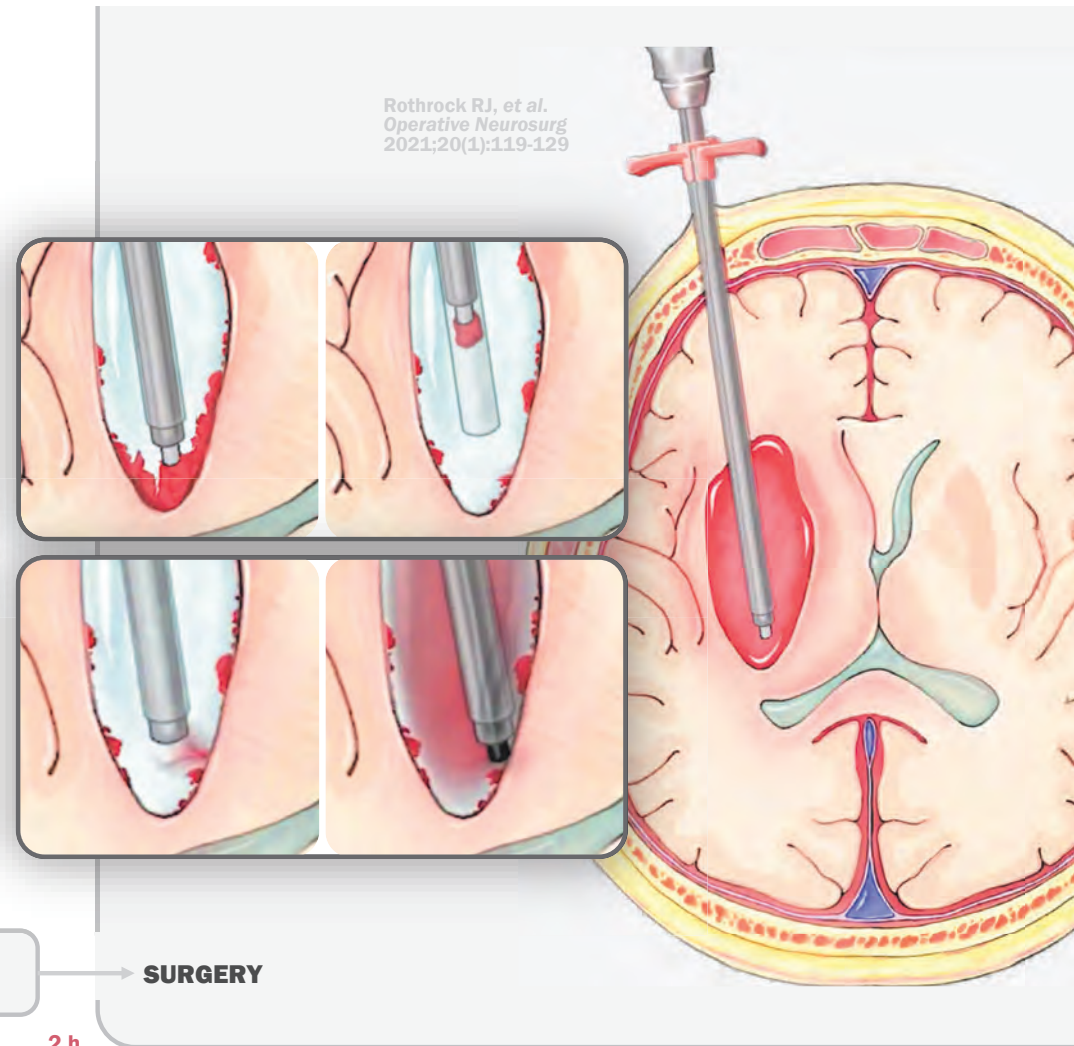
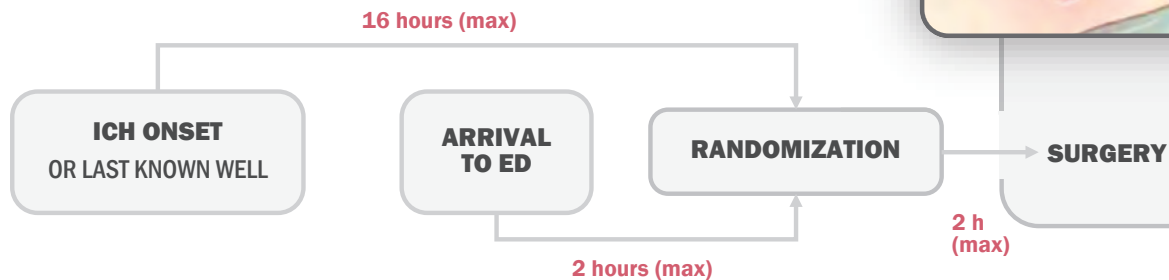
Age 18-80

Basal ganglia ICH ≥ 20 mL

$\pm$ IVH $< 50\%$ of lateral ventricle

NIHSS ≥ 6 at presentation

Baseline mRS ≤ 2



38M with multiple vascular risk factors on aspirin who developed acute 71cc left putaminal ICH. CTA showed a spot sign. Patient was treated with BP and glycemic control and DDAVP.

MRI showed no evidence of neoplasm, CAA

CTA and DSA showed no evidence of vascular malformation.

Patient remains neurologically stable.

**IS OUR PATIENT ELIGIBLE FOR
MINIMALLY INVASIVE ICH EVAC?**

FOLLOW-UP NON-CONTRAST HEAD CT

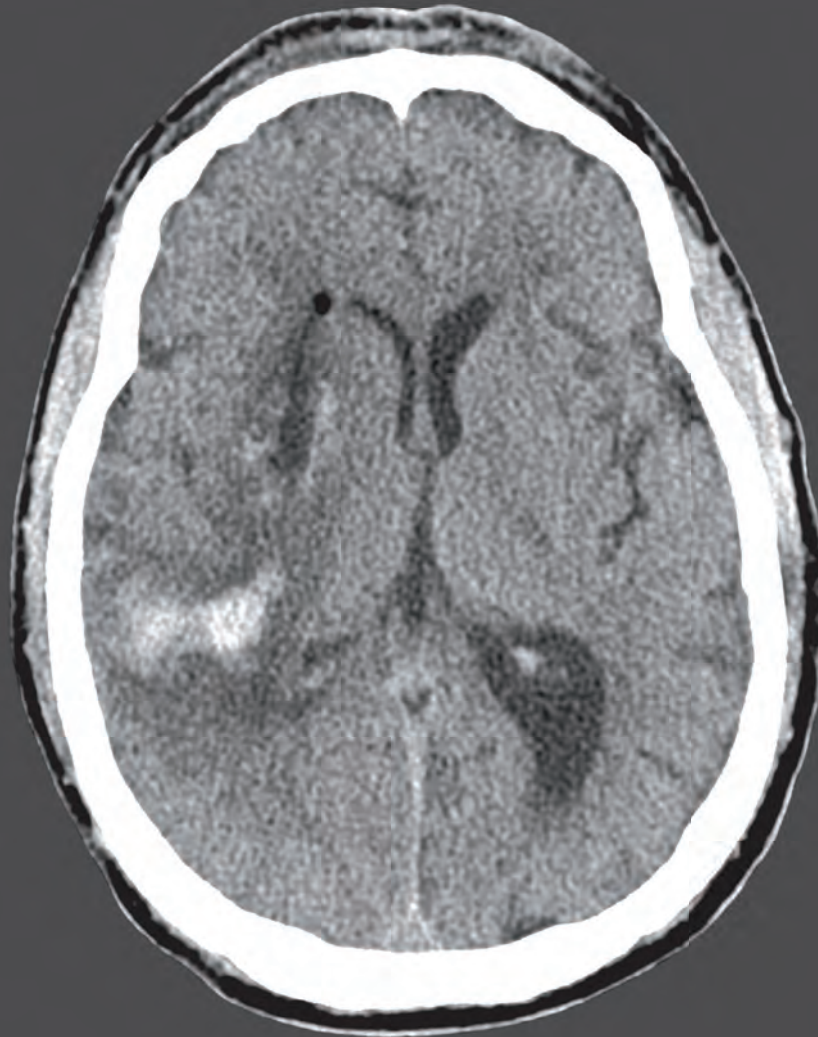
Axial cut through the basal ganglia



23 HOURS
FROM LAST KNOWN WELL

**FOLLOW-UP NON-CONTRAST HEAD CT
POST MINIMALLY INVASIVE EVACUATION**

Axial cut through the basal ganglia



6 DAYS

FROM LAST KNOWN WELL

Same Problem, Different Approach

HEMORRHAGE DISCOVERED ON IMAGING

SAME PROBLEM, DIFFERENT APPROACH

38M with multiple vascular risk factors on aspirin

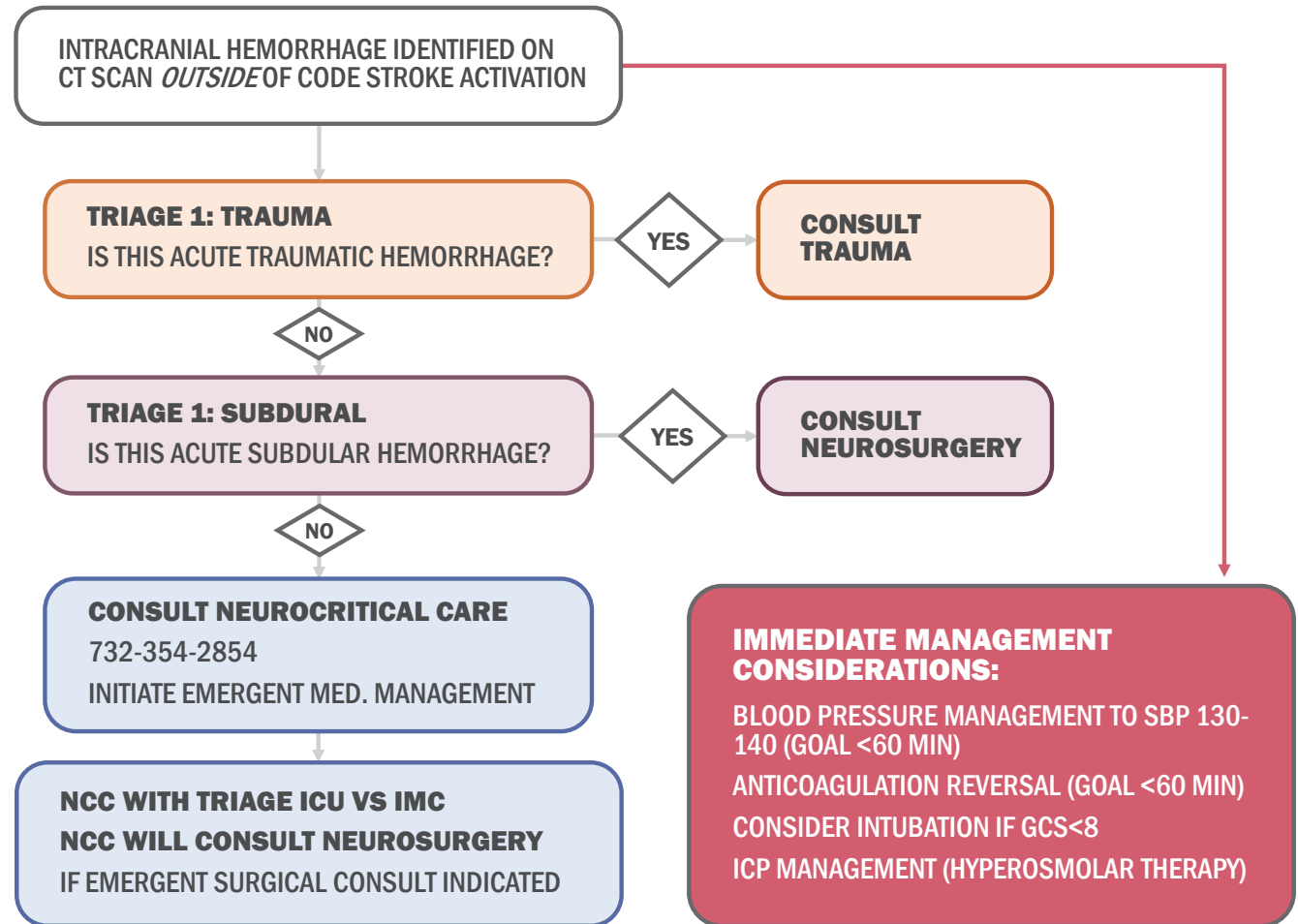
Brought by EMS after witnessed bilateral clonic activity.

Waking up, but still lethargic with headache.

Exam is limited by poor cooperation.

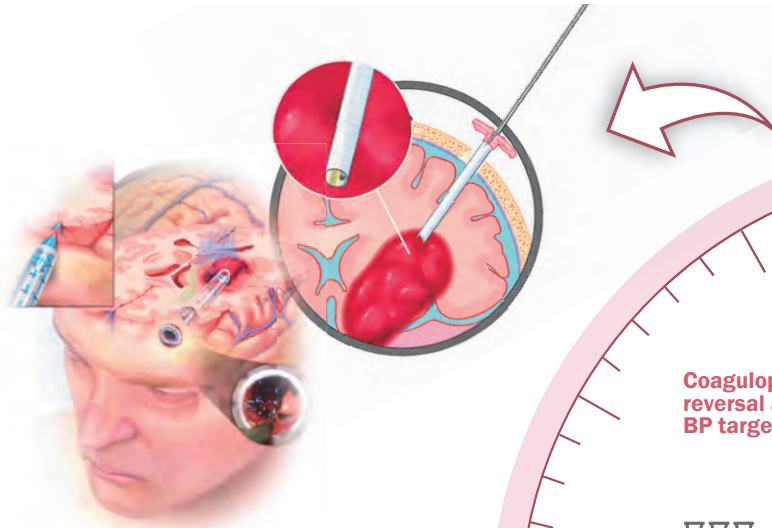
**ICH IS DISCOVERED ON IMAGING.
WHAT IS THE DIFFERENCE IN
MANAGEMENT?**

NON-CODE STROKE INTRACRANIAL HEMORRHAGE CONSULT PATHWAY



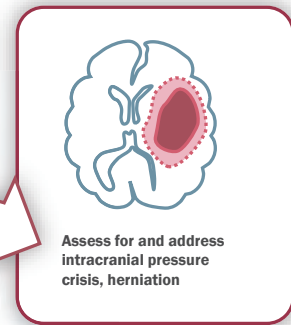
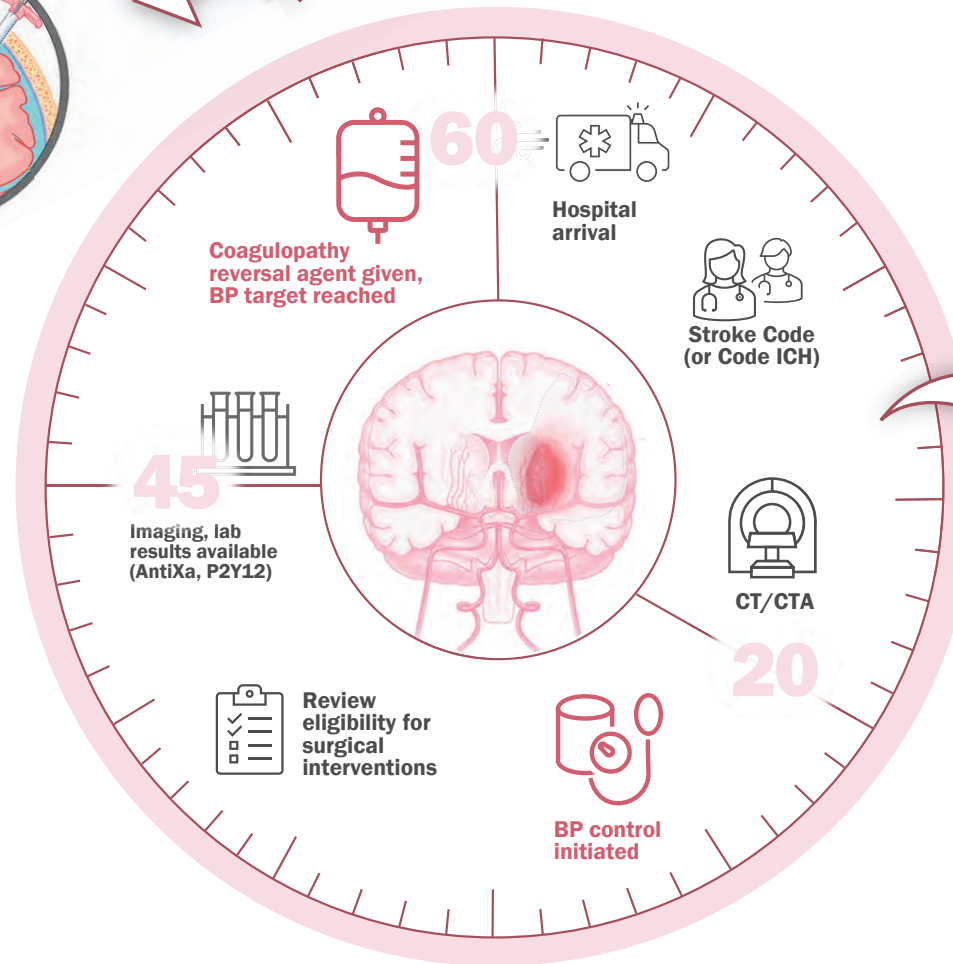
Summary

THE 10% OF THIS TALK YOU SHOULD REMEMBER



WITHIN 24 HOURS IN
ELIGIBLE PATIENTS

FIRST HOUR

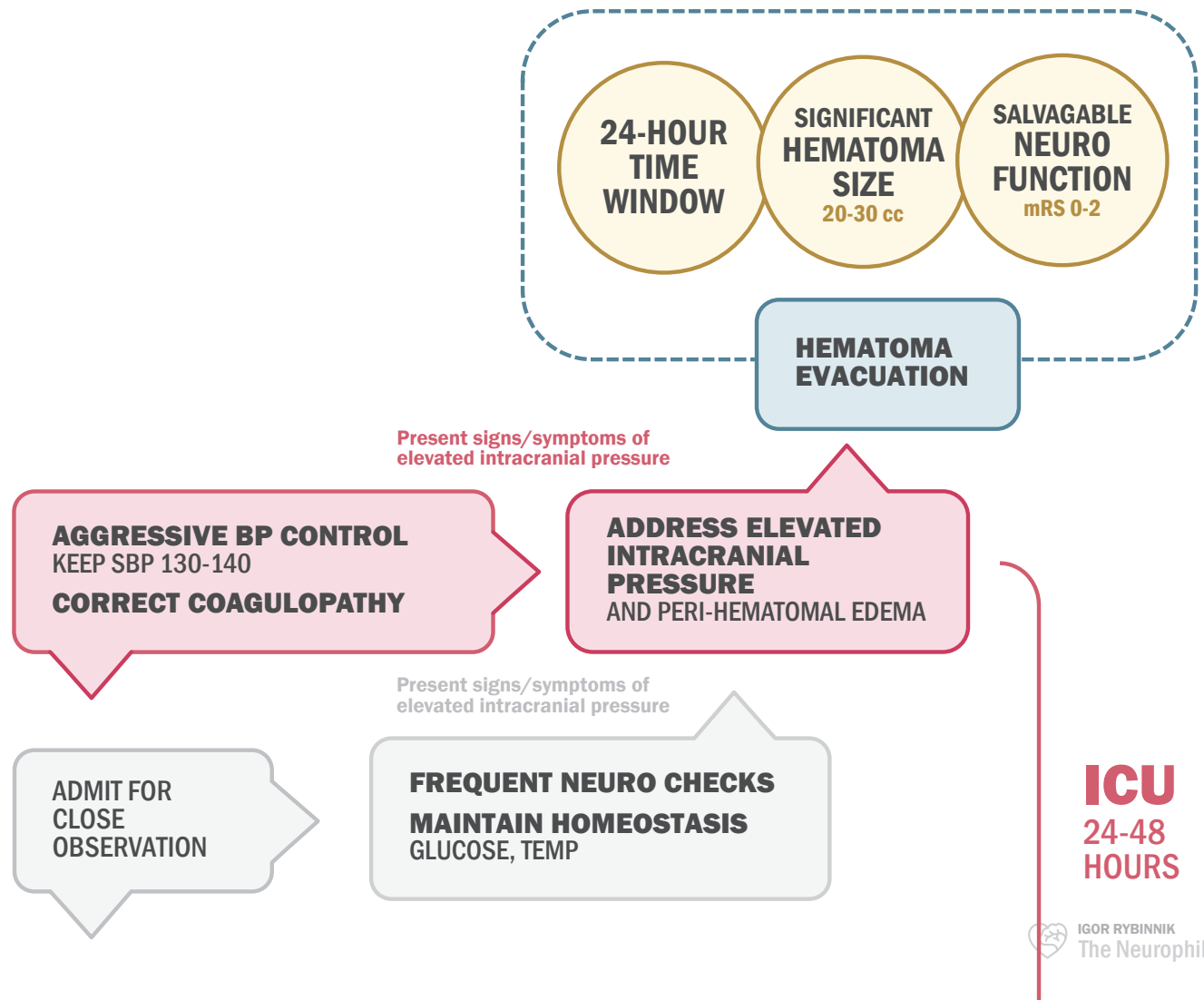


+1.4 cc
EVERY 5 MINUTES

Adapted from Bowry et al,
Stroke 2022;53(7):2352-2360

THE NEXT 24-72H

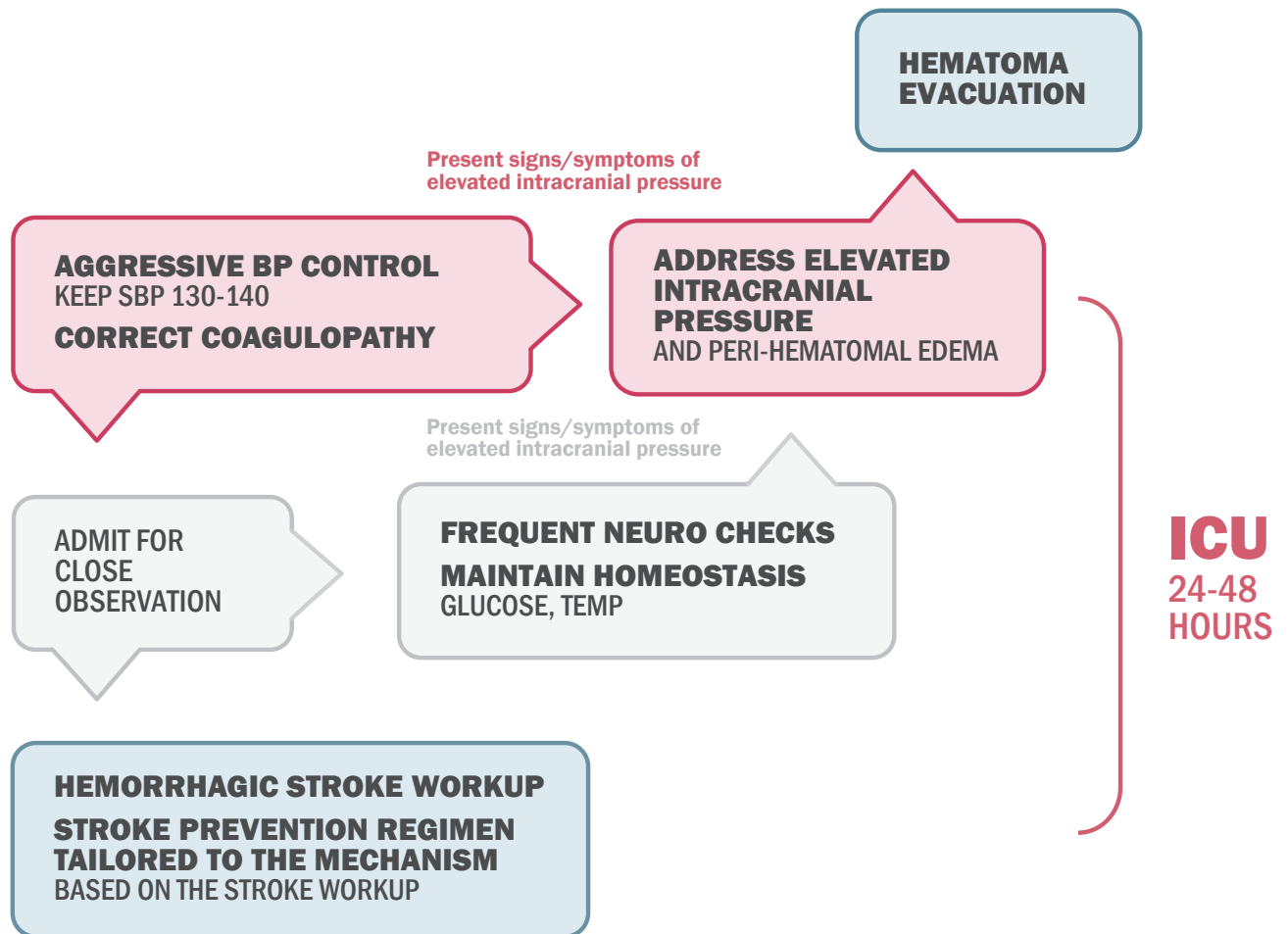
2 PREVENT HEMATOMA EXPANSION AND SECONDARY INJURY

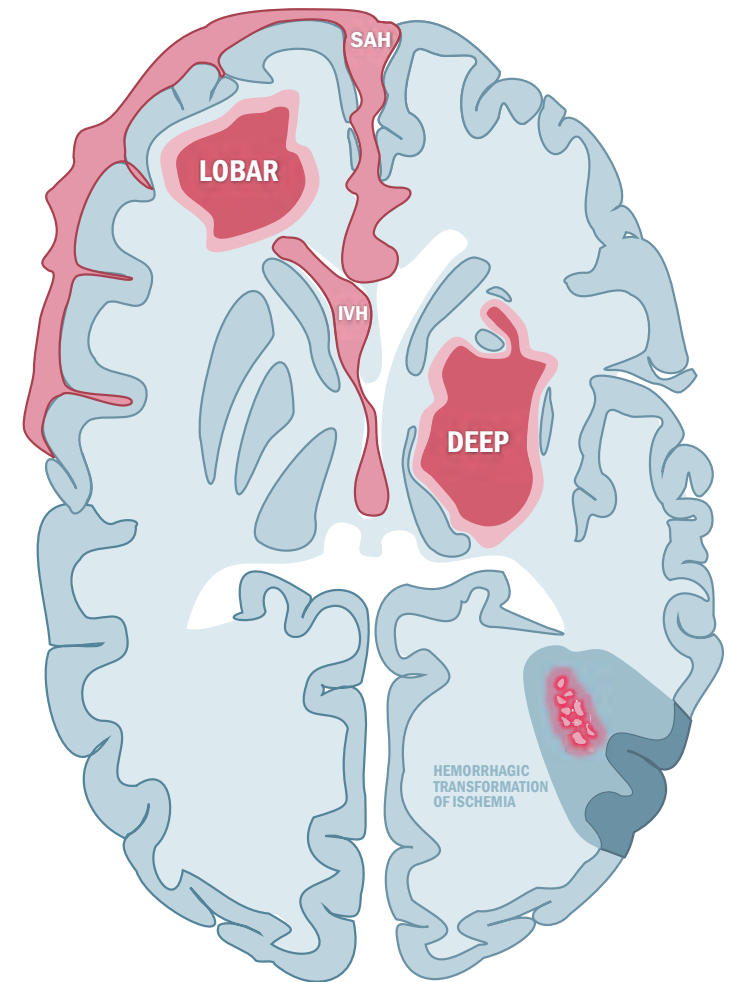
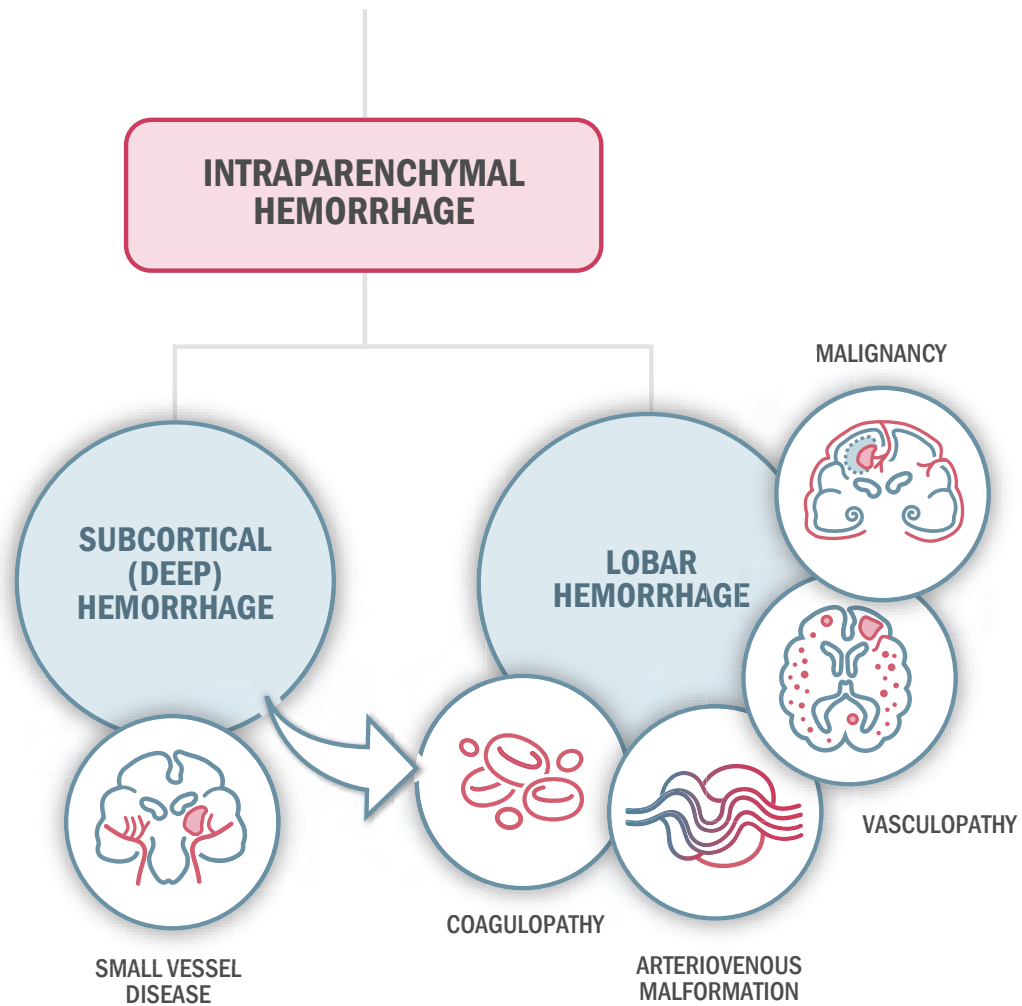


2 PREVENT HEMATOMA EXPANSION AND SECONDARY INJURY



3 PREVENT RECURRENCE





Thank you

