This activity is designed for primary care physicians, internal medicine, neurologists, emergency physicians, hospitalists, and other healthcare professionals who care for patients with cerebrovascular disease, desiring an update in these specialty areas.
Cerebrovascular Education Day

General Information

Course Description/Objective
The course objective is to bring together clinicians and experts in diverse areas of cerebrovascular disease management, affording them an environment in which to discuss new clinical developments and advances. Each of the presenters will allow ample time for questions and comments, inviting participants to reflect on the information which has been shared. This advanced professional conference provides information, reviewing the latest advances in cerebrovascular disease as they affect clinical care. The course will explore new insights and provide diagnostic, management and treatment options from a team of experts.

Accreditation
Vassar Brothers Continuing Medical Education is accredited by the Medical Society of the State of New York (MSSNY) to provide Continuing Medical Education for physicians.

AMA Credit Designation
Vassar Brothers Continuing Medical Education designates this live educational activity for a maximum of 8.00 AMA PRA Category 1 Credit(s)™. Physicians should claim only the credit commensurate with the extent of their participation in the activity. Physicians should only claim credit as faculty for presentations that are original and presented for the first time.

Nursing Accreditation
Contact Hours
8.00 CME = 8.00 contact hours
http://www.nursecredentialing.org/RenewalRequirements.aspx
This event will offer a total of 8.00 Contact Hours.

AAPA Accreditation
AAPA accepts certificates of participation for educational activities certified for Category 1 from AOACCME, prescribed credit from AAFP, and AMA/PRA Category 1 Credit™ from organizations accredited by ACCME or a recognized state medical society. Physician Assistants may receive a maximum 8.00 of Category 1 credit for completing this program.

Physical Therapy Accreditation
Vassar Brothers Medical Center is recognized by the New York State Education Departments State Board for Physical Therapy as an approved provider of physical therapy and physical therapist assistant continuing education. This activity has been approved for 8 hours.

Americans With Disabilities Act
We encourage participation by all individuals. If you have a disability, advance notification of any special needs will help us to better serve you. Please notify us of your needs in advance of the program. Thank you.

Acknowledgements

Special Thanks To:
Alison Nohara, MD, Education Director for Cerebrovascular Education Day
Michelle Palumbo, CME Director, Vassar Brothers Medical Center
Kim Brown, RN, Stroke Coordinator

Disclosure
In accordance with the disclosure policies of Vassar Brothers CME, the effort is made to ensure balance, independence, objectivity and scientific rigor in all educational activities. These policies include resolving all conflicts of interest between faculty and commercial interests that might otherwise compromise the goal and educational integrity of this activity. All faculty members participating in this activity have disclosed all significant relationships – financial or otherwise – with the manufacturers or providers of products or services mentioned in the activity. The planners of this activity have reviewed these disclosures and have determined that the faculty relationships are not inappropriate in the context of their respective presentations and are consistent with the educational goals and integrity of the activity.

Thus far the planners and faculty participants do not have any financial arrangements or affiliations with any commercial entities whose products, research or services may be discussed in these materials.

No commercial funding has been accepted for the activity.

Upcoming CME Conferences

Oncology Teaching Day
Wednesday, February 25, 2015
12:30PM-5:30PM
The Culinary Institute of America, Hyde Park, NY

Pulmonary & Critical Care Medicine Conference
Friday, April 17, 2015
7:30AM-4:00PM
The Grandview, Poughkeepsie, NY

3rd Annual Hospital Medicine Conference
Friday, April 24, 2015
7:00AM-4:00PM
The Grandview, Poughkeepsie, NY

2015 Urology Teaching Day
Thursday, April 30, 2015
2:00PM-6:30PM
Villa Borghese, Wappingers Falls, NY

Go to http://vbmc.libguides.com/cme for more information.
Cerebrovascular Education Day

Schedule

7:00am—7:30am— Registration

7:30am—8:30am— Welcome & Opening Remarks/Case Presentations
—Samuel Koszer, MD - Medical Director, Stroke

8:30am—10:15am— Neuroanatomy & Physiology
—Linda R. Littlejohns, MSN, RN, FAAN - Neuroscience and Leadership Consultant

10:15am—10:30am— BREAK

10:30am—12:00pm— Introduction to Neurointerventional Surgery
—Alison Nohara, MD – Medical Director, Neurointerventional Surgery

12:00pm—12:45pm— LUNCH

12:45pm—2:00pm— Neuro Assessment
—Linda R. Littlejohns, MSN, RN, FAAN - Neuroscience and Leadership Consultant

2:00pm—3:00pm— Hemodynamic Management of the Neurological Patient
—Michelle Ross-King, MD - Intensivist

3:00pm—3:15pm— BREAK

3:15pm—4:15pm— Post Operative Neurosurgical Management of Stroke
—Jack McNulty, MD - Medical Director, Neurosciences

4:15pm—4:30pm— Closing Remarks
—Alison Nohara, MD - Medical Director, Neurointerventional Surgery
Cerebrovascular Education Day

Faculty

Education Director

Alison Nohara, MD
Medical Director,
Neurointerventional Surgery
Health Quest

Presenters

Linda R. Littlejohns, RN, MSN, FAAN
Neuroscience and Leadership Consultant

John McNulty, MD
Medical Director, Neurosciences
Vassar Brothers Medical Center

Samuel Koszer, MD
Medical Director, Stroke
Vassar Brothers Medical Center

Michelle Ross-King, MD
Intensivist
Vassar Brothers Medical Center
Welcome & Opening Remarks
Case Presentations

Samuel Koszer, MD
Medical Director, Stroke
Vassar Brothers Medical Center
Cerebrovascular Education Day

Neuroanatomy & Physiology

Linda R. Littlejohns, MSN, RN, FAAN
Neuroscience & Leadership Consultant

Due to copyright, Linda Littlejohns’ slide notes are not available in the online syllabus.
Introduction to Neurointerventional Surgery

Alison Nohara, MD
Medical Director, Neurointerventional Surgery
Health Quest
Introduction to NeuroInterventional Surgery 2015

Dr. Alison Nohara
Director of NeuroInterventional Surgery
Vassar Brothers Medical Center

Types of Stroke

- Embolic
- Ischemic Stroke: 83%
- Intracerebral Hemorrhage: 10%
- Subarachnoid Hemorrhage: 7%
- Small-Vessel Thrombotic: 31%
- Large-Vessel Thrombotic: 20%

Subarachnoid Hemorrhage Overview

- Spontaneous subarachnoid hemorrhage causes:
  - Trauma – most common cause of SAH
  - Intracranial aneurysm
    - 77-85% of non-traumatic SAH.
      - Types: saccular, mycotic & fusiform
  - Vascular malformations of brain & spinal cord
  - Blood dyscrasias
  - Less common causes: tumors, infection, and vasculopathies.

Subarachnoid Hemorrhage Overview

- Prevalence of cerebral aneurysms: 0.2-9.9%
  - Suggesting 10-15 million people in the United States have intracranial aneurysms
  - Autopsy prevalence of aneurysm: 1%
- Annual rupture rate 6-16 per 100,000 / year
- 10-30% die before reaching the hospital
- Risk of SAH increases with age and peaks at 50 years

Surgical Treatment

- Walter Dandy 1938 performed first surgical clipping
- Delayed (traditional) surgical clipping
  - If a patient survived 10 days post bleeding, then surgery would be performed
  - Patient is taken immediately or soon after stabilization to surgery

Endovascular Treatment

- Serbinenko – 1974
  - Detachable balloons for vessel occlusion
- Hieshima and Higashida - 1980’s
  - detachable fibered coils
- Guglielmi (UCLA) -1990
  - Guglielmi detachable coils
International Subarachnoid Aneurysm Trial – (ISAT)

• Conclusion: In patients with ruptured intracranial aneurysm suitable for both treatments, endovascular coiling is more likely to result in independent survival at 1 year than neurosurgical clipping; the survival benefit continues for at least 7 years. The risk of late rebleeding is low, but is more common after endovascular coiling than after neurosurgical clipping.

- Lancet 2002; 360(9342) 1267-1274
- Lancet 2005; Sep 3-9;366(9488) 809-17

Subarachnoid Hemorrhage Signs & Symptoms

• Headache: sudden onset and very severe
• Meningeal signs
• A warning leak may occur in up to 50% of the patients several days or weeks prior to the hemorrhage.

Subarachnoid Hemorrhage Diagnosis

• CT head without contrast detects 80-90% of the SAH in first 24 hours.
• The longer the interval between onset of symptom and scan, less likely CT will show the bleed.
• If the history is convincing but CT head negative, consider LP.
• MRI may be more sensitive in detecting SAH for onset > 4 days ago.
### Classification of SAH and plan for treatment

<table>
<thead>
<tr>
<th>Hunt &amp; Hess</th>
<th>Clinical Presentation</th>
<th>Timing for surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>asymptomatic or mild headache</td>
<td>May benefit from early surgery</td>
</tr>
<tr>
<td>II</td>
<td>headache, stiff neck, no focal deficit other than cranial nerve deficit</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Drowsy, mild focal deficit</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Stupor, hemiparesis</td>
<td>Timing of surgery unclear, with less favorable outcome</td>
</tr>
<tr>
<td>V</td>
<td>Deep coma, decerebration</td>
<td></td>
</tr>
</tbody>
</table>

### Case Presentation - SAH

- 34 year-old female
- Goes to her primary care with stiff neck and headache
- No significant past medical history
- Paternal grandmother died of aneurysm rupture
- Patient recommended to take an aspirin and exercise to reduce stress

### Case Presentation – SAH

- Patient returns to primary care physician’s office two days later stating that exercise was difficult secondary to back and leg stiffness
- Headache unresolved
- Physician orders a CT scan for the following week and reassures the patient nothing is wrong
Case Presentation - SAH

• Patient cannot move, having terrible pain and is unable to attend a family event
• Mother (RN) tells patient to go to her nearest emergency room where CT scan is performed and read as negative

CT Scan

Case Presentation - SAH

• Lumbar puncture is performed and positive for blood in all four tubes
• Patient is transferred for full evaluation
**Angiogram - Pre**

- Aneurysm
- Aneurysm with extravasation

**Angiogram - Post**

- Post AP
- Post Oblique

**Outcome**

- Stayed in the hospital 7 days
- No vasospasm
- Celebrated her birthday
- Went home without further problem
- Angiogram performed at 6 months showed no residual aneurysm
Unruptured Intracranial Aneurysms – Wiebers Study

- Conclusions:
  - Incidental non-ruptured aneurysm rupture rates depend on size, location, morphology and rate of change (when under servalence)
  - Anterior circulation
    - Size >7mm (5 year risk of rupture 2-6%)
  - Posterior circulation
    - Less than 7mm (5 year risk of rupture 2-5%)
    - Includes posterior communicating artery aneurysms
  - Lancet 2003; 362(9378): 103-110

Unruptured Intracranial Aneurysms - Overview

- Risk factors for aneurysm rupture:
  - Smoking
  - Increasing age
  - Female gender
  - Black race
  - Familial history
  - Hypertension
  - Alcohol/drug abuse.

Unruptured Intracranial Aneurysms - Symptoms

- Large aneurysms (>1.5cm) – mass effect
  - Cranial nerve palsy
  - Motor deficits
  - Headache
  - Seizures
- Smaller aneurysms
  - Commonly, no symptoms exist
  - Commonly, scans are performed for other reasons (i.e. headache)
Unruptured Intracranial Aneurysms - Diagnosis

• Screening for incidental aneurysms
  – CTA vs MRA
    • CTA good image quality if facility is facile at the study but uses radiation and contrast
    • MRA image quality not as good, but less user dependent and uses no radiation or contrast

Treatment Options

• Nothing (Servanlence)
• Surgical Clipping
• Endovascular Coiling

Case Presentation

• 36 year-old female
• Family history: mother and maternal grandfather died from ruptured intracranial aneurysms
• Headaches
• Mild hypertension
• Smoker
**Outcome**

- Patient spent 2 days in the hospital
- Back to work two weeks later
- Angiographic follow up performed at one and two years post-procedure

---

**Types of Stroke**

Greater than 80% of stroke is ischemic in nature

- Ischemic Stroke 83%
- Embolic
- Intracerebral Hemorrhage 10%
- Subarachnoid Hemorrhage 7%
- Hemorrhagic Stroke 17%
- Large-Vessel Thrombotic 31%
- Small-Vessel Thrombotic 20%


---

**Epidemiology of Ischemic Stroke**

- Incidence: 550,000 cases per year
- 158,061 of all 2,312,180 deaths in the U.S.
  - 60.2 deaths per 100,000 annually
  - 1:15 Americans
- 3.5 million stroke survivors in the U.S.
  - 1 million Americans >15 years old had disability secondary to stroke
Morbidity Rates

- Survivors of stroke
  - 31% need help caring for themselves
  - 20% need help walking
  - 71% have impaired vocational capacity

Thrombus

ECASS I – European Trial of rt-PA

Conclusion: Intravenous thrombolysis in acute ischemic stroke is effective in improving some functional measures and neurologic outcome in a defined subgroup of stroke patients who present with moderate to severe neurologic deficit.

*JAMA 1996; 274: 1017-1025*
PROACT Studies

Conclusion: Intra-arterial local rpro-UK infusion was associated with superior recanalization in acute thrombotic/thromboembolic stroke compared to placebo.

*Stroke 1998;29:4-11*

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PROACT Studies

Conclusion: Despite an increased frequency of early symptomatic intracranial hemorrhage, treatment with IA r-proUK with 6 hours of onset of acute ischemic stroke caused by MCA occlusion significantly improved clinical outcome at 90 days.

*JAMA 1999;282:2003-2011*

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Multi-Merci Trial Conclusions

- Mechanical thrombectomy of acute intracranial ICA occlusion using Merci with or without adjunctive endovascular therapy has a high rate of successful vessel revascularization.
- Successful ICA recanalization have improved poststroke outcome and survival compared with subjects in which the ICA is not successfully recanlized.

*Stroke 2008;39:1205-1212*
ECASS III – Stroke Treatment with Alteplase given at 3.0-4.5 hours

Conclusion: Results support the use of alteplase up to 4.5 hours after the onset of stroke symptoms across a broad range of subgroups of patients.

- *The Lancet: October 21, 2009*

IMS-III: Interventional Management of Stroke

Conclusion: The IMS III Trial failed to demonstrate a difference in functional independence as measured by the mRS but showed similar safety with IV t-PA followed by endovascular therapy as compared to IV t-PA alone.

*International Stroke Conference February 2012*
A Randomized Trial of Intra-arterial Treatment for Acute Ischemic Stroke
(MR CLEAN)

CONCLUSIONS

• In patients with acute ischemic stroke caused by a proximal intracranial occlusion of the anterior circulation, intraarterial treatment administered within 6 hours after stroke onset was effective and safe.

*New England Journal of Medicine 2015; 372:11-20*
Causes of Ischemic Stroke

- Large Vessel – artery to artery or slow flow
- Cardioembolic
- Cryptogenic – small vessel ischemia

Large Vessel disease
Intracranial Stenosis with Clot

- Patient History
  - 47 year-old man presenting with dysconjugate gaze, dizziness, hoarseness and left-sided numbness and right-sided weakness
  - Patient given IV-TPA
  - Continued to deteriorate, with loss of ability to speak and somnolence

Initial CT and CTA

![CT Image](image1)
![CTA Image](image2)
Final Angiogram

Large Vessel Occlusion  
Carotid Stenosis

- Patient History:
  - 74 year-old woman with stuttering symptoms of word-finding difficulty and right-sided weakness.

Initial Angiograms

Right ICA injection  
Right Vertebral Artery Injection
Initial Angiograms

Cervical Left ICA

Intracranial Left ICA

String Sign with ulceration

Final Angiograms

Final Cervical Left ICA

Final Intracranial Left ICA

Causes of Ischemic Stroke

• Large Vessel – artery to artery or slow flow
• Cardioembolic
• Cryptogenic – small vessel ischemia
Cardioembolic Stroke
Atrial Fibrillation

• Patient History
  – 62 year-old woman with acute onset of left sided hemiplegia/flaccidity
  – Known atrial fibrillation
  – CTA shows complete occlusion of the right MCA
  – Transfer from GSH
Final Angiograms

Cardioembolic
Post Aortic Valve embolus

• Patient History:
  – 62 year old man s/p aortic valve replacement that day
  – Witnessed by physician to have acute onset of right hemiparesis
  – Clot in ACA territory hyperdense, consistent with calcification

Angiograms
Balloon Angioplasty

Final Angiograms

Causes of Ischemic Stroke

- Large Vessel – artery to artery or slow flow
- Cardioembolic
- Cryptogenic – small vessel ischemia
Small vessel disease

• 45 year old man presenting with left sided weakness and facial droop
• Diabetes and hypertension
• Initial CT and CTA “normal”

MRI

Acute Diffusion Abnormality (Stroke)

Treatment

• “Best Medical” management
  – Antiplatelet regime
  – Statin medication
  – Permissive hypertension
    • (Target 120-140 mmHg)
Neuroassessment

Linda R. Littlejohns, MSN, RN, FAAN
Neuroscience & Leadership Consultant

Due to copyright, Linda Littlejohns' slide notes are not available in the online syllabus.
Hemodynamic Management of the Neurological Patient

Michelle Ross-King, MD
Intensivist
Vassar Brothers Medical Center
Hemodynamic Management of the Neurological Patient

Dr Michelle Ross-King MD, FCICM

Goals

- Physiology of the Cerebrovascular system
- Differentiate the common presentations
- Discuss the management strategies

Physiology of Cerebrovascular System

- Neurons are dependent on blood flow
- Brain has high metabolic requirement - little ability to store metabolic precursors
- Cerebral Blood Flow (CBF) 50ml/min/100g tissue
  - Glucose
  - Oxygen
Protection

Collateral blood flow
  anterior -70%
  posterior -30%
Bridging circulation -Circle of Willis
Autoregulation

Cerebral Perfusion Pressure

perfusion pressure across the brain
major determinant of CBF

  MAP - Intracranial Pressure (ICP)

Injury

lack of nutrients, O2, glucose

  nutritional
  ischemia  tumor  trauma
  infarction  infection  metabolic
  inflammation
Impaired autoregulation!!!

Reperfusion Injury

WBCs
- impede blood flow
- free radical formation and cytokines
- cell destruction
- vasoconstriction, edema
- damage to penumbra

Injury

CBF
- <50ml/min/100g - slowed EEG
- 15-25ml/min/100g loss of electrical activity
- 10-15ml/min/100g ATP maintained
- <10ml/min/100g loss of ATP (2-3 minutes)

Reduced Oxygen Extraction Fraction (OEF)
Monro-Kellie Doctrine

The cranial vault is incompressible and has a finite volume
blood (10%), CSF(10%), brain (80%)

any increase in volume dramatically increases the pressure, decreasing CBF
Presentations

Diagnosis

CT
Brain WOC angiography
MRI
Lumbar puncture
Four Ps of Acute Stroke

Parenchyma
Pipes
Perfusion
Penumbra


Four Ps of Acute Stroke

Parenchyma → Ischemia vs Hemorrhage
Pipes
Perfusion
Penumbra


Four Ps of Acute Stroke

Parenchyma
Pipes → large arteries or veins involved
Perfusion
Penumbra

Four Ps of Acute Stroke

Parenchyma
Pipes
Perfusion → collaterals, net circulation
Penumbra


Parenchyma
Ischemia(80%)
thrombosis
embolic
Hemorrhage(20%)
subarachnoid
epidural
subdural
intraparenchymal

Management Strategies

KEY CONCEPTS
Airway
Breathing
Circulation
Disability

KEY CONCEPTS
Airway
Breathing
Circulation
Disability
Ischemic Stroke

Ischemic core + penumbra

Two stages

I - autoregulatory vasodilation
II - reduced CBF/increased OEF

Ischemic Stroke

60-80% present with hypertension
unclear if protective response

Clear that extremes of blood pressure range have higher mortality and morbidity

Ischemic Stroke

Hypertension AHA guidelines:
post-thrombolysis BP<185/110
15% reduction in first 24hrs

Hypotension
limited data
SBP<130-150mmHg or neurologic decline below demonstrated threshold
Ischemic Stroke

Vasopressors
unclear benefits of individual drugs
ALIAS pilot trial
demonstrated safety of albumin in acute ischemic stroke

Palesch, Y. Stroke. 2006;37:2107-2114

Ischemic Stroke

Embolic
atrial fibrillation -controversy anticoagulation and rhythm control

Hemorrhagic Stroke

Subarachnoid Hemorrhage
unsecured AVM
unsecured AVM post-SAH
secured AVM post-SAH

Embolic atrial fibrillation -controversy anticoagulation and rhythm control

Subarachnoid Hemorrhage unsecured AVM unsecured AVM post-SAH secured AVM post-SAH
Hemorrhagic Stroke
Subarachnoid Hemorrhage
85% berry aneurysms

Hemorrhagic Stroke
Subarachnoid Hemorrhage
acute hydrocephaly
early rebleeding
cerebral vasospasm
parenchymal hematoma
seizures
medical complications

Hemorrhagic Stroke
SAH medical complications
neurodeficits
hepatic dysfunction
respiratory failure/pneumonia/ARDS
acute (neurogenic) pulmonary edema
Takatsubo’s cardiomyopathy/Acute MI
renal dysfunction
Hemorrhagic Stroke
Subarachnoid Hemorrhage
unsecured AVM
definitive management
endovascular vs NS
maintain normal BP

Hemorrhagic Stroke
Subarachnoid Hemorrhage
unsecured AVM post-SAH
definitive management
avoidance of extremes of BP

Hemorrhagic Stroke
Subarachnoid Hemorrhage
secured AVM post-SAH
prevention of vasospasm
**VASOSPASM**

Etiology is complex
- impaired autoregulation
- imbalance between endothelial messengers
- neuronal cell death
- free radical liberation

MCA velocities >120cm/s (daily TCD)
4-21 days post-bleed

**VASOSPASM Prevention**

Nimodipine

Triple H therapy*
- Hypertension
- Hemodilution
- Hypervolemia

Novel: Mg, statins

**VASOSPASM Prevention**

We cannot fully agree on recommendations!

Broad range of practices in European respondents

Neurocritical Care Society, US Neurointensivists
VASOSPASM Prevention
Nimodipine - clearly of benefit in prophylaxis of vasospasm
Triple H therapy*
  Hypertension
  Hemodilution
  Hypervolemia
Novel: Mg, statins, endothelin antagonists - limited evidence

VASOSPASM Prevention
Triple H therapy*
  Hypertension (phenylephrine/norepi)
    MAP > 100
  Hemodilution
    HCT < 30
  Hypervolemia
    Total Input > 3L (strict avoidance of hypovolemia)

VASOSPASM Treatment
Triple H therapy
Endovascular management
  angioplasty
  vasodilator therapy - papaverine, milrinone, CCB
Hemorrhagic Stroke

Trauma
- goal to maintain normal blood pressure
- avoid hypertension and hypotension
- definitive therapy to evacuate hematoma (if indicated)

Antihypertensive Therapy

Ideal agent
- short-acting
- easily titratable
- metabolized independent of organ function
- positive effect on cerebral vascular bed

Antihypertensive Therapy

ACE-I
Beta-blockers
Calcium channel blockers
- nimodipine
- nicardipine
- hydralazine
- nitrates
Hypertensive Therapy

Vasopressors
- phenylephrine
- norepinephrine

Fluid resuscitation
- Isotonic fluid (LR, plasmalyte, albumin)
- Hypertonic fluid (3% vs 20%)

Summary

Ischemic CVA
- reduce BP progressively
- avoid extremes of BP in first 24 hrs

SAH
- definitive therapy
- post-tx hypertension
- hemodilution
- hypervolemia

Questions?
Post Operative Neurosurgical Management of Stroke

Jack McNulty, MD
Medical Director, Neurosciences
Vassar Brothers Medical Center
Do Not Forget to Fill Out Your Course Evaluation

**CLICK HERE** to access the online evaluation. Please complete at the end of the conference. Your comments help us plan these conferences so that they best suit your needs.

### Online Resources

During the conference, the full digital syllabus will be available on the conference webpage: [http://vbmc.libguides.com/2015stroke](http://vbmc.libguides.com/2015stroke) You can view and take notes on this PDF syllabus on your mobile device through the free Adobe Reader app downloadable at [http://www.adobe.com/products/reader-mobile.html](http://www.adobe.com/products/reader-mobile.html).

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