Objectives

• To become familiar with components of the neurological exam and NIH Stroke Scale
• To understand what stroke severity and prognostic data can be derived by the NIH Stroke Scale
• To understand the rationale of using NIH Stroke Scale score use in acute stroke patient evaluation

Neurological Examination in Acute Stroke Care

• Must be brief → “Time is Brain”
  – Estimated 1.9 million neurons are lost in each minute of ischemia
• Should focus on aspects that are informative and can be predictive of outcome
• Scales developed to be used in trials and clinical practice
  – Reliable, valid
  – Predictive potential
What is the NIHSS and Why Do We Need It?

- Standardized stroke severity scale to describe neurological deficits in acute stroke patients
- Allows us to:
  - Quantify our clinical exam
  - Determine if the patients’ neurological status is improving or deteriorating
  - Provide for standardization
  - Communicate patient status

Elements of the NIH Stroke Scale

- 11 item scoring system
- Integrates components of neurological exam
- Includes testing of:
  - level of consciousness (LOC),
  - select cranial nerves,
  - motor,
  - sensory,
  - cerebellar function,
  - language, and
  - inattention (neglect)
- Maximum score: 42, minimum score: 0
  - However, a patient correctly scored would not be able to score a 41 or 42
- Not a linear scale

Comparing the Neurological Examination to the NIHSS

- Neurological Examination
- Mental status and cognitive function
- Cranial nerves
- Motor system
- Sensory function
- Cerebellar system (coordination and gait)
- Reflexes
- NIHSS
- LOC
- Best gaze
- Visual field testing
- Facial paresis
- Arm & leg motor function
- Limb ataxia
- Sensory
- Best language
- Dysarthria
- Extinction & inattention
NIHSS -- Guiding Principles

• The most reproducible response is generally the first response
• Do not coach patients unless specified in the instructions
• Some items are scored only if definitely present
• Record what the patient does, not what you think the patient can do

Possible Points: Summary

• LOC 7
• Cranial Nerves (Portions of CN II,III,V,VI, VII) 8
• Motor 8x2 = 16
• Ariaux 2
• Sensory 2
• Language 5
• Inattention 2
• NIHSS total 42

• Scores of 41 and 42 are improbable to obtain in a living patient that is correctly scored

NIHSS and Patient Outcomes

• Total scores range from 0-42 with higher values representing more severe infarcts
  – >25 Very severe neurological impairment
  – 15-24 Severe impairment
  – 5-14 Moderately severe impairment
  – <5 Mild impairment
• A 2-point (or greater) increase on the NIHSS administered serially indicates stroke progression.
  – It is advisable to report this increase.
NIH Stroke Scale and Outcome at 7 days

Probability of an excellent or good outcome at 7 days and 3 months as influenced by the baseline NIHSS

Acute ischemic stroke 30-day mortality rates by NIHSS
NIHSS and Patient Outcomes

- Initial score of 7 was found to be important cut-off point
  - NIHSS >7 demonstrated a worsening rate of 65.9%.
  - NIHSS <7 demonstrated a worsening rate of 14.8% and were almost twice (1.9x) as likely to be functionally normal at 48 hours (45%).
  - (DeGraba et al., 1999)
- NIHSS <5 most strongly associated with D/C home
- NIHSS 6-13 most strongly associated with D/C to rehab
- NIHSS >13 most strongly associated with D/C to nursing facility
  - (Schlegel et al., 2003)

Our Experience

- All stroke admissions from January 2008 to April 2012 were evaluated for presence of an admission NIHSS and documented eventual discharge disposition
  - 2191 previously abstracted patient records were available
  - 1070 admission NIHSS were documented (48.8%)
- In stroke patients in which an admission NIHSS was documented, the NIHSS predicted the following:
  - 0-5 predicted usually an eventual discharge home
  - 6-15 predicted a higher proportion placed in an inpatient rehabilitation facility (IRF)
  - >15 predicted a higher proportion placed in either a skilled nursing facility (SNF) or long term care hospital
  - >25 predicted either eventual in-hospital mortality or hospice placement

NIHSS 0-5 Disposition

- HOME OR HHC: 71%
- REHAB: 20%
- SNF OR LTVH: 3%
- EXPIRED OR HOSPICE: 1%
Using the NIH Stroke Scale

Dion F. Graybeal, MD

NIHSS 6-15 Disposition

NIHSS > 15 Disposition

NIHSS > 25 Disposition
NIHSS and Patient Outcomes

• Likelihood of intracranial hemorrhage:
  – NIHSS > 20 = 17% likelihood
  – NIHSS < 20 = 3% likelihood
  • (Adams et al., 2003)

Caveats of the NIH Stroke Scale

• Weighted toward language
  – Right hemisphere stroke typically 5 points lower than left hemisphere stroke
• Neurological deficits from pre-morbid conditions are scored as abnormalities at the time of examination
  – ex. pre-morbid blindness, paraplegia

NIH Stroke Scale and rt-PA Use in Acute Ischemic Stroke Patients

• Gladstone et al.
  – NINDS rt-PA trial data showed milder strokes in rt-PA group
  – Excluded extreme values of NIHSS (0 - 5 and > 20)
  – Benefit still seen in moderate to severe strokes
    • 16.6% absolute benefit (AB) NIHSS 6 - 10
    • 10.4% AB NIHSS 11 - 20

Gladstone et al. CMAJ. 2002;166:1652
NIH Stroke Scale and rt-PA Use in Acute Ischemic Stroke Patients

- NINDS re-analysis (NIHSS-adjusted)
  - Tertiles of initial NIH Stroke Scale score
    - NIHSS 1 - 7, 8 - 14, > 14
  - Sliding-scale dichotomy endpoint analysis
  - Outcome: modified Rankin Scale (mRS) score

Saver et al. Stroke. 2007;38:414

NIH Stroke Scale and rt-PA Use in Minor Acute Ischemic Stroke

- Low NIHSS score seen with certain disabling neurological deficits
  - Isolated aphasia, muteness, pure motor deficit of dominant side
- Benefit with rt-PA use in NIHSS ≤ 9
- Symptomatic hemorrhage rate 3% (vs. 6.4%)
Conclusions

• Neurological exam of acute stroke patients must be simple and focused
• NIH Stroke Scale score is a validated neurological exam score with predictive value for stroke outcome
• rt-PA beneficial with mild → moderately severe acute ischemic stroke

NIH Stroke Scale Online Resources

• NIH Stroke Scale training:
  • http://www.nihstrokescale.org/
  • http://learn.heart.org/
• NIH Stroke Scale booklet:
  • http://www.ninds.nih.gov/doctors/NIH_Stroke_Scale_Booklet.pdf

WHAT TOOK YOU A LIFETIME TO LEARN CAN BE LOST IN MINUTES.
Update on Flow Diversion

David Kallmes, MD
Professor of Radiology and Neurosurgery
Mayo Clinic
Rochester, MN

Pipeline Embolization Device

- Flexible mesh-like device
- Bimetallic self expanding braid
  - 25% platinum tungsten
  - 75% cobalt chromium
- 48 interwoven strands
- 30%-35% surface coverage
Aneurysms: Update on Flow Diversion

David F. Kallmes, MD
### Covidien/Medtronic Pipeline Studies

<table>
<thead>
<tr>
<th>Study Type</th>
<th>PUFs</th>
<th>IntRePED</th>
<th>ASPIRe</th>
<th>PREMIER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of treated patients</td>
<td>107</td>
<td>793</td>
<td>191</td>
<td>141 (planned)</td>
</tr>
<tr>
<td>Number of sites</td>
<td>10</td>
<td>17</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Follow-up duration</td>
<td>5 years</td>
<td>~3 years per standard of care</td>
<td>~2 years per standard of care</td>
<td>3 years</td>
</tr>
<tr>
<td>Status</td>
<td>Completed</td>
<td>Completed</td>
<td>Completed</td>
<td>Enrolling</td>
</tr>
</tbody>
</table>

#### PUFs – 180 Day Outcomes

**Primary Endpoint Result**

- **Complete Aneurysm Occlusion**: 73.6% (78/106)
- **Major Ipsilateral Stroke or Neurologic Death**: 5.6% (6/107)

> - Basis for Pipeline PMA approval in April 2011 -

**Indications**: The Pipeline® Embolization Device (PED) is indicated for the endovascular treatment of adults (22 years of age or older) with large or giant wide-necked intracranial aneurysms (1a) in the internal carotid artery from the petrous to the superior hypophyseal segments.

#### PUFs – 5-Year Outcomes

**Post-approval study was condition of PMA approval**

- **Occlusion Rate**
  - 180 Day: 79.8%
  - 1 Year: 94.6%
  - 3 Years: 95.9%
  - 5 Years: 95.7%

- **Major Ipsilateral Stroke or Neurologic Death**
  - 180 Day: 0%
  - 1 Year: 0%
  - 3 Years: 0%
  - 5 Years: 0.6%

> Complete occlusion  Residual neck  Residual aneurysm.
IntrePED – Study Design

- **Design**: Retrospective multi-center, global post-market registry
- **Patient Population**: All consecutive patients from time of commercial device approval
- **Aneurysm Type & Target Vessel**: Data collection was performed on all-comers (including ruptured aneurysms)
- **Number Subjects**: 793 patients (906 aneurysms)
- **Sites**: 17 centers (12 US and 5 OUS)
- **Follow-up**: Per standard of care
- **Primary Safety Endpoint**: Spontaneous rupture, ipsilateral intracranial hemorrhage, ischemic stroke, parent artery stenosis, permanent cranial neuropathy


ASPIRe – Study Design

- **Design**: Prospective multi-center, global post-market registry
- **Aneurysm Type & Target Vessel**: Unruptured IA treated with Pipeline per the instructions of use approved for the country in which the patient was treated
- **Number Subjects**: 191 patients (207 aneurysms)
- **Sites**: 28 centers (20 US and 8 OUS)
- **Follow-up**: Per standard of care
- **Primary Safety Endpoint**: Spontaneous rupture, intracranial hemorrhage, ischemic stroke, parent artery stenosis, permanent cranial neuropathy


Outcome Summary – Safety

<table>
<thead>
<tr>
<th>Major Complications</th>
<th>PUF (n=177)</th>
<th>IntrePED (n=793)</th>
<th>ASPIRE (n=191)</th>
<th>Total (n=1091)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ipsilateral Ischemic Stroke</td>
<td>2.8%</td>
<td>4.3%</td>
<td>1.0%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Ipsilateral Intracranial Hemorrhage</td>
<td>1.9%</td>
<td>2.0%</td>
<td>3.0%</td>
<td>2.2%</td>
</tr>
<tr>
<td>Aneurysm Rupture</td>
<td>0.5%</td>
<td>0.6%</td>
<td>1.0%</td>
<td></td>
</tr>
<tr>
<td>Major Morbidity &amp; Neurological Mortality</td>
<td>5.6%</td>
<td>7.9%</td>
<td>5.8%</td>
<td>7.5%</td>
</tr>
</tbody>
</table>

Safety outcomes are similar across studies
IntrePED Subset Analyses

<table>
<thead>
<tr>
<th>Major Complication</th>
<th>ICA ≥ 10mm (n=296)</th>
<th>ICA &lt; 10mm (n=291)</th>
<th>Posterior (n=90)</th>
<th>Other Anterior (n=112)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Aneurysm Size</td>
<td>16.8 ± 6.3</td>
<td>5.3 ± 2.9</td>
<td>14.2 ± 8.5</td>
<td>9.7 ± 8.5</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Ipsilateral Ischemic Stroke</td>
<td>5.4%</td>
<td>2.4%</td>
<td>6.7%</td>
<td>6.5%</td>
<td>0.1701</td>
</tr>
<tr>
<td>Ipsilateral Intracranial Hemorrhage</td>
<td>2.7%</td>
<td>1.4%</td>
<td>2.2%</td>
<td>5.4%</td>
<td>0.2299</td>
</tr>
<tr>
<td>Aneurysm Rupture</td>
<td>1.4%</td>
<td>0.0%</td>
<td>1.1%</td>
<td>0.0%</td>
<td>0.1657</td>
</tr>
<tr>
<td>Neurological Morbidity &amp; Mortality</td>
<td>9.5%</td>
<td>4.1%</td>
<td>13.3%</td>
<td>13.1%</td>
<td>0.0046</td>
</tr>
</tbody>
</table>

IntrePED subset analyses provided new information on different types of aneurysms.

Outcome Summary

- Significant learning from Pipeline post-market data
- Long-term 5-Year PUFs follow-up are favorable
  - Progressive aneurysm occlusion
  - No delayed safety events
- Post-market registries (>1000 patients) validated PUFs
- Post-market registries collected new data and identified trends
  - Small aneurysms → lower rate of safety events
  - Posterior aneurysms → higher rate of safety events
  - Spontaneous rupture → very rare and only in giant aneurysms

These data and learnings are specific to Pipeline.

Literature Summary – Pipeline M&M

Pipeline outcomes in PUFs, IntrePED and ASPIRe are consistent with the literature.
Literature Summary – Pipeline Occlusion

Pipeline aneurysm occlusion in PUFs is consistent with the literature.

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Complete Aneurysm Occlusion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-6 Months</td>
<td>Ref 1</td>
</tr>
<tr>
<td>7-12 Months</td>
<td>Ref 2, Ref 6</td>
</tr>
<tr>
<td>13-36 Months</td>
<td>Ref 3, Ref 4, Ref 5</td>
</tr>
</tbody>
</table>

What matters most?

- Device sizing?
- Number of devices?
- Proper placement?
- “Diversion” of flow?
- Endothelialization?

1. Actual flow rates in vivo
2. 3D model from Angiography
3. “Virtual” PED deployment and alignment
4. Prediction of Occluded versus Open voxels
region | accuracy | correct/total | range (%)
--- | --- | --- | ---
sac | 84 % | 28854 / 33254 | [82.6, 84.5]
dome | 94 % | 9649 / 10299 | [92.7, 94.0]
body | 92 % | 12232 / 13274 | [91.5, 92.4]
neck | 71 % | 11060 / 15050 | [71.8, 73.9]

model | accuracy | RMS error
--- | --- | ---
logistic regression | 86% | 0.32
neural network | 90% | 0.27
support vector machine | 85% | 0.38
Effect of size matching on flow

4.0mm vessel segment

“Isosized”
4mm PED

Slight oversize
4.5mm PED

More oversized
5mm PED

Particle Image Velocitometry (PIV)

Device sizing (4mm vessel)

Poor wall apposition
4.5mm

5mm

4mm

No PED
PIV study of wall apposition

Poor wall apposition vs Good wall apposition

4mm vessel, 4.5mm PED

Patent aneurysm
Conclusions

- Flow diverters highly efficacious, even in giant aneurysms
- Some complications, including distant hemorrhages, must be better explained
- Proper sizing and good wall apposition essential
- Complete endothelialization is necessary for final closure of the aneurysm
Stroke: Trials and TRIUMPHS!!!!

David F. Kallmes, MD
Professor of Radiology and Neurosurgery
Mayo Clinic, Rochester, MN

Outline

• Brief overview of recent acute stroke intervention trials: Major findings
• Patient selection with focus on imaging
• Device and type of sedation
• Benefit of high volume centers

Old vs new

<table>
<thead>
<tr>
<th>Trial</th>
<th>Good Outcome^ EVT, %</th>
<th>Good Outcome^ Control, %</th>
<th>Absolute Difference, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMS III</td>
<td>40.8</td>
<td>38.7</td>
<td>2.1</td>
</tr>
<tr>
<td>SYNTHESIS</td>
<td>42.0</td>
<td>46.4</td>
<td>-4.4</td>
</tr>
<tr>
<td>MR RESCUE</td>
<td>18.8</td>
<td>20.4</td>
<td>-1.6</td>
</tr>
<tr>
<td>MR CLEAN</td>
<td>32.6</td>
<td>19.1</td>
<td>13.5</td>
</tr>
<tr>
<td>ESCAPE</td>
<td>53.0</td>
<td>29.3</td>
<td>23.7</td>
</tr>
<tr>
<td>EXTEND IA</td>
<td>71.4</td>
<td>40.0</td>
<td>31.4</td>
</tr>
<tr>
<td>SWIFT PRIME</td>
<td>60.2</td>
<td>35.5</td>
<td>24.7</td>
</tr>
</tbody>
</table>

Pierrot and Dardennes, Stroke, 2015
Overall findings

• Study design
  – RCTs
  – ivTPA vs thrombectomy (5/6 stentriever)
  – mRS 0-2 at 90 days primary or secondary outcome

• Conclusions
  – 5/5 Stentriever trials showed benefit of thrombectomy over ivTPA
    • Odd ratio for good outcome 1.7-2.7 across studies, all highly statistically significant
    • Aspiration trial (THERAPY) showed no difference compared to ivTPA

Overview

What else can we learn from these trials?

• Patient selection
  – Subgroup analysis
  – Imaging paradigm

• Treatment
  – Device choice
  – Anesthesia type
Subgroups

REVA/SCAT Trial

ESCAPE Trial

Patient selection: Imaging

• Non-contrast CT: ALL studies
  – ASPECTS >6 in 3 trials

Menon, et al., Radiology, 2015
**Does imaging predict treatment outcome?**

- MR CLEAN
- ESCAPE
- SWIFT-PRIME
- EXTEND-IA

**Does it matter?**

- SICH low in both groups
- Why not revascularize?

**Impact of reperfusion rates**

Time matters


GA vs conscious sedation

GA vs conscious sedation


Propensity-matching


Stroke: Trials and Triumphs

David F. Kallmes, MD
Type of anesthesia: MR CLEAN

van den Berg, et al., Stroke 2015;46:1257-1262

CS vs GA: Mechanism?

<table>
<thead>
<tr>
<th>Hemodynamic Parameters</th>
<th>CS (n=61)</th>
<th>GA (n=38)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum SBP (mmHg)</td>
<td>165 (25)</td>
<td>154 (24)</td>
<td>0.02</td>
</tr>
<tr>
<td>Minimum SBP (mmHg)</td>
<td>119 (26)</td>
<td>94 (16)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Maximum Variability SBP</td>
<td>46 (26)</td>
<td>60 (26)</td>
<td>0.002</td>
</tr>
<tr>
<td>Maximum DBP (mmHg)</td>
<td>88 (26)</td>
<td>91 (22)</td>
<td>0.07</td>
</tr>
<tr>
<td>Minimum DBP (mmHg)</td>
<td>63 (14)</td>
<td>50 (12)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Maximum Variability DBP</td>
<td>35 (18)</td>
<td>41 (19)</td>
<td>0.08</td>
</tr>
<tr>
<td>Maximum MAP (mmHg)</td>
<td>111 (27)</td>
<td>109 (18)</td>
<td>0.1</td>
</tr>
<tr>
<td>Minimum MAP (mmHg)</td>
<td>70 (14)</td>
<td>62 (13)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Maximum Variability MAP</td>
<td>32 (16)</td>
<td>43 (19)</td>
<td>0.03</td>
</tr>
<tr>
<td>Maximum HR (beats/min)</td>
<td>93 (19)</td>
<td>95 (25)</td>
<td>0.8</td>
</tr>
<tr>
<td>Minimum HR (beats/min)</td>
<td>79 (14)</td>
<td>64 (15)</td>
<td>0.2</td>
</tr>
<tr>
<td>Maximum Variability HR</td>
<td>24 (15)</td>
<td>30 (21)</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Unpublished data

Center experience: NIS

- Discharge to home/short term facility
  - High volume centers: 28%, (234/848)
  - Low volume centers: 18%, (94/526) (P=0.0001).
- Discharge to long-term facility
  - High volume centers: 49% (413/848)
  - Low volume centers: 58% (304/526) (P=0.0008).
- Mortality rate did not differ by center volume (P=0.89).
- Multivariate analysis
  - High volume centers had significantly increased odds of discharge to home/short term facilities compared to those treated at low volume centers (OR=1.80, 95%CI=1.38-2.35, P<.0001).
  - No difference in mortality was seen for patients treated at high versus low-volume centers (OR=0.93, 95%CI=0.73-1.20, P=0.61).

Unpublished data
Take home messages

- IA therapy works
- Hurry
- Closely scrutinize non-contrast CT
- Obtain CTA to identify large vessel occlusion
- Use stent-triever
- Avoid the use of GA
Current Management of Symptomatic Carotid Artery Stenosis

William P. Shutze, MD
Texas Vascular Associates
Baylor University Medical Center
Heart Hospital Baylor Plano

Definition of Stroke

Cessation of blood flow to the brain resulting in ischemia and neurologic deficit

Definition

Transient Ischemic Attack
- Sudden focal neurologic deficit lasting for less than 24 hours, of presumed vascular origin, and confined to an area of the brain or eye perfused by a specific artery
- Brief episode of neurologic dysfunction caused by focal brain or retinal ischemia, with symptoms typically lasting less than an hour, and without evidence of acute infarction

Background

- Stroke is a leading cause of morbidity and mortality worldwide
- Over 750,000 strokes in United States annually
- Estimated costs of $40 billion per year
- Majority are ischemic and involve the anterior circulation

Blood Supply to Brain

- Carotid Arteries
  - Right: common carotid arises from the brachiocephalic trunk, external branches to supply the face and the internal continues intracranially
  - Left: common carotid branches off the aortic arch and continues as above

Blood Supply to Brain

Vertebral Arteries

- First branch of the subclavian artery on both the right and left
- Enters the skull via the foramen magnum and the right and left vertebral arteries join to form the basilar artery
Blood Supply to Brain

CIRCLE OF WILLIS
Directs flow from carotids and vertebrals to anterior, middle and posterior cerebral arteries
Only 20% patients have classic anatomy
Hypoplasia of PCA 25%
Hypoplasia of A1 25% pts

Etiology of Arterial Stroke

- Ischemic (80%)
  - Embolism
  - Decreased perfusion
  - Thrombosis
- Hemorrhagic (20%)
  - Intracerebral
  - Subarachnoid

Stroke Deaths (per 100,000)
- 240-480
- 120-240
- 60-120
- 30-60
- 0-30
- No Data

1 Minute = 1

1 in 6 people will have a stroke in their lifetime.
15 million people experience a stroke each year. 6 million of them do not survive.
Every six seconds someone dies from a stroke, worldwide.
Ischemic Stroke

Embolism

- Myocardial Infarction
- Atrial Fibrillation
- Valvular Disease
- Embolism from Aortic Arch
- Patent Foramen Ovale

Etiology of Ischemic Atherosclerotic Stroke

- Large Artery Atherosclerotic Plaque
- Vasculitis
- Small Artery Occlusion
- Intrinsic Small Artery Disease
Ischemic Stroke
Thrombosis

- Prothrombotic States
  - Antithrombins
  - Protein C & S deficiencies
  - Antiphospholipid antibodies

Risk Factors
Non-Modifiable

- Age
  - Single most important risk factor
- Gender
  - Incidence higher in men, but more women die of stroke secondary to greater longevity
- Race
  - African-Americans twice as likely to die of stroke as whites
- Heredity
- Previous Stroke

Risk Factors
Modifiable

- Hypertension
- Cigarette smoking
- Transient Ischemic Attacks
- Heart Disease
- Diabetes Mellitus
- Hypercoagulopathy
- Carotid stenosis
Risk Factors

Hypertension

- Single most important modifiable risk factor
- RR increased 4 fold by hypertension (SBP>160 and/or DBP>95)
- In summary of 17 treatment trials involving ~50,000 patients, there was a 38% reduction in stroke and 40% reduction in fatal stroke in those treated for hypertension


JAMA 265: 3255, 1991

SHEP (Systolic Hypertension in the Elderly): demonstrated 36% decrease in stroke rate with modest reduction in systolic hypertension

Image: www.myhealthblogs.com

Risk Factors

Heart Disease

ATRIAL FIBRILLATION (AF)

- Most profound cardiac precursor of stroke (6 fold increase, 5%/year stroke rate)
- Over last ten years, 16 randomized trials have investigated the role of warfarin and aspirin for stroke risk reduction

MYOCARDIAL INFARCTION (MI)

- Important complication in acute MI occurring 3-5% of all infarcts (2-6% anterior wall MIs)
- Most strokes occur first weeks after infarct, usually from mural thrombosis
- Consider anti-coagulation (INR 2.5-3.5) for 6 months in those at high risk for embolism

REMEMBER:
Risk of intracranial hemorrhage with coumadin is 1% per year

Image: www.clevelandclinic.org

Diagnosis of Stroke

- Key element in diagnosis is differentiation of ischemic versus hemorrhagic stroke
- Computed tomography or magnetic resonance imaging is required because the differentiation cannot reliably be made with history and physical alone.

Note: spinal tap is only reliable if hemorrhage is into subarachnoid space
Diagnosis of Carotid Disease

Angiography

- Gold Standard
- Risk of stroke is real (1.2% risk)
- Advantages include ability to visualize aortic arch as well as intracranial anatomy
- Digital subtraction angiography used as standard means of evaluating stenosis in NASCET and ACAS

Duplex Ultrasound

- Color duplex ultrasound has replaced arteriography as the preferred screening test for carotid artery occlusive disease
- Accuracy in diagnosing carotid stenosis severity approaches 90% in experienced laboratories
- Degree of carotid stenosis usually described as one of five categories (1-15%, 16-49%, 50-79%, 80-99%, occluded)
- Carotid endarterectomy can be performed on the basis of a good quality duplex scan only without contrast angiography

Ultrasound – Excellent Screening Tool

Speed Limit

- Ultrasound measures the velocity of blood in the artery
- As the peak systolic velocity increases, then it correlates to an increased degree of stenosis
- PSV >300 cm/s – likely significant stenosis

Diagnosis of Carotid Disease
MRA and CT angiography

- Often used to confirm findings of ultrasound
- Require local expertise in evaluating
- Accuracy approaches that of digital subtraction angiography
- Limited in evaluation aortic arch and origin of vertebral vessels

Medical Treatment
Prophylaxis

- Control of Hypertension
- Cessation of Smoking
- Control Cholesterol
- Anti-Platelet therapy
- Warfarin in the setting of atrial fibrillation
Medical Treatment

TIA

- Stop smoking, control HTN, lower lipids
- Patients with atrial fibrillation and TIA have stroke risk 17 times that of others, if safe begin anti-coagulation
- Anti-platelet therapy

<table>
<thead>
<tr>
<th>TIME POST TIA</th>
<th>STROKE RISK (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Month</td>
<td>4 - 8</td>
</tr>
<tr>
<td>One Year</td>
<td>12 - 13</td>
</tr>
<tr>
<td>Five Years</td>
<td>24 - 29</td>
</tr>
</tbody>
</table>


Natural History

Annual Percentage Rate of Vascular Events

<table>
<thead>
<tr>
<th>Degree of Stenosis</th>
<th>TIA %</th>
<th>Stroke %</th>
<th>Cardiac Event %</th>
<th>Vascular Death %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 75</td>
<td>7.2</td>
<td>3.3</td>
<td>8.3</td>
<td>6.5</td>
</tr>
<tr>
<td>50-75</td>
<td>3.0</td>
<td>1.3</td>
<td>6.6</td>
<td>3.3</td>
</tr>
<tr>
<td>&lt; 50 (mild)</td>
<td>1.0</td>
<td>1.3</td>
<td>2.7</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Medical Treatment

TIA

- Four anti-platelet drugs have been approved for prevention of stroke
- Aspirin decreases recurrent stroke ~25% (Anti-platelet Trials Collaboration, British Medical Journal, 1994), optimal dosing range is debatable, but FDA recommends 50mg-325mg
- Ticlopidine Aspirin Stroke Study (TASS, NEJM, 321: 501, 1989) showed absolute risk reduction of 1%/year for ticlopidine compared to aspirin
- Clopidigrel versus Aspirin in Patients at Risk of Ischemic Events (CAPRIE, Lancet, 348: 1329, 1996) showed absolute risk reduction of 0.4% for plavix compared to aspirin
Medical Treatment
Ischemic Stroke

• Acutely: diagnosis, ABCs, control hypertension, maintain euglycemia, activate stroke team (consideration for rTPA, only FDA approved thrombolytic, onset must be less than 3 hours), if no thrombolysis, ASA
• After resolution, same as TIA

Carotid Endarterectomy for Symptomatic Stenosis

• NASCET
  *North American Symptomatic Carotid Endarterectomy Trial*
• ECST
  *European Carotid Surgery Trial*
• VA309
  *Veterans Affairs Trial*

Trial and Tribulation

<table>
<thead>
<tr>
<th></th>
<th>ECST</th>
<th>NASCET</th>
<th>VACSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
<td>Europe and Australia</td>
<td>North America</td>
<td>United States</td>
</tr>
<tr>
<td>Age</td>
<td>63</td>
<td>66</td>
<td>65</td>
</tr>
<tr>
<td>Male (%)</td>
<td>24</td>
<td>36</td>
<td>37</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td>52</td>
<td>31</td>
<td>92</td>
</tr>
</tbody>
</table>
Symptomatic Carotid Stenosis
NASCET (50-69%) Subgroup Analysis

<table>
<thead>
<tr>
<th></th>
<th>CEA</th>
<th>CONTROL</th>
<th>ARR</th>
<th>RRR</th>
<th>NNT</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>16.7%</td>
<td>24.8%</td>
<td>8.1%</td>
<td>33%</td>
<td>12</td>
<td>0.04</td>
</tr>
<tr>
<td>Women</td>
<td>13.8%</td>
<td>15.1%</td>
<td>1.3%</td>
<td>9%</td>
<td>77</td>
<td>0.94</td>
</tr>
<tr>
<td>Diabetes</td>
<td>26.7%</td>
<td>34.6%</td>
<td>7.9%</td>
<td>23%</td>
<td>13</td>
<td>0.51</td>
</tr>
<tr>
<td>Non-Diabetes</td>
<td>12.4%</td>
<td>19.2%</td>
<td>6.8%</td>
<td>35%</td>
<td>15</td>
<td>0.04</td>
</tr>
<tr>
<td>Stroke</td>
<td>2.2%</td>
<td>9.7%</td>
<td>7.5%</td>
<td>77%</td>
<td>13</td>
<td>0.01</td>
</tr>
<tr>
<td>TIA</td>
<td>3.4%</td>
<td>5.1%</td>
<td>1.7%</td>
<td>33%</td>
<td>59</td>
<td>0.01</td>
</tr>
</tbody>
</table>

ARR (absolute risk reduction), RRR (relative risk reduction), NNT (number needed to treat, one event over five years)

One Quick Note
Carotid Endarterectomy for Asymptomatic Stenosis: Results of ACST
- 1993-2003, 3120 patients with stenosis >60% randomized to surgery + medical treatment or medical treatment alone (surgeons required to show operative risk of <6%)
- Net 5-year risk of stroke (P=0.00001)
  - 6% CEA
  - 12% Medical treatment

Appropriate Carotid Endarterectomy
AHA, Multidisciplinary Ad Hoc Committee

Best Case: CEA in symptomatic male with high grade stenosis by surgeon with low complication rate
Worst Case: CEA in asymptomatic female with moderate stenosis by surgeon with high complication rate
Technical Aspects of CEA
Timing
• Recent studies have favored earlier (<30 days after stroke) compared with longer waiting times, particularly a non-disabling one
• NASCET subgroup analysis showed perioperative stroke rate of 4.8% in early group (3-30 days) versus 5.2% in late group (33-117 days) for P=1.00
• Ballotta, et al (Surgery, March 2002) have reported similar findings in a randomized study of 86 patients with non-disabling stroke, early CEA could be safely performed (perioperative morbidity/mortality of 2%)

Technical Aspects of CEA
To Patch or Not to Patch
• Patching is better than not patching
• Both vein patch and PTFE are superior to primary closure to reduce perioperative stroke, acute postoperative thrombosis and symptomatic recurrent stenosis over the long term
• The advantages of vein over PTFE and other materials (with the exception of Hemashield which should not be used) are still debatable


To Shunt or Not?
Technical Aspects of CEA Complications

- Wound Infection
- Patch Infection
- Bleeding
- Nerve Damage
- Stroke
- Death

Special Circumstances
Recurrent Stenosis

- During the first 2-3 years after CEA recurrent stenosis is usually due to myointimal hyperplasia, but after 3 years the main cause is recurrent atherosclerosis
- Reoperation for carotid stenosis can be safely performed
- Hill, et al JVS 1999 describe series of 390 operations, 40 of which were reoperative and note a procedure related stroke and death rate of 0.8% in both groups

Early Studies of Carotid Angioplasty versus CEA

<table>
<thead>
<tr>
<th>Year</th>
<th>Carotid PTA Stroke &amp; Mortality</th>
<th>CEA Stroke &amp; Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jordan 1997</td>
<td>9.3%</td>
<td>3.6%</td>
</tr>
<tr>
<td>Jordan 1998</td>
<td>9.7%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Gallodge 2000</td>
<td>7.1%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Alberts (randomized) 2000</td>
<td>12.1%</td>
<td>3.6%</td>
</tr>
<tr>
<td>CAVATAS (randomized) 2001</td>
<td>10.1%</td>
<td>9.9%</td>
</tr>
</tbody>
</table>
Results of SAPPHIRE

<table>
<thead>
<tr>
<th>Event</th>
<th>Stenting (N=159)</th>
<th>Endarterectomy (N=151)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>11 (7%)</td>
<td>19 (12.9%)</td>
<td>0.08</td>
</tr>
<tr>
<td>Stroke</td>
<td>9 (5.8%)</td>
<td>11 (7.4%)</td>
<td>0.42</td>
</tr>
<tr>
<td>Major ipsilateral</td>
<td>7 (5.8%)</td>
<td>9 (6.1%)</td>
<td>0.53</td>
</tr>
<tr>
<td>MI</td>
<td>4 (2.5%)</td>
<td>12 (8.1%)</td>
<td>0.03</td>
</tr>
<tr>
<td>Cranial Nerve Palsy</td>
<td>0</td>
<td>3 (2.0%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Conventional End Point</td>
<td>0.53</td>
<td>11 (7.5%)</td>
<td>0.40</td>
</tr>
<tr>
<td>Primary End Point</td>
<td>19 (12%)</td>
<td>30 (20.1%)</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Conventional End Point: stroke or death at 30 days plus ipsilateral stroke or death from neurologic causes within 31 days to one year
Primary End Point: death, stroke or MI at 30 days plus ipsilateral stroke or death from neurologic causes within 31 days to one year

CREST TRIAL

• Largest study to compare CEA to stenting with 2502 patients
• Symptomatic and asymptomatic
• Primary endpoint – stroke, MI or death
  – Surgery 7.2%
  – Stent 6.8%
• Stenting system was Acculink and Accunet

CREST TRIAL DESIGN

• Stroke was defined as an acute neurological event with focal symptoms and signs lasting ≥ 24 hours consistent with focal cerebral ischemia.
• Myocardial infarction was defined as elevation of cardiac enzymes (CK-MB or troponin) to a value ≥ twice the upper limit of normal for the local center laboratory, plus either the occurrence of chest pain or equivalent symptoms consistent with myocardial ischemia, or ECG evidence of ischemia including new ST segment depression or elevation > 1 mm in ≥ 2 contiguous leads (as determined by the centralized core laboratory)
Demographics

Table 1. Selected Characteristics of the Study Cohort by Treatment Group

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Surgery (N=125)</th>
<th>Stent (N=120)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>68.8 (±3.0)</td>
<td>69.2 (±3.2)</td>
<td>0.55</td>
</tr>
<tr>
<td>Male sex, % of patients</td>
<td>59.6</td>
<td>56.3</td>
<td>0.42</td>
</tr>
<tr>
<td>Asymptomatic stroke, % of patients</td>
<td>47.1</td>
<td>47.3</td>
<td>0.9</td>
</tr>
<tr>
<td>Retrospective stroke, % of patients</td>
<td>23.3</td>
<td>25.0</td>
<td>0.32</td>
</tr>
<tr>
<td>Hypertension</td>
<td>85.6</td>
<td>84.6</td>
<td>0.7</td>
</tr>
<tr>
<td>Diabetes</td>
<td>35.0</td>
<td>35.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>62.5</td>
<td>62.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Current smoker</td>
<td>66.8</td>
<td>66.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Median time from randomization to</td>
<td>0</td>
<td>7</td>
<td>0.7</td>
</tr>
<tr>
<td>treatment end date</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The p-value of 0.05 for the difference in the baseline risk of endpoints between the groups.

CREST OUTCOMES

Table 2. Composite Primary End Point and Components of the Primary End Point

<table>
<thead>
<tr>
<th>Event</th>
<th>Surgery (N=125)</th>
<th>Stent (N=120)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-year Study Period</td>
<td>85 (69-100)</td>
<td>80 (65-95)</td>
<td>0.05</td>
</tr>
<tr>
<td>Absolute Treatment Effect (SEG)</td>
<td>2.9 (2.1-5.0)</td>
<td>2.3 (1.4-4.4)</td>
<td>0.22</td>
</tr>
<tr>
<td>Percentage Points</td>
<td>2.9</td>
<td>2.2</td>
<td></td>
</tr>
</tbody>
</table>

Devil in the Details

Stroke
- Surgery 2.3%
- Stent 4.1%

Myocardial Infarction
- Surgery 2.3%
- Stent 1.1%

Exploratory analyses among 1-year survivors with regard to quality of life suggested a sustained effect for stroke, but not for MI.
Who to Stent?
High Risk and >70% stenosis

- Age >80;
- Recent (< 30 days) myocardial infarction (MI);
- Left ventricle ejection fraction (LVEF) < 30%;
- Contralateral carotid occlusion;
- New York Heart Association (NYHA) Class III or IV congestive heart failure;
- Unstable angina (Canadian Cardiovascular Society (CCS) Class III/IV);
- Renal failure (end stage renal disease on dialysis);
- Common carotid artery (CCA) lesion(s) below clavicle;
- Severe chronic lung disease;
- Previous neck radiation;
- High cervical internal carotid artery (ICA) lesion(s);
- Restenosis of prior carotid endarterectomy (CEA);
- Tracheostomy; and/or
- Contralateral laryngeal nerve palsy

CONCLUSIONS

- Stroke will continue to be a major source of morbidity and mortality (especially as population ages)
- Ischemic causes are most common
- Medical therapy is cornerstone of therapy (coumadin for atrial fibrillation, anti-platelet therapy for prevention of stroke)
- Stroke is a medical emergency and should be treated with similar expediency as myocardial infarction

CONCLUSIONS

- Carotid endarterectomy is one of the most highly scrutinized operations in the field of surgery and continually shows its efficacy in the prevention of stroke in both symptomatic and asymptomatic patients
- Ultimately, carotid stenting and endarterectomy need to be individualized to the patient population
- And, guaranteed more studies to come!!
Thank You For Your Attention!

QUESTIONS?

William P. Shutze
Texas Vascular Associates
214-821-9600
Achieving STEEEP Health Care
Stroke Therapy Conference
May 17, 2015

David J. Ballard, MD, MSPH, PhD, FACP
Chief Quality Officer, Baylor Scott & White Health
President, STEEEP Global Institute

Topics to be Covered

1. Overview of Baylor Scott & White Health
2. Defining STEEEP Care and the STEEEP Journey
3. System Alignment for STEEEP Care
   - Governance
   - Organization
   - Leadership
   - Accountability: Goal Setting & Incentives
4. Infrastructure and Tools for STEEEP Care
   - STEEEP Academy
   - STEEEP Measurement, Analytics, and Reporting
5. Achieving STEEEP Health Care
6. STEEEP Care Framework in an Accountable Care Organization
7. Concluding Remarks

Baylor Scott & White Health

- More than 500 patient care sites including 43 hospitals
- 5.3 million patient encounters annually
- More than 34,000 employees
- More than 6,000 affiliated physicians
- Scott & White health plan
- $8.3 billion in total assets
- $5.8 billion in total net operating revenue
BSWH Game Plan for the Future

Support A Full Continuum of Services

Topics to be Covered

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To Err is Human: Building a Safer Health System

November 30, 1999
Institute of Medicine Committee on Quality of Health Care in America announces its first report…

- “At least 44,000 people, and perhaps as many as 98,000 people, die in hospitals each year as a result of medical errors that could have been prevented…”
- “More commonly, errors are caused by faulty systems, processes, and conditions that lead people to make mistakes or fail to prevent.”
- “…estimated to result in total costs…of between $17 billion and $29 billion per year in hospitals nationwide.”


Crossing the Quality Chasm
(Institute of Medicine, 2001)

- The nation’s health care delivery system has fallen far short in its ability to translate knowledge into practice and to apply new technology safely and appropriately
- Overly devoted to dealing with acute, episodic care needs and lacking the multidisciplinary infrastructure required to provide the full complement of services needed by people with common chronic conditions
- Delivery of care often is overly complex and uncoordinated, requiring steps and patient “handoffs” that slow down care and decrease rather than improve safety
- Bringing state-of-the-art care to all Americans in every community will require a fundamental, sweeping redesign of the entire health system…

IOM Six Aims for Improvement

Safe
Avoids injuries to patients from care that is intended to help them

Timely
Reduces wait and harmful delays impacting smooth delivery of care

Effective
Provides services based on scientific knowledge to all who could benefit & refrains from providing services to those not likely to benefit (avoids overuse & underuse)

Efficient
Uses resources to achieve best value by reducing waste, production, and administration costs

Equitable
Does not vary in quality according to personal characteristics such as gender, income, ethnicity & location

Patient Centered
Respectful of and responsive to individual patient preferences, needs, and values
The STEEEP Health Care Improvement Journey

- The STEEEP acronym was trademarked by BHCS to communicate the challenge of achieving its objective to provide ideal care in terms of the IOM’s call for care that is safe, timely, effective, efficient, equitable, and patient-centered.

- STEEEP also communicates the “steep” challenge of ascending from current levels of care to achieving the Triple Aim (articulated by Don Berwick in 2008) of better care for individuals, better health for populations, and reduction in per-capita health care costs.

Topics to be Covered

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   - STEEEP Academy
   - STEEEP Measurement, Analytics, and Reporting
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7. Concluding Remarks

System Alignment for STEEEP Care:
Governance

- Board of Trustees Quality Resolution (2000, reaffirmed in 2010)

“Therefore, be it resolved, that the Board of Trustees of Baylor Health Care System hereby challenges itself and everyone involved in providing health care throughout the system to give patient safety and continuous improvement in the quality of patient care the highest priority in the planning, budgeting and execution of all activities in order to achieve significant, demonstrable and measurable positive improvement in the quality of patient care and safety.”
System Alignment for STEEEP Care: Organization

STEEEP Governance Council
- Consolidates efforts of clinical, operational, & financial leadership and ensures that all improvement efforts encompass all domains of STEEEP care

STEEEP Subcommittees
1. Patient Safety
2. Timeliness, Effectiveness, & Efficiency
3. Equity / Population Health
4. Patient Centeredness/Patient Experience

New Business Development
- STEEEP framework applied to new model urgent care centers

BSWH STEEEP Governance Council, Subcommittees & Aligned Entities

Voting members:
- Chief Quality Officer (Chair), Chief Medical Officers (North & Central), Presidents (North & Central), Chief Financial Officer, Chief Nursing Officers (North & Central), Chair of Physician Groups (North & Central), President of the BSWH Accountable Care Organization

BSWH STEEEP Governance Council Subcommittees
- Patient Safety
- Timeliness, Effectiveness, & Efficiency
- Equity / Population Health
- Patient Centeredness/Patient Experience

Aligned Entities
- STEEEP Measurement, Analytics, and Reporting
- STEEEP Care Improvement Training
- Clinical Service Lines

BSWH STEEEP Governance Council Members
- David J. Ballard, MD, MSPH, PhD, FACP - Chief Quality Officer
- Glen Couchman, MD - Chief Medical Officer
- Irving Prengler, MD, MBA - Chief Medical Officer
- Tiffany Berry, MD - Chief Patient Experience Officer
- Brett Stauffer, MD, MHS - Vice President, Hospital Care Quality Improvement
- Chris Shutts, MBA - Director STEEEP Academy
- Joseph Schneider, MD, MBA - CMIO and Medical Director, Clinical Informatics
- Andrew Masica, MD, MSCI - Chief Clinical Effectiveness Officer
- Cliff Fullerton, MD, MSc - Chief Population Health Officer
- Jan Compton, RN, BSN, MS - Chief Patient Safety Officer
- Mark Liston - VP, Entity Officer, Finance, Corporate
- Sharon Johnson - Director of Business Services & Contracts
- Terry Long, RN, MSN - VP and COO for Quality

BSWH STEEEP Governance Council Subcommittees Members
- Joe DeSimone, MD - Chief Quality/State Area Officer
- Terry Long, RN, MSN, MBA - Chief Patient Safety Officer
- David J. Ballard, MD, MSPH, PhD - Chief Quality Officer
- Chris Shutts, MBA - Director STEEEP Academy
- Brett Stauffer, MD, MHS - Vice President, Hospital Care Quality Improvement
- Chris Shutts, MBA - Director STEEEP Academy
- Jennifer Jovanovic, MS, MBA - Chief Financial Officer
- Joseph Schneider, MD, MBA - CMIO & Medical Director, Clinical Informatics
- Andrew Masica, MD, MSCI - Chief Clinical Effectiveness Officer
- Cliff Fullerton, MD, MSc - Chief Population Health Officer
- Nanette Myers, MBA - Director of Development

STEEEP Global Institute (For Profit Entity)

BSWH = For Profit Entity

Achieving STEEEP Health Care
David J. Ballard, MD, MSPH, PhD, FACP
Achieving STEEEP Health Care
David J. Ballard, MD, MSPH, PhD, FACP

System Alignment for STEEEP Care: Accountability: Goal Setting & Incentives

- System-wide care goals aligned with 'Circle of Care' and 'Circle of Innovation'
- People: Employee Satisfaction Survey
- Quality: Core Measures, Readmissions, Patient Safety
- Finance: Operating Margin, Unrestricted Days Cash on Hand
- Director-level and above have compensation at risk, linked to performance relative to goals
- All employees have annual merit compensation linked to performance relative to goals
- Accountability: Goal Setting & Incentives
  - Leadership
  - Organization
  - Governance
  - System-wide care goals aligned with 'Circle of Care' and 'Circle of Innovation'

Example of System Goals

<table>
<thead>
<tr>
<th>Goals</th>
<th>Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUALITY: Patient Experience and Value-Driven Care</td>
<td>CTX Hospital</td>
</tr>
<tr>
<td>- At least 80% for Social Determinants care as high as 72% (Goal)</td>
<td>- Combined Hospital Bриуe (CH) care at least 70% goals</td>
</tr>
<tr>
<td>- Combined Hospital Bриуe (CH) care at least 70% goals</td>
<td>- Operating Margin, Unrestricted Days Cash on Hand</td>
</tr>
<tr>
<td>SERVICE EXCELLENCE: Deliver Value for Our Patients and Our Community</td>
<td>CTX Division</td>
</tr>
<tr>
<td>- If 418 clinicians achieve Target HCAHPS composite score levels in category, - Operating Margin, Unrestricted Days Cash on Hand</td>
<td></td>
</tr>
<tr>
<td>- If 418 clinicians achieve Target HCAHPS composite score levels in category, - Operating Margin, Unrestricted Days Cash on Hand</td>
<td></td>
</tr>
<tr>
<td>- If 6 hospitals achieve Target CGCAHPS composite score levels in category, - Operating Margin, Unrestricted Days Cash on Hand</td>
<td></td>
</tr>
<tr>
<td>- STEEEP Core Measures, Readmissions, - Operating Margin, Unrestricted Days Cash on Hand</td>
<td></td>
</tr>
<tr>
<td>FINANCE: Responsible Financial Stewardship</td>
<td>FY2017 and Fy2018: Ensure Target HCAHPS composite score levels in category, - Operating Margin, Unrestricted Days Cash on Hand</td>
</tr>
<tr>
<td>- Avoiding readmissions that generate $120,000 or more per case than category, - Operating Margin, Unrestricted Days Cash on Hand</td>
<td></td>
</tr>
<tr>
<td>- Achieving mean length of stay (LOS) in category, - Operating Margin, Unrestricted Days Cash on Hand</td>
<td></td>
</tr>
<tr>
<td>- Achieving mean LOS in category, - Operating Margin, Unrestricted Days Cash on Hand</td>
<td></td>
</tr>
<tr>
<td>- Achieving mean LOS in category, - Operating Margin, Unrestricted Days Cash on Hand</td>
<td></td>
</tr>
</tbody>
</table>

Topics to be Covered

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3. System Alignment for STEEEP Care
   - Governance
   - Organization
   - Leadership
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6. STEEEP Care Framework in an Accountable Care Organization
7. Concluding Remarks
Infrastructure and Tools for STEEEP Care: STEEEP Academy

Teaches the theory and techniques of process improvement and empowers physicians, nurses, administrators, and other stakeholders with the skills and strategies needed to improve health care quality, patient safety, and operational outcomes.

Project alignment with BSWH’s four areas of focus and annual goals

<table>
<thead>
<tr>
<th>Area</th>
<th>Issues/Goals/Initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>Patient satisfaction (e.g., indicators HCAHPS, Press Ganey, and Point-of-Care patient satisfaction surveys); departmental service scores—how well the department/service line serves its customers</td>
</tr>
<tr>
<td>Quality</td>
<td>Projects that affect the outcomes of care given to the end-user (patient or population) (e.g., indicators including National Patient Safety Goal compliance, Quality Measures, Leapfrog, and National Quality Forum standards); in-service activities; efforts to eliminate unnecessary variance in processes that affect clinical outcomes</td>
</tr>
<tr>
<td>People</td>
<td>Mobilization of human resources (e.g., float pools, PRN programs, cross-training); recruitment, retention, training, and development; environmental work culture (e.g., Magnet designation)</td>
</tr>
<tr>
<td>Finance</td>
<td>Reducing waste/value-added activities; decreasing average length of stay; increasing revenue; increasing volume; improving coding.</td>
</tr>
</tbody>
</table>

> More than 3200 employees and 250 external customers have been trained to date

Infrastructure and Tools for STEEEP Care: STEEEP Measurement, Analytics, and Reporting

- Data management, analysis, reporting and data mining to support data-driven decision making
- Implementation and reporting of performance measurement indicators
- Integration of data from multiple sources within BSWH, as well as state, regional, and national databases for benchmarking purposes
- Biomedical data management from electronic health records and other clinical systems
- System-wide support for standardized reporting and ad-hoc data requests

Major areas of performance measurement and reporting at BSWH include:

- Value-based purchasing (clinical process and outcomes, patient experience, efficiency; $/enrollee)
- CMS Core Measures
- Clinical preventive service delivery
- Adverse Events/Hospital Acquired Conditions
Achieving STEEEP Health Care: Safe Care

The BSWH patient safety vision:
- Achieving no preventable deaths (hospital-standardized mortality ratio)
- Ensuring no preventable injuries (hospital-acquired adverse events)
- Seeking no preventable risk

Strategies and Tactics:
- **Culture:** Employee patient safety culture survey, hospital and clinic biennial patient safety survey, data review, site visits, formal report to leaders and shared goal setting
- **Processes:** e.g., increased evidence-based order set use, reduce adverse drug events, National Patient Safety Goals, National Quality Forum Safe Practices...
- **Technology:** Electronic medical record (EMR) and clinical decision support, computerized physician order entry, bar code medication administration

These goals require strategic efforts in the categories of culture, processes, and technology.
BSWH Biennial Patient Safety Culture Survey

- Electronic survey designed to facilitate data-driven conversations about patient safety issues
- Assesses the culture of safety as measured by both attitudes and practices pertinent to patient safety
- Specific reports to target groups
  - System leaders; hospital level; service line/care areas

<table>
<thead>
<tr>
<th>Domain</th>
<th>Domain Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>The degree to which hospital leadership promotes patient safety through their direct involvement and their ability to deal with staff issues that impact patient safety.</td>
</tr>
<tr>
<td>Resources</td>
<td>The degree to which the resources provided to staff are adequate to support a safe environment to give and receive care.</td>
</tr>
<tr>
<td>Teamwork</td>
<td>The degree in which there is teamwork among individual staff, departments and different professional groups.</td>
</tr>
<tr>
<td>Reporting &amp; Feedback</td>
<td>The degree in which there is a safe environment that encourages speaking up to protect patient safety and to learn from near misses.</td>
</tr>
</tbody>
</table>

**OPPORTUNITY FOR IMPROVEMENT**

Sup-optimal response to the survey item:

“The Safe Surgery Saves Lives process took place as well as you would like if you or a family member were the patient”

**INTERVENTIONS**

- Rounded with operating room staff to determine barriers in compliance with the Safe Surgery Saves Lives checklist
- Passed resolution to fully implement and monitor the Safe Surgery Saves Lives process (Operating Policy and Procedure Board, September 2009)
- Monitored checklist compliance every 6-8 months by e-Survey
- Increased operating room staff competence and confidence in “stopping the line” if processes were not followed in the operating room
- Shared survey data with surgeons/operating room team and recognized those surgeons, anesthesiologists, and team members that consistently complied with checklist
- Continuing e-Survey questions and rounding with operating room staff as part of the Patient Safety Program every two years
BSWH Biennial Patient Safety Culture Survey

RESULTS

The Safe Surgery Saves Lives process took place as well as you would like if you or a family member were the patient

<table>
<thead>
<tr>
<th>Year</th>
<th>Overall Results for BSWH-North Hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>88%</td>
</tr>
<tr>
<td>2010</td>
<td>92%</td>
</tr>
<tr>
<td>2011</td>
<td>94%</td>
</tr>
<tr>
<td>2012</td>
<td>95%</td>
</tr>
<tr>
<td>2013</td>
<td>94%</td>
</tr>
<tr>
<td>2014</td>
<td>96%</td>
</tr>
</tbody>
</table>

Example: Safe Care

OPPORTUNITY FOR IMPROVEMENT

In 2006, BSWH-North hospitals performed worse than the Society of Thoracic Surgeons national averages for:

- Risk-adjusted mortality for isolated coronary bypass surgery and aortic valve surgery
- Use of internal mammary artery
- Pre-operative beta blockade (for coronary bypass surgery)

INTERVENTIONS

- Education and monthly feedback on performance on key Society of Thoracic Surgeons quality metrics
- All cardiovascular surgeons expected to attend semi-annual meetings during which facility-level metrics are reported & individual surgeon data are presented (originally blinded; now unblinded). No elective cardiac surgeries scheduled before meetings
- Physician, nurse, and non-clinical administrator training in rapid-cycle quality improvement (STEEP Academy)
- Implementation of standardized care paths, order sets, and nurse checklists
- Mandatory 2nd opinion for pre-op risk assessment >8% for in-hospital or 30-day mortality
**Achieving STEEEP Health Care: Timely Care**

- Delivery of the “right care at the right time”
- Lack of timeliness signals a lack of attention to flow and a lack of respect for the patient, which can result in:
  - Physical harm due to delay in diagnosis or treatment
  - Emotional distress
- Waiting times should be continually reduced for both patients and those who give care
- Requires multiple ways of responding to patient needs beyond patient visits, including use of the internet

**Example: Safe Care**

**RESULTS**

2 BSWH-North hospitals are among only 24 hospitals nationwide to have a 3-star rating from Society of Thoracic Surgeons for both isolated coronary artery bypass graft surgery.

<table>
<thead>
<tr>
<th>Year</th>
<th>ISOCAB Risk Adjusted Mortality By Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>4.79%</td>
</tr>
<tr>
<td>2010</td>
<td>2.0%</td>
</tr>
<tr>
<td>2011</td>
<td>2.0%</td>
</tr>
<tr>
<td>2012</td>
<td>1.90%</td>
</tr>
<tr>
<td>2013</td>
<td>2.28%</td>
</tr>
<tr>
<td>2014</td>
<td>1.83%</td>
</tr>
</tbody>
</table>

*STS* = Society of Thoracic Surgeons

**Example: Timely Care**

**OPPORTUNITY FOR IMPROVEMENT:**

STEMI* care processes at The Heart Hospital Baylor Plano were deemed inefficient and inconsistent with average door-to-balloon time below the target of 90th percentile for STEMI*-receiving hospitals nationwide.

- The size of a heart attack and the risk of death are directly related to the amount of time the heart is ischemic, or starved for blood and oxygen.
- Opening the blocked artery within 90 minutes of hospital, as recommended by national guidelines (American College of Cardiology/American Heart Association) has repeatedly been associated with better outcomes.

* STEM = ST Segment Elevation Myocardial Infarction
Example: Timely Care

**INTERVENTION:**
- Creation of structured and collaborative STEMI teams
- Increased education and support for local emergency medical services and referring hospitals
- Standardized tools and care processes including a “STEMI bucket” containing essential medical supplies

STEMI = ST Segment Elevation Myocardial Infarction

Example: Timely Care

**RESULTS**
The median door-in-door-out time was reduced from 68 minutes to 50 minutes between 2013 and 2014. This surpassed the U.S. hospital goal of 53 minutes.

The median door-to-balloon time was reduced from 51 minutes to 28.5 minutes between 2013 and 2014. This also surpassed the U.S. hospital goal of 36.7 minutes.

Achieving STEEEP Health Care:
**Effective Care**
- Clinical care processes centered on patient health status
- Evidence-based practice is supported by integrating evidence with clinical expertise and patient values
- Underuse of effective care (e.g., flu vaccination) and overuse of ineffective care should be avoided (e.g., imaging for lower back pain)
Example: Effective Care

OPPORTUNITY FOR IMPROVEMENT:
Baseline data collected for the Medicare Image Demonstration project from December 2011 through March 2012 revealed that 43% of lumbar spine MRIs ordered by HealthTexas physicians were inappropriate compared with 7% for the national comparison group.

- Frequent and unnecessary lumbar spine imaging is a major contributor to unnecessary surgical procedures and the inherent risks therein.

Example: Effective Care

INTERVENTIONS

- Major education initiative to raise awareness about imaging overuse among HealthTexas Provider Network (HTPN) physicians and to educate them, and their patients, about appropriate use.
- Development of a Low Back Pain Protocol, approved by the HTPN Best Care Committee and Board, to assist physicians in providing evidence-based treatment, while reducing costly and unnecessary imaging and/or diagnostic studies.
- Regular reporting and dissemination of performance measures commensurate with participation in the Medicare Imaging Demonstration project.

Example: Effective Care

RESULTS

Appropriateness data collected through the Medicare Imaging Demonstration (MID) project between April 1, 2012 and August 31, 2012 show that the percentage of inappropriate lumbar spine MRIs decreased from 43% during the baseline period to 8%.

<table>
<thead>
<tr>
<th></th>
<th>Baseline Period (n = 40)</th>
<th>Intervention Period (n = 109)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% inappropriate</td>
<td>43%</td>
<td>7%</td>
</tr>
<tr>
<td>% uncertain</td>
<td>3%</td>
<td>9%</td>
</tr>
<tr>
<td>% appropriate</td>
<td>54%</td>
<td>84%</td>
</tr>
</tbody>
</table>

Baseline Period (Oct. 1, 2011–March 31, 2012)
Intervention Period (April 1, 2012–August 31, 2012)

HTPN (n = 40) Demonstration
HTPN (n = 109) Demonstration
Achieving STEEEP Health Care: Efficient Care

Efficiency = Avoidance of Waste

• Waste Reduction
  • Eliminating
    • Processes that are not useful (Lab tests)
    • Multiple Entries (Re-entry of prescriptions or laboratory tests)
    • Classifications that add Complexity Without adding value
      (Appointment Type)
    • Layers of Control (Approvals and Signoffs)

Example: Efficient Care

OPPORTUNITY FOR IMPROVEMENT

An inventory of heart failure initiatives across BSWH revealed more than 60 order sets in use across the health care system, many of which duplicated efforts and were implemented by different teams with different processes at individual facilities.

INTERVENTION

Development and implementation of a standardized heart failure order set:
• Order set was developed internally, with content driven by the prevailing American College of Cardiology/American Heart Association clinical practice guidelines, and deployed system-wide via an intranet physician portal
• More than 2000 staff members trained in rapid-cycle quality improvement over a 15-month period, creating a critical mass of physicians, nurses, and hospital administrators to drive change initiatives including standardized order set adoption.
• Rapid dissemination of unblinded hospital-level and physician-level performance data (order set use)
Example: Efficient Care

RESULTS

- 95% use of the standardized order set at 9 months
- 51% decrease in risk of in-hospital mortality
- $1909 decrease in total direct cost (initial hospitalization + 1-yr all-cause readmissions costs)

Annually, this translates into savings of >15,000 in-hospital deaths and $2 billion in hospital costs nationally.


Achieving STEEEP Health Care: Equitable Care

- Equity, as part of the STEEEP infrastructure refers to a mechanism to drive sustainability and direction to developing strategies around access to and quality of care for vulnerable populations rather than a focus on racial and ethnic disparities as barriers to care.
- Populations: Under and Uninsured, Medicaid, Veterans, & Children (CHIP)

Major Initiatives:
- HTPN* Volunteers-in-Medicine (for community health improvement)
- Community-based partnership to reduce emergency department utilization among the uninsured
- Baylor Community Care Clinics (full functioning clinics with electronic health records and National Committee for Quality Assurance Patient-Centered Medical Home recognition for un- and under-insured)
- Vulnerable Patient Network (house calls w/ Advanced Practice RN)
- Diabetes Health & Wellness Institute

*HTPN = HealthTexas Provider Network

Example: Equitable Care

OPPORTUNITY FOR IMPROVEMENT

In June 2010, only 12% of participants at the BSWH Diabetes Health and Wellness Institute in South Dallas met the recommended diabetes care guidelines for hemoglobin A1c control:

- Prevalence of diabetes in Dallas County exceeds both state and national rates (11.4%, compared with 9.6% in Texas, and 8.3% nationwide).
- The burden is disproportionately borne by communities in southern Dallas County (which lack adequate access to health services, safe environments, and healthy foods).
Example: Equitable Care

INTERVENTION
Diabetes Health and Wellness Institute of holistic care model coordinated by a diabetes care team that includes a primary care physician, nurses, diabetes educators, community health workers, pastors, social workers, and exercise specialists.

Example: Equitable Care Results

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Diabetes w/o Community Health Worker</th>
<th>Diabetes &amp; Community Health Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>1462</td>
<td>624</td>
</tr>
<tr>
<td>A1C</td>
<td>n</td>
<td>886</td>
</tr>
<tr>
<td></td>
<td>Within Guidelines (% &lt;7.0%)</td>
<td>40.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>44.0%</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>n</td>
<td>937</td>
</tr>
<tr>
<td></td>
<td>Within Guidelines (% &lt;130/80 mmHg)</td>
<td>45.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.5%</td>
</tr>
<tr>
<td>LDL</td>
<td>n</td>
<td>790</td>
</tr>
<tr>
<td></td>
<td>Within Guidelines (% &lt;100 mg/dl)</td>
<td>48.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>58.1%</td>
</tr>
</tbody>
</table>

Achieving STEEEP Health Care: Patient-Centered Care

Patients need to be actively invited at every encounter, by every caregiver, to:
- Participate in their own care
- Offer their needs, values, and preferences
- Understand all of their options and the related consequences and commitments before making informed decisions

Example Initiatives:
- AIDET (acknowledge, introduce, duration, explanation, thank you)
- Rounding for outcomes
- Care calls
- Open access
- Shared decision making
Example: Patient-Centered Care

OPPORTUNITY FOR IMPROVEMENT

According to system-wide Hospital Consumer Assessment of Healthcare Providers and Systems, scores in 2009, only 72% of patients rated BSWH hospitals a 9 or 10 on a scale of 0-10; and 72% thought that nurses explained things in a way they understood.

Example: Patient-Centered Care

INTERVENTIONS

Open access to loved ones to meet the preferences or patients in their care including:

- **Signage & Access**: Restrictive signage removed; additional signage in 2 nd language where appropriate
- **Policy**: New policy adopted as a system; changes made to the Patients’ Rights guide
- **Primary Support**: Systematic process to identify the primary support person, including adding field to electronic health record (EHR)
- **Open Access 24/7**: Accommodations to support presence of primary support person; reasons for restrictions explained and documented
- **Guidelines**: Written for facility or unit level

Example: Patient-Centered Care

RESULTS

Improved system-wide Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) scores in the areas of nurse and overall hospital rating.

Question:

- Nurses explain things in a way you understand
  - Top box includes rating of “Always”

Question:

- How would you rate this hospital during your stay?
  - 0 (worst) – 10 (best)
  - Top box includes ratings “9” and “10”
Topics to be Covered

1. Overview of Baylor Scott & White Health
2. Defining STEEEP Care and the STEEEP Journey
3. System Alignment for STEEEP Care
   - Governance
   - Organization
   - Leadership
   - Accountability: Goal Setting & Incentives
4. Infrastructure and Tools for STEEEP Care
   - STEEEP Academy
   - STEEEP Measurement, Analytics, and Reporting
5. Achieving STEEEP Health Care
6. STEEEP Care Framework in an Accountable Care Organization
7. Concluding Remarks

Population Health Management

- Accountable for Care
  - [Diagram with icons and text]
- Integrated Health System
  - [Diagram with icons and text]
- Care Management
  - [Diagram with icons and text]
- Access
  - [Diagram with icons and text]
- Data Analytics/Reporting
  - [Diagram with icons and text]
- Link/Out
  - [Diagram with icons and text]

Baylor Scott & White Quality Alliance: Potential Covered Life Growth

<table>
<thead>
<tr>
<th>Contract Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing or Newly Signed</td>
<td></td>
</tr>
<tr>
<td>Baylor Scott &amp; White North Texas EEs</td>
<td>33,000</td>
</tr>
<tr>
<td>Baylor Scott &amp; White Central Texas EEs</td>
<td>34,000</td>
</tr>
<tr>
<td>Humana Medicare Advantage</td>
<td>5,000</td>
</tr>
<tr>
<td>Aetna Medicare Advantage</td>
<td>10,000</td>
</tr>
<tr>
<td>Scott &amp; White Medicare Advantage</td>
<td>1,000</td>
</tr>
<tr>
<td>Aetna Commercial - Attribution Model</td>
<td>10,000</td>
</tr>
<tr>
<td>Aetna Commercial - Product Model</td>
<td>30,000</td>
</tr>
<tr>
<td>Cigna - Dallas Children’s EEs</td>
<td>5,000</td>
</tr>
<tr>
<td><strong>Total Expected Lives</strong></td>
<td><strong>58,000</strong></td>
</tr>
</tbody>
</table>

New Potential Contracts

<table>
<thead>
<tr>
<th>Contract Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicare Shared Savings Program</td>
<td>60,000</td>
</tr>
<tr>
<td>United Health Care - Attribution Model</td>
<td>24,000</td>
</tr>
<tr>
<td>Blue Cross &amp; Blue Shield</td>
<td>60,000</td>
</tr>
<tr>
<td><strong>Total New Potential Lives</strong></td>
<td><strong>144,000</strong></td>
</tr>
</tbody>
</table>

**Total Projected Lives**: 242,000
Cardiovascular Subcommittee Webpage

Oncology

Example of combined service line/subcommittee webpage

Service Line Report

Baylor Scott & White Quality Alliance
Year 1 Results- Generics: 4% improvement
Baylor Scott & White Quality Alliance Year 1 Results

All Cause Re-Admission Rate
BSW NTD Employee Plan

2011  2012

18% drop

Admissions per Thousand
BSW NTX Employee Plan

2012  2013

4.3% drop

Baylor Scott & White Quality Alliance Year 1 Results: $14 Million Savings

Employee Health Plan Medical Costs Reductions (PMPM)

7% cost reduction vs. expected expenses

PMPM = Per Member Per Month

7% cost reduction (as compared to expected expenses) in our employee health plan medical costs generated savings approaching $14 million overall (based on 14,000 lives)
Concluding Remarks

BSWH has gained valuable experience along its STEEEP quality journey. Critical success factors include:

1. Commitment to quality improvement from the highest levels of leadership
2. Investments in training leaders in quality improvement techniques and clinicians in leadership skills, and supporting their application of those skills
3. Creation and maintenance of the infrastructure needed to support large-scale, in-depth data collection, analysis, and reporting of performance data
4. Application of the STEEEP framework both to clearly communicate goals and priorities throughout the organization and to guide the organizational management framework
5. Close alignment with employed physicians as well as other physician members of our accountable care organization
6. Remaining vigilant of changing conditions in the health care environment through participation in national organizations & implementing new strategies, tactics, and tools when these indicate a new need to be met

Additional Resources on BSWH’s STEEEP Journey

Handling the Pressure: The Complicated Clinical Course of a SAH
Debbie Summers, MSN, RN ACNS-BC, CNRN, SCRN

Objectives

1. Identify endovascular and surgical treatment options for the aneurysmal SAH patient
2. Describe best nursing practices in the care for the SAH stroke patient
3. Understand the clinical signs and implications of elevated ICP in the patient with SAH
4. Understand proper ICP monitoring, using various intracranial devices

Assessment – Aneurysm Location

<table>
<thead>
<tr>
<th>FINDING</th>
<th>LIKELY LOCATION OF ANEURYSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuchal rigidity</td>
<td>Any (could result from possible complications of aneurysmal rupture: hydrocephalus, hematomas, or ischemia)</td>
</tr>
<tr>
<td>Diminished level of consciousness</td>
<td>Any</td>
</tr>
<tr>
<td>Papilledema</td>
<td>Any</td>
</tr>
<tr>
<td>Retinal and subhyaloid hemorrhage</td>
<td>Any</td>
</tr>
<tr>
<td>Third-nerve palsy</td>
<td>Posterior communicating artery</td>
</tr>
<tr>
<td>Sixth-nerve palsy</td>
<td>Posterior fossa*</td>
</tr>
<tr>
<td>Bilateral weakness in legs or abulia</td>
<td>Anterior communicating artery</td>
</tr>
<tr>
<td>Nyctagmus or ataxia</td>
<td>Posterior fossa</td>
</tr>
<tr>
<td>Aphasia, hemiparesis, or left-sided visual neglect</td>
<td>Middle cerebral artery</td>
</tr>
</tbody>
</table>
Sixth nerve palsy is associated with an aneurysm in the cavernous sinus.

Occipital or posterior cervical pain is associated with PICA or AICA aneurysm.

Third nerve palsy, sixth nerve palsy, and ataxia may be associated with giant basilar artery aneurysm.

Patient management is directed at preventing a rebleed. The goal to secure ruptured aneurysms within 24 hours of bleed. Delay – increases risk.

The nursing neuro assessment continues to be important in this patient utilizing the NIHSS, GCS and pupil monitoring because of risk of increased ICP and risk of herniation.

Supporting the patient and minimizing further deterioration is the goal.

Anticipating immediate insertion of an extraventricular device or lumbar drain to monitor for developing hydrocephalus or rebleeding.
Hydrocephalus may develop within the first 24 hours because of obstruction of CSF outflow in the ventricular system by clotted blood. Caused by obstruction of CSF flow by clotted blood. Can occur early (EVD) or late (VP shunt). Careful with drainage – reduction in ICP can increase the risk of rebleeding.

Diagnosis
- Clinical assessment
- Imaging

Management
- Ventriculostomy
  - Infection reduction

External Ventricular Drains (EVD)
- Used to quickly reduce the amount of CSF in ventricles and intracranial pressure
- Most widely used devices – Most Accurate
- Allows treatment and monitoring simultaneously
- A catheter is actually placed inside one of the ventricles (a fluid filled cavity in the brain where CSF is produced)
- Fluid can be easily removed for specimen collection.
- It is usually temporary, dependency on the EVD usually results in a V-P shunt placement.
Pre-Intervention Care

- Rebleeding is highest following initial bleed and commonly occurs within the first 72 hours
- Patients at higher risk
  - LOC at time of initial bleed
  - Delay in securing the aneurysm
  - Worsened neurological status as evidenced by higher Hunt and Hess grade
  - Prior history of headache lasting one hour but no diagnosis of aSAH at the time
  - Patients with SBP > 160 mm Hg have a higher rebleeding risk
  - Aneurysms that are larger in size

Complications: Rebleeding

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early aneurysm repair</td>
<td>High</td>
</tr>
<tr>
<td>Early short course of antifibrinolytic - Amicar prior to aneurysm repair</td>
<td>Low</td>
</tr>
<tr>
<td>Avoid antifibrinolytic therapy &gt; 48 post ictus or &gt; 3 days, concern with side effects</td>
<td>High</td>
</tr>
<tr>
<td>Screen for DVT while on Amicar</td>
<td>Moderate</td>
</tr>
<tr>
<td>Discontinue Amicar 2 hours prior to treatment</td>
<td>Very Low</td>
</tr>
<tr>
<td>Treat extreme hypertension in unsecured</td>
<td>Low</td>
</tr>
<tr>
<td>Do not treat modest hypertension (MAP &lt;110)</td>
<td>Low</td>
</tr>
</tbody>
</table>

SAH Management

- Phases of Care
  - Onset to securing of aneurysm
  - Early aneurysm intervention versus late
  - Impact on outcome
  - Securing of aneurysm
    - Clip versus coil
    - Vasospasm window
    - 4–21 days post SAH
Blood Pressure

- Pre-treatment of aneurysm
  - Elevated blood pressure associated with aneurysm rebleeding
  - General consensus SBP < 140-160 mmHg

- Post-treatment of aneurysm
  - Vasospasm window 4-21 days
  - Once aneurysm secured
    - BP parameters liberalized to permissive hypertension
    - With clinical signs of vasospasm
      - Induced hypertension

Clip versus (And) Coil of Aneurysm

- Surgery Pros/Cons
  - Maximally invasive
  - Permanent
  - Low rebleeding rate

- Coil Pros/Cons
  - Minimally invasive
  - May require re-treatment
  - Follow up angiograms
  - Long term outcomes unknown

Clipping
Occluding aneurysms using endovascular coils was described in 1991. Improved outcomes have been linked to hospitals that provide endovascular services. Use of endovascular versus surgical techniques varies greatly across centers. Coil embolization is associated with a 2.4% risk of aneurysmal perforation and an 8.5% risk of ischemic complications. Combined morbidity and mortality was significantly greater in surgically treated patients than in those treated with endovascular techniques (30.9% vs. 23.5%; absolute risk reduction 7.4%, P = 0.0001). During the short follow-up period in ISAT the re-bleeding rate for coiling was 2.9% versus 0.9% for surgery.
Coiling

Angio showing large ICA aneurysm
Same aneurysm - Post GDC Coiling

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Debbie Summers, MSN, RN ACNS-BC, CNRN, SCRN

Coil Embolization: Immediate Result

Angio showing large ICA aneurysm
Same aneurysm - Post GDC Coiling
Coil Embolization Evolution

- Stent assisted coil embolization
  - Requires antiplatelet therapy
- Pipeline
  - New approach to NiR aneurysm repair
  - Fine mesh stent
  - No treatment of aneurysm
  - Investigation ongoing

Coil Embolization Procedure

- General anesthesia
- Diagnostic angiography via femoral artery
- Anticoagulated during the procedure
- Guide catheter
- Guide wire placed
- Coils passed over the catheter
- Wide neck may need – stent placement

Coil Embolization

- Risks
  - Angiogram related
  - Procedural related rupture
- Nursing Considerations
  - Puncture site
    - Pulses
    - Bleeding
    - Retroperitoneal hematoma
    - BP control
    - First 24 hours
    - After
- Recovery post-anesthesia
- Monitoring for new or evolving neurologic deficits
  - Hemorrhage
  - New ischemia related to procedure
**2011 Neurocritical Care Society Recommendations for aSAH**

- High – “Further research unlikely to change effect”
- Moderate – “Further research is likely to change effect”
- Low – “Further research is very likely to change effect”
- Very Low – “Very uncertain of effect”

Neurocrit Care (2011) 15:211–240

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**Monitor Intravascular Volume**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor volume status</td>
<td>Moderate</td>
</tr>
<tr>
<td>No specific modality is recommended</td>
<td></td>
</tr>
<tr>
<td>Use clinical assessment</td>
<td></td>
</tr>
<tr>
<td>Intravascular volume management should target euvolemia and avoid prophylactic hypervolemic therapy</td>
<td>Moderate</td>
</tr>
<tr>
<td>Vigilant fluid balance management – Isotonic crystalloid is the preferred agent for volume replacement</td>
<td>Moderate</td>
</tr>
<tr>
<td>In patients with a persistent negative fluid balance, use of fludrocortisone or hydrocortisone may be considered</td>
<td>Moderate</td>
</tr>
<tr>
<td>Do not place central venous lines solely for measurement</td>
<td>Moderate</td>
</tr>
<tr>
<td>Routine use of Pulmonary Artery Catheter is not recommended</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

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**Glucose Management**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid hypoglycemia (&lt;80 mg/dL)</td>
<td>High</td>
</tr>
<tr>
<td>Maintain glucose ≤200 mg/dL</td>
<td>Moderate</td>
</tr>
<tr>
<td>May adjust serum glucose with use of microdialysis</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

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Management of Pyrexia

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent temperature monitoring &gt; 38 associated with worsened outcomes</td>
<td>High</td>
</tr>
<tr>
<td>Fever is common after aSAH, is more prevalent in patients with a poor Hunt-Hess grade, and if there is blood in the ventricles</td>
<td></td>
</tr>
<tr>
<td>Seek and treat infectious fever</td>
<td>High</td>
</tr>
<tr>
<td>Control fever during risk for delayed cerebral ischemia</td>
<td>Low</td>
</tr>
<tr>
<td>Use acetaminophen, ibuprofen as first line agents</td>
<td>Moderate</td>
</tr>
<tr>
<td>Surface/intravascular cooling when antipyretics fail</td>
<td>High</td>
</tr>
<tr>
<td>Monitor &amp; treat shivering with cooling</td>
<td>High</td>
</tr>
</tbody>
</table>

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Deep Vein Thrombosis Prophylaxis

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide DVT Prophylaxis</td>
<td>High</td>
</tr>
<tr>
<td>Use SCDs routinely</td>
<td>High</td>
</tr>
<tr>
<td>Withhold prophylaxis LMWH or UFH in untreated patients</td>
<td>Low</td>
</tr>
<tr>
<td>Start UFH 24 hours after surgery</td>
<td>High</td>
</tr>
<tr>
<td>Withhold LMWH or UFH 24 hours before and after intracranial procedures</td>
<td>Moderate</td>
</tr>
<tr>
<td>Duration of DVT prophylaxis is uncertain</td>
<td>Low</td>
</tr>
</tbody>
</table>

Anemia and Transfusion

- Minimize blood loss from blood draws (Low)
- Give PRBC maintain hemoglobin 8–10g/dl (Moderate)
- Higher hemoglobin may be appropriate for patient at risk for DCI – uncertain if transfusion is useful (No Evidence)
Endocrine Dysfunction
Hyponatremia
- Consider hypothalamic dysfunction when not responding to vasopressor (Moderate)
- Do not give high dose corticosteroids (High)
- Consider mineralocorticoids (Moderate)
- Stress-dose corticosteroids with vasospasm and no response to induced hypertension (Weak)
- Cerebral Salt-Wasting Syndrome (CSWS)
- Syndrome of Inappropriate Anti-diuretic Hormone (SIADH)

Cerebral Salt-Wasting Syndrome
- (CSWS) first described by Peters et al in 1950
- Defined by the development of excessive natriuresis and subsequent hyponatremic dehydration in patients with intracranial disease.
- Pathophysiology unclear.
- Increased UOP with subsequent decrease in serum sodium

Endocrine Monitoring
- Cerebral Salt Wasting
  - Common in patients with a higher Hunt and Hess severity score, hydrocephalus and ruptured anterior communicating artery
  - Most common is aSAH
  - Results in hypovolemia and hyponatremia
  - Treated with hypertonic saline and sometimes desmopressin (DDAVP) or fludrocortisone (Florinef)
Syndrome Inappropriate Diuretic Hormone (SIADH)

- Dilutional hyponatremia caused by excessive release of antidiuretic hormone (ADH)
  - Many Causes: Neuro: Pituitary and/or hypothalamic dysfunction, meningitis/encephalitis, brain tumors, psychosis
  - Lung diseases
  - Medications

Endocrine Monitoring

- Hyponatremia is the most common electrolyte imbalance after aSAH repair and should be monitored regularly. It increases the risk of vasospasm.
  - SIADH
    - Occurs due to excessive secretion of ADH resulting in impaired water excretion, hyponatremia and water retention
    - Free water is retained leading to hypervolemia or euvolemia

Complications: Seizures

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not use phenytoin for prophylaxis</td>
<td>Low</td>
</tr>
<tr>
<td>Consider other anticonvulsants for prophylaxis</td>
<td>Very Low</td>
</tr>
<tr>
<td>Short course (3-7days) AED prophylaxis</td>
<td>Low</td>
</tr>
<tr>
<td>Give anticonvulsant with seizure presentation</td>
<td>Low</td>
</tr>
<tr>
<td>Consider continuous EEG</td>
<td>Low</td>
</tr>
</tbody>
</table>

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Complications: Cardiopulmonary

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obtain baseline cardiac assessment (Echo, EKG)</td>
<td>Strong</td>
</tr>
<tr>
<td>Monitor CO may be useful</td>
<td>Low</td>
</tr>
<tr>
<td>Treat pulmonary edema by maintaining euvolemia</td>
<td>Moderate</td>
</tr>
<tr>
<td>Treat heart failure while maintaining CPP/MAP for cerebral perfusion</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

Handling the Pressure: The Complicated Clinical Course of a SAH
Debbie Summers, MSN, RN ACNS-BC, CNRN, SCRN

LV Cardiak Dysfunction

- Common after a SAH.
  - The cardiac biomarkers will elevate
  - The cardiac dysfunction has been defined as stunned myocardium.
  - The cardiac dysfunction complicates the ability to treat vasospasm aggressively with fluids.
  - Breath sounds should be monitored closely for the development of pulmonary edema.
  - A chest x-ray should be completed to evaluate the lungs

Statins and Magnesium

- Continue statin if previously on it (Low)
- Consider statin for statin-naïve patient (Moderate)

  - Do not induce hypermagnesemia (Moderate)
  - Avoid hypomagnesemia (Moderate)
High Volume Centers

- Treat at high volume center (Moderate)
- Favorable outcomes are more likely in institutions that treat high volumes of patients with SAH, in institutions that offer endovascular services, and in selected patients whose aneurysms are coiled rather than clipped.

Critical Care Issues: Vasospasm

- Vasospasm from arterial smooth muscle contraction is symptomatic in 36% of patients.
- Pathophysiology unclear
  - Oxyhemoglobin in contact with the abluminal side of blood vessel
  - Occurs in large and small vessels
- Narrowing of arterial vessels resulting in ischemia or infarct
- Window 4–21 days, most common between 7–10 days after rupture

Vasospasm and Delayed Cerebral Ischemia

- Patient management is aimed at monitoring for these complications and acting quickly when they do occur.
- Vasospasm is the narrowing of the cerebral artery demonstrated by sonography or by radiological images.
- The narrowing decreases cerebral blood flow and delivery of oxygen leading to possible DCI.
Risk of Vasospasm

- According to Clinical Grade – Hunt Hess Grade
  - 1  22%
  - 2  33%
  - 3  52%
  - 4  53%
  - 5  74%

Presentation: Vasospasm/DCI

- The patient exhibits any neurological deterioration that correlates with cerebral ischemia.
- Nurses doing neurological assessment and reporting any subtle changes
- Vasospasm is diagnosed with visualization of arteries by angiography (CTA or DSA) or a Transcranial Doppler (TCD).
- The highest risk of DCI is 3–14 days after the SAH.

SIGNS AND SYMPTOMS OF INCREASED ICP

- **EARLY**: Decreased level of consciousness
- Restlessness, agitation
- More stimuli required to arouse
- Confusion
- Less able to follow commands or Less purposeful response to pain
- Pronator drift
- CN deficits
- Headache
- Vomiting: w/ or without nausea; May be projectile

- Brain compression increases, there is pupillary dysfunction, motor weakness, headache, seizures, vomiting, that leads to posturing and coma.
Monitoring and Management

- Monitoring of spasm
  - Gold standard: angiography
  - TCD as a screening tool
  - CTA as a screening tool
  - EEG
  - PBtO2

- Management of spasm
  - Angiography with intervention
  - Hypertension (induced)
Role of nimodipine
- Oral calcium channel blocker
- Does NOT prevent vasospasm
- Is associated with improved outcomes at 90 days
  - Unclear mechanism
  - Neuroprotectant
  - Support of collateral circulation
- Dosing 60mg po every 4 hours
  - Hypotension side effect
  - Dose may be split to 30mg po every 2 hours
  - When to discontinue of significant impact on BP
  - Do not take with grapefruit juice

Maintain euvolemma (Moderate)
- Consider saline bolus to increase CBF (Moderate)
- Trial induced hypertension with DCI (Moderate)
- Choose vasopressor based of effects (Moderate)
- Augment BP based on MAP in stepwise fashion (Poor)
- Change dose of nimodipine if hypotension occurs – discontinue with persistent hypotension (Poor)
Hemodynamic Management of DCI (con’t)

- Consider inotropic (Dobutamine) (Low)
- May need to augment with vasopressor (High)
- IABP maybe useful (Low)
- Do not provide hemodilution (Moderate)
- Caution with increasing BP in unsecured (Low)
- Unruptured should not influence management (Moderate)

Nursing Management and Assessment

Goal: Maintain optimal cerebral tissue perfusion

- Perform and document neuro assessment every hour and PRN and note trends.
- Notify physician for changes in neuro status and CPP less than 60mm Hg for more than 5 minutes.

Monitor Hourly:
- Vital Signs: BP, pulse, respiration and temperature.
- Pupil size and reaction
- Glasgow coma scale
- ICP
- MAP
- CPP = MAP – ICP

EVD, External Ventricular Drain
Intracranial Pressure (ICP) is the pressure exerted by the brain content:
- Brain Tissue (85%)
- Cerebral Spinal Fluid (CSF) (10%)
- Intravascular blood (2–11%)

Cerebral Autoregulation: The ability of the cerebral vessels to constrict and dilate as needed to maintain adequate cerebral perfusion
- Impaired with brain injury and the cerebral blood flow becomes passively dependent on blood pressure

Monro-Kellie Hypothesis: an increase in one component must be offset by an equal decrease in one or more components otherwise an increase in ICP will result

ICP Pressures
Normal ICP 0–10 mmHg
- Increased ICP occurs when the intracranial volume exceeds the brain’s ability to compensate for increased volume
- Sustained ICP above 20 mmHg is considered a neurologic emergency
- When the brain suffers an insult or injury, changes occur that affect cerebral hemodynamics, including changes in ICP, cerebral blood flow, and oxygen delivery

Cerebral Perfusion Pressure
Cerebral Perfusion Pressure (CPP):
- Pressure at which the brain is perfused
- About 15–20% of cardiac output

CPP = Mean Arterial Pressure (MAP) – ICP.
- Normal CPP 60–80 mmHG
- CPP less than 50mmHg will result in cerebral ischemia and tissue death
ICP Monitoring and the EVD

- Intraventricular catheters are the **gold standard** for measuring ICP
  - Placed directly in the ventricle (typically in the anterior horn of the lateral ventricle through a burr hole in the skull)
  - Attached to a pressure transducer

- An external ventricular device (EVD)
  - Has ICP monitoring capabilities
  - Can also assist with controlling increased ICP by CSF drainage

Intracranial Monitoring

LICOX

- Parenchymal probe that monitors brain tissue
  - Oxygenation (PbtO2)
  - Temperature
- Values
  - Normal 25-35 mmHg
- Risk Cell Death
  - < 15 mm Hg for 30 mins
  - < 10 mm Hg for 10 mins
  - < 5 mm Hg high mortality
  - < 2 mm Hg neuronal death
Waveforms

- ICP waveform analysis identify patients who are at risk for increases in ICP and decreases in CPP
- The ICP waveform has three components: pulse, respiratory, and "slow waves"
- Pulse: consists of three peaks, decreasing in height
- Pulse waves represent arterial pulsations in large cerebral vessels as they produce a fluctuation in the volume within the ventricles
  - P1, the first and sharpest peak, "percussive wave" and results from arterial pressure being transmitted from the choroid plexus.
  - P2, the second peak, referred to as the "tidal wave," varies in amplitude with brain compliance
  - P3 represents the "dicrotic wave" and is caused by closure of the aortic valve

As the ICP increases the amplitude of P1, P2, and P3 all increase
- If ICP continues to rise, P2 becomes more elevated than P1 until eventually P1 may disappear within the waveform
- Constriction of cerebral blood vessels (Seen with hypocapnia or vasospasm) will exhibit a decrease in the amplitude of the waveform
- Patients who have undergone a craniectomy (bone flap removal) will have a dampened waveform

Waveforms Cont.

[Diagram showing ICP waveform analysis]
Pharmacologic options
- Mannitol 0.25 gm/kg q4h (may need to increase dose over time)
- Hypertonic saline (requires central line)
  - 3%
  - 7.5%
  - 23.4% (30 mL over 10 min)
- Steroids only for edema around tumors or abscesses (not for use in trauma or cerebrovascular disease)

Sedation
- Benzodiazepines
- Propofol
- Works by decreasing cerebral metabolic rate, which is coupled to blood flow
  - Requires autoregulation, which often fails in patients with elevated ICP
  - Often causes a drop in MAP, impairing cerebral perfusion and thus requiring vasopressors (e.g., norepinephrine)
Increased Intracranial Pressure

- Posture and head position
  - ICP monitoring usually needed to guide therapy
  - Avoid jugular vein compression
  - Head should be in neutral position
  - Cervical collars should not be too tight
  - Elevation of the head and trunk may improve jugular venous return.
  - Zero the arterial pressure transducer at the ear, rather than the heart, to measure the true cerebral perfusion pressure when the head is above the heart.

Nursing Management and Assessment

- Identify activities that alter intracranial pressure
  - lights, noise, repositioning
- Arrange nursing care to minimize elevation in ICP (cluster care)
- Educate family
- Assess ICP waveform continuously
- Body temperature should remain below 38.
- Assure prescribed seizure prophylaxis is instituted if indicated.

Increased Intracranial Pressure

- Hyperventilation (PaCO2 < 35 mmHg) works by decreasing blood flow and should be reserved for emergency treatment and only for brief periods.
  - The major determinant of arteriolar caliber is the extracellular pH, not actually the PaCO2, but this is the parameter we can control.
Monitor labs, as ordered.
- Maintain HCT greater than 25%.
- If patient is receiving Mannitol, obtain Serum Osmolarity every 6 hours. (Notify MD prior to administering if serum osmo > than 310).

Record I/O every hour.
- If urine output is greater than 200 mL for 2 hours and specific gravity is less than 1.005, not associated with Mannitol dosing, notify neurosurgeon.

Nursing Management and Assessment

The significance of raised ICP (1)
- Rate of ICP rise
  - More important than actual value
  - Slow volume increases with tumours are well tolerated by decreasing CSF volume or brain tissue atrophy
- Sustained elevations of ICP (above 20 mmHg) are associated with poor outcome
  - no direct proof that lowering ICP affects outcome
- However some ICP values carry clinical significance
Herniation

- ICP rises are not equally distributed throughout the skull & pressure gradients develop

- This may result in herniation
  - laterally (cingulate herniation)
  - downwards (transtentorial herniation)
Summary and Conclusions

- Optimal treatment requires availability of a team with experienced cerebrovascular surgeons and endovascular surgeons working in a collaborative effort to evaluate each case of SAH.
- The missing component of the guideline was the:
  - NURSE

NURSE
Objectives

1. Discuss how stroke severity measurement guides clinical practice
2. Understand the implications of stroke severity measurement
3. Identify key aspects of neurological assessment in detecting early neurologic deterioration
4. Connect neurologic injury with corresponding physical and cognitive deficits through neurological assessment

Stroke Scoring

1. National Institute of Health Stroke Scale (NIHSS)
2. Glasgow Coma Score
3. ICH Score – Intracerebral Hemorrhage
4. Hunt and Hess – Non traumatic SAH
5. Spetzler Martin – AVM
6. Outcome – mRS, FIM, Barthel, Quality of Life
7. Decision Aid Tools
National Institute Stroke Scale

- Correlates with infarct size, clinical severity, and long-term outcome.
- Originally designed as a research tool to measure baseline data on patients in acute stroke clinical trials.
- Used as a clinical assessment tool to evaluate acuity of stroke patients, determine appropriate treatment, and predict patient outcome.

Limitations

- Highly weighted toward deficits caused by anterior circulation strokes
  - Patients with left brain strokes score 4 points higher on the NIHSS compared with right brain strokes.
- Deficits caused by posterior circulation strokes receive fewer points.
- It is possible that some patients with persistent symptoms on arrival to ED and an NIHSS score of 0 still have an infarct.

NIH Stroke Scale

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>LOC</td>
<td>0 – 3</td>
</tr>
<tr>
<td>1b</td>
<td>LOC Questions</td>
<td>0 – 2</td>
</tr>
<tr>
<td>1c</td>
<td>LOC Commands</td>
<td>0 – 2</td>
</tr>
<tr>
<td>2</td>
<td>Best Gaze</td>
<td>0 – 2</td>
</tr>
<tr>
<td>3</td>
<td>Best Visual</td>
<td>0 – 3</td>
</tr>
<tr>
<td>4</td>
<td>Facial Palsy</td>
<td>0 – 3</td>
</tr>
<tr>
<td>5</td>
<td>Motor Arm Left</td>
<td>0 – 4</td>
</tr>
<tr>
<td>6</td>
<td>Motor Arm Right</td>
<td>0 – 4</td>
</tr>
<tr>
<td>7</td>
<td>Motor Leg Left</td>
<td>0 – 4</td>
</tr>
<tr>
<td>8</td>
<td>Motor Leg Right</td>
<td>0 – 4</td>
</tr>
<tr>
<td>9</td>
<td>Limb Ataxia</td>
<td>0 – 2</td>
</tr>
<tr>
<td>10</td>
<td>Sensory</td>
<td>0 – 2</td>
</tr>
<tr>
<td>11</td>
<td>Neglect</td>
<td>0 – 2</td>
</tr>
<tr>
<td>12</td>
<td>Dysarthria</td>
<td>0 – 2</td>
</tr>
<tr>
<td>13</td>
<td>Best Language</td>
<td>0 – 3</td>
</tr>
</tbody>
</table>
Focuses on 5 Major Areas

- **Level of Consciousness**
  - 1a. LOC
  - 1b. LOC Questions
  - 1c. LOC Commands

- **Visual Function**
  - 2. Best Gaze
  - 3. Visual Fields

- **Motor Function**
  - 4. Facial Palsy
  - 5. Motor Arm
  - 6. Motor Leg
  - 7. Limb Ataxia

- **Sensory & Neglect**
  - 8. Sensory
  - 11. Extinction & Neglect

- **Speech & Language**
  - 9. Best Language
  - 10. Dysarthria

- **Cranial Nerves**
  - Portions of CN II, III, V, VI, VII

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**Review**

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**Image:**

- Diagram of the brain with areas labeled:
  - Motor Cortex
  - Frontal Lobe
  - Temporal Lobe
  - Occipital Lobe
  - Cerebral Cortex
  - Sensory Cortex

---

**Image:**

- Cartoon drawing with text:
  - "I'm not sure if I should tell you how I am or if I should just tell you how I am through your head. But if I do play it safe, I'm ending a bunch of words."
LOC Pearls

- MOST IMPORTANT
  - Sensitive indicator of cortical function
  - Only assessing at one point in time – may change rapidly

- Consciousness is divided into two categories
  - Alertness reflects function of the cerebral hemispheres and brain stem
  - Awareness reflects cerebral cortex activity

Best Gaze

- Vertical movement (III and VI).
- Can test EOMs and pupillary constriction
- Abnormal involving
  - frontal lobe
  - brainstem
  - cerebellar or vestibular dysfunction

Best Gaze Pearls

- This is assessing motor function related to ability to gaze towards opposite hemisphere of injury/infarct.
- Think Seizure if gaze away from injury infarct and toward paralyzed side
- If the patient is unresponsive, this item can be scored using the oculocephalic reflex (doll’s eyes maneuver.)
- Double vision– think midbrain or cerebellar
Best Visual

- This item is a visual field assessment.
- Abnormalities here usually arise from damage of the optic radiations or occipital lobes.

Visual Field Cuts

Visual Pathways Anatomy
Visual Fields Pearls
- If patient cannot speak: use visual threat to determine if they blink when you move fingers at their eyes.

Facial Palsy
- This item evaluates symmetry or equality of facial movement.
- Pathology:
  - Central Nervous (UMN) lesion
- Deficit – contralateral facial weakness

CN VII Central (UMN) Facial Palsy
- Referred to as central seven
  - Characterized by paralysis or paresis of the lower half of one side of the face. Typically seen in stroke
  - Spared ability to raise eyebrows, wrinkle forehead helps differentiate a peripheral palsy from a central process.
**LMN Lesion of CN VII**

- Lower Motor Neuron Lesion
  - Lesion of the lower motor neuron from damage to the motor nucleus of CN VII or its axons.
  - A LMN lesion results in the paralysis of all muscles of facial expression (including those of the forehead) ipsilateral to the lesion.
- Brain Stem Stroke
- Bells Palsy

**Motor – Arm and Leg**

- This item evaluates symmetry of voluntary movement in both upper extremities

**Motor Pearls**

- Aphasic and confused patient may need coaxing or pantomime.
- Initial dip of the limb is allowed, only score if limb drifts after a dip.
- Reflex postural movements do not count.
- Can be tested with patient sitting or supine
- Arthritis / joint pain: use your best judgement.
Limb Ataxia

- This is used to evaluate the stroke patient’s coordination of movements which may indicate a unilateral cerebellar lesion.

Limb Ataxia Pearls

- Make sure this is done in the intact visual field.
- Ataxia out of proportion to weakness is scored.
- Walk a patient if complain of dizziness, at least sat up on side of bed to test for truncal ataxia.
- If patient cannot understand (e.g. aphasic) or paralyzed limb: score 0.
- Comatose patient: score 0.
- CANNOT TEST: CANNOT SCORE

Sensory

- Abnormal findings or sensory loss usually indicate lesions or dysfunction involving the contralateral thalamus or parietal lobe cortex
Sensory Pearls
- Consider parietal lobe injury
- Contralateral injury occurs
- Unilateral neglect syndrome may be present
- Compare sides: don’t ask sharp or dull.
- Score bare skin: not through clothing.
- Aphasic patient: test withdrawal of limb from noxious stimulus.
- Comatose patients: automatically scored 2.
- Brainstem stroke: bilateral loss of sensation: score 2.

Language Center
- MCA
  - Broca’s area – superior division of L MCA causes expressive aphasia
  - Wernicke’s area – inferior division of L MCA causes receptive aphasia

Dysarthria
- Dysarthria is a motor speech disorder resulting from neurological injury, characterized by poor articulation
Dysarthria Tips

- Unresponsive or comatose patient: score 2.
- If patient is mute score 2.
- If difficulty understanding due to a physical barrier such as no teeth, score 1.

Extinction & Inattention

- This item primarily evaluates the contralateral parietal lobe cortex.

Only Three Items Untestable (UN)

1. Motor Arm or Leg
2. Ataxia
   - If amputation or joint fusion
3. Dysarthria
   - If Intubated
Special Situation: Coma

For patients scoring a 3 on Item 1a, the remaining items should be scored as follows:

- Item 1b (LOC Questions) – Score 2
- Item 1c (LOC Commands) – Score 2
- Item 2 (Best Gaze) – Patient can be in coma and have gaze palsy that can be overcome by moving the head. Thus the oculocephalic maneuver must be done and the patient scored
- Item 3 (Visual) – Test using bilateral visual threat
- Item 4 (Facial Palsy) – Score 3

Special Situation: Coma (cont’d)

- Items 5 and 6 (Motor Arm and Leg) – This is interpreted as the voluntary ability to attain a posture. Score 4 for both arm and leg
- Item 7 (Limb Ataxia) – Score 0
- Item 8 (Sensory) – Score 2 (arbitrary)
- Item 9 (Best Language) – Score 3
- Item 10 (Dysarthria) – Score 2
- Item 11 (Extinction and inattention) – Coma implies loss of all cognitive abilities. Score 2

Special Situation: Persons Who Refuse to Cooperate

In the event that a patient refuses to perform the tasks in the course of the examination resulting in an item untested, a detailed explanation must be clearly written on the form.
Facing Cranial Nerve Assessment
Barbara Bolek, APRN, MSN, CCRN, PCCN American Nurse
Today November 2006

Sizing up Stroke: Measuring Stroke Severity through Neurologic Assessment
Debbie Summers, MSN, RN ACNS-BC, CNRN, SCRN

Guiding Clinical Practice
Stroke Severity

- 643 patients with AIS with initial total NIHSS score of ≥8 points was predictive of neurological deteriorations within the first week. *J Stroke Cerebrovasc Dis.* 2013;22:205-210.

- In the NINDS IV rt-PA trial patients with an NIHSS, total score of >22 had a 17% risk of intracranial hemorrhage, whereas patients with a total NIHSS score of <10 had a 3% risk. *Stroke.* 2009;40:2911-2944.
Guiding Clinical Practice

Stroke Outcome

- Small study looked at the NIHSS items and found that increases in the LOC motor and limbs total scores were related to neurological deterioration within the first 120 minutes after administration of intravenous rt-PA. J Stroke Cerebrovasc Dis. 2013;22:1117–1124.

- Another study reported that an improvement in the total NIHSS of >3 points at 15 minutes or of >5 points at 30 minutes predicts a more favorable outcome and helps identify patients who are not responding to rt-PA. J Stroke Cerebrovasc Dis. 2014;23:69–74.

Guiding Clinical Practice

Stroke Outcome

- Thirty-day mortality rates based on the admission NIHSS are mild stroke (NIHSS of 0–7) moderate stroke (NIHSS of 8–13), severe stroke (NIHSS of 14–21), and extremely severe stroke (NIHSS of 22–42). Journal of the AHA, 2012;1, 42–50

- Increasing age and stroke severity based on the admission NIHSS scores are independently associated with poor outcomes. Stroke, 2012 43, 1872Y1877

Guiding Clinical Practice

Care Management

- The NIHSS was better at predicting the presence of dysphagia compared with a nursing dysphagia screening tool in a retrospective cohort study of veterans. J Rehabil Res Dev. 2009;46:1127–1134.

- Swedish study of 347 patients found that for each point on the baseline NIHSS there was an increase in length of stay by 0.8 days and the total length of stay (including rehabilitation) by 3.4 days up to a NIHSS of 19 points. Acta Neurol Scand. 2007;116:15–19.
Guiding Clinical Practice
Discharge Planning

› In a study of 385 patients 3 months after a stroke, a total NIHSS score of \( \geq \) 15 points was associated strongly with the patient being dependent (in a nursing home, chronic home, or substantially dependent on a caregiver).  
*Neuroepidemiology.* 2006;27:96–100.

› One study reported that patients with a NIHSS total score of <10 have a more favorable outcome at 1 year compared with patients with an NIHSS score of \( > \) 20.  

Guiding Clinical Practice
Disposition

› In a community-based sample of 377 patients scoring <4 on baseline NIHSS, 75% were independent 1 year after the stroke, 17% were dependent, and 8% were dead.  

› Discharge Dispositions and NIHSS
  - NIHSS <5 most strongly associated with D/C home
  - NIHSS 6–13 most strongly associated with D/C to rehab
  - NIHSS >13 most strongly associated with D/C to nursing facility (Schlegel et al., 2003)

Glasgow Coma Scale

*Add the 3 scores (1 from each category)*

› Eye Opening
  - 4 spontaneous
  - 3 to speech
  - 2 to pain
  - 1 none

› Best Motor
  - 6 obeys commands
  - 5 localizes pain
  - 4 withdraws to pain
  - 3 abnl flexion to pain
  - 2 extension to pain
  - 1 none

› Best Verbal
  - 5 oriented
  - 4 confused
  - 3 inappropriate
  - 2 incomprehensible
  - 1 none
ICH Score

- The ICH score is a validated tool for predicting 30-day morbidity and mortality in patients with intracerebral hemorrhage.

- The purpose of this grading scale is to provide a standard assessment tool that can be easily and rapidly determined at the time of ICH presentation.

ICH Score

- Glasgow Coma Scale
  - GCS 3–4: 7 points
  - GCS 5–15: 6 points

- Intracerebral hemorrhage (ICH) volume
  - ICH > 30 ml: 7 points
  - ICH ≤ 30 ml: 2 points

- Intracerebral hemorrhage grade
  - Yes: 7 points
  - No: 3 points

- Infratentorial angle of ICH
  - Yes: 7 points
  - No: 3 points

- Age
  - Age ≤ 60 years: 7 points
  - Age > 60 years: 3 points

Interpretation:
30-Day mortality increases as the (summed) ICH score increases.
- ICH Score 0: no mortality
- ICH Score 1: 5%
- ICH Score 2: 15%
- ICH Score 3: 25%
- ICH Score 4: 35%
- ICH Score 5: 55%
It requires calculating the Intracerebral Hemorrhage Volume. The volume of blood is measured from the longest axis and shortest axis and then the number of slices that blood is seen and a calculation of volume is determined.

### Intracerebral Hemorrhage (ICH) Score

<table>
<thead>
<tr>
<th>Component</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glasgow Coma Scale 3-4</td>
<td>2</td>
</tr>
<tr>
<td>Glasgow Coma Scale 5-12</td>
<td>1</td>
</tr>
<tr>
<td>ICH Volume ≥ 30 cc</td>
<td>1</td>
</tr>
<tr>
<td>Intra-ventricular Hemorrhage</td>
<td>1</td>
</tr>
<tr>
<td>Infra-tentorial</td>
<td>1</td>
</tr>
<tr>
<td>Age ≥ 80</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Score</strong></td>
<td><strong>0-6</strong></td>
</tr>
</tbody>
</table>

The ICH Score and 30-day mortality. Thirty-day mortality increases as ICH Score increases. No patient with an ICH Score of 0 died. All patients with an ICH Score of 5 died.
The Hunt and Hess scale, introduced in 1968, is one of the grading systems used to classify the severity of a subarachnoid hemorrhage based on the patient's clinical condition. It is used as a patient's prognosis/outcome. With a higher grade correlating to lower survival rate.
**Hunt and Hess Description Grade**

- **1** – Asymptomatic, mild headache, slight nuchal rigidity
- **2** – Moderate to severe headache, nuchal rigidity, no neurologic deficit other than cranial nerve palsy
- **3** – Drowsiness / confusion, mild focal neurologic deficit
- **4** – Stupor, moderate–severe hemiparesis
- **5** – Coma, decerebrate posturing

**Approximate Survival Rate based on Hunt & Hess**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Approximate Survival Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>70%</td>
</tr>
<tr>
<td>Grade 2</td>
<td>60%</td>
</tr>
<tr>
<td>Grade 3</td>
<td>50%</td>
</tr>
<tr>
<td>Grade 4</td>
<td>20%</td>
</tr>
<tr>
<td>Grade 5</td>
<td>10%</td>
</tr>
<tr>
<td>Grade 6</td>
<td>Death; brain dead</td>
</tr>
</tbody>
</table>

**AVM**

Spetzler–Martin Grading Scale
The Spetzler Martin Grading Scale estimates the risk of open neurosurgery for a patient with AVM, by evaluating AVM size, pattern of venous drainage, and eloquence of brain location.

- A Grade 1 AVM would be considered as small, superficial, and located in non-eloquent brain, and low risk for surgery.
- Grade 4 or 5 AVM are large, deep, and adjacent to eloquent brain.
- Grade 6 AVM is considered not operable.

Spetzler–martin grading scale for AVM’s

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Number of Points Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of AVM</td>
<td></td>
</tr>
<tr>
<td>Small (&lt;2cm)</td>
<td>1 point</td>
</tr>
<tr>
<td>Medium (2-4cm)</td>
<td>2 points</td>
</tr>
<tr>
<td>Large (&gt;4cm)</td>
<td>3 points</td>
</tr>
<tr>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Non-eloquent site</td>
<td>5 points</td>
</tr>
<tr>
<td>Eloquent site*</td>
<td>1 point</td>
</tr>
<tr>
<td>Pattern of venous drainage</td>
<td></td>
</tr>
<tr>
<td>Superficial only</td>
<td>6 points</td>
</tr>
<tr>
<td>Deep component</td>
<td>1 point</td>
</tr>
</tbody>
</table>

*Semisensory, language, visual cortex, hypothalamus, thalamus, internal capsule, brain stem, cerebellar peduncle, or cerebellar nuclei

Outcomes

- The severity scores (NIH, ICH, Hunt and Hess, and Spetzler Martin) are helpful in determining baseline of stroke patients.
- Follow-up outcomes are very important.
  - mRS, FIM, Barthel, Quality of Life
**Modified Rankin Scale - mRS**

<table>
<thead>
<tr>
<th>Score</th>
<th>Score Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No symptoms at all</td>
</tr>
<tr>
<td>1</td>
<td>No significant disability despite symptoms; able to carry out all usual duties and activities</td>
</tr>
<tr>
<td>2</td>
<td>Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance</td>
</tr>
<tr>
<td>3</td>
<td>Moderate disability; requiring some help, but able to walk without assistance</td>
</tr>
<tr>
<td>4</td>
<td>Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance</td>
</tr>
<tr>
<td>5</td>
<td>Severe disability; bedridden, incontinent and requiring constant nursing care and attention</td>
</tr>
<tr>
<td>6</td>
<td>Dead</td>
</tr>
</tbody>
</table>

A mRS of 0–2 is an excellent outcome

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**The FIM® Instrument Items**

**Motor**
- 1. **Self-care**
  - Eating
  - Dressing - Up
  - Grooming
  - Dressing - Lo
  - Bathing
  - Toileting

- 2. **Sphincter Control**
  - Bowel Management
  - Bladder Management

- 3. **Transfers**
  - Bed, Chair, Wheelchair
  - Toilet
  - Tub, Shower

- 4. **Locomotion**
  - Walk/Wheelchair
  - Stairs

**Cognitive**
- 5. **Communication**
  - Comprehension
  - Expression

- 6. **Social Cognition**
  - Social Interaction
  - Problem Solving
  - Memory

---

**FIM® Instrument Rating Levels**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Complete Independence (timely, safely)</td>
</tr>
<tr>
<td>6</td>
<td>Modified Independence (device)</td>
</tr>
<tr>
<td>5</td>
<td>Modified Dependence</td>
</tr>
<tr>
<td>4</td>
<td>Supervision</td>
</tr>
<tr>
<td>3</td>
<td>Minimal Assist (Subject = 76%+)</td>
</tr>
<tr>
<td>2</td>
<td>Moderate Assist (Subject = 50% - 74%)</td>
</tr>
<tr>
<td>1</td>
<td>Total Assist (Subject &lt; 25%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Helper</td>
</tr>
<tr>
<td></td>
<td>Helper</td>
</tr>
</tbody>
</table>

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10–40% of patients with acute ischemic stroke (AIS) suffer an early neurological deterioration (END).

Early identification of neurological deterioration is vital to preventing secondary brain injury.

Beyond the NIHSS

- NIHSS does not include evaluation of pupillary asymmetry or non-reactivity, which can be a crucial finding in patients with large cerebral infarctions who are developing worsening midline shift or transtentorial herniation.
- Therefore, in patients with a decreased level of consciousness, Full Outline of UnResponsiveness (FOUR) score may be more informative.
- ICP elevation often lags behind clinical worsening of patients with AIS and not recommended.
Early Neurological Deterioration

- A significant change between two consecutive assessments
  - Consciousness was given precedence over the other signs
  - Increase of the NIHSS score by two or more points can be used as an indicator of neurological worsening and prompt repeat brain imaging
- Important to have a standardized neuro assessment and frequency
  - GCS
  - NIH
  - Four Score

Full Outline of UnResponsiveness (FOUR) score

Eye Response
- E4 = eyelids open or opened, tracking, or blinking to command
- E3 = eyelids open but not tracking
- E2 = eyelids closed but open to loud voice
- E1 = eyelids closed but open to pain
- E0 = eyelids remain closed with pain

Motor Response
- M4 = thumbs-up, fist, or peace sign
- M3 = localizing to pain
- M2 = flexion response to pain
- M1 = extension response to pain
- M0 = no response to pain or generalized myoclonus status
**Full Outline of UnResponsiveness (FOUR) score**

**Brainstem Reflexes**

- **B4** = pupil and corneal reflexes present
- **B3** = one pupil wide and fixed
- **B2** = pupil or corneal reflexes absent
- **B1** = pupil and corneal reflexes absent
- **B0** = absent pupil, corneal, and cough reflex

**Respiration Pattern**

- **R4** = not intubated, regular breathing pattern
- **R3** = not intubated Cheyne-Stokes breathing pattern
- **R2** = not intubated, irregular breathing
- **R1** = breathes above ventilatory rate
- **R0** = breathes at ventilator rate or apnea.

*“Off hand, I’d say you’re suffering from an arrow through your head, but just to play it safe, I’m ordering a bunch of tests.”*
Other Important Clinical Evaluations
• Imaging to evaluate for stroke progression of AIS, hemorrhagic transformation, enlargement of ICH
• Hypoxia is another suggested marker for END
• Hyperglycemia can increase the risk of intracerebral hemorrhage, especially when blood glucose level is greater than 200 mg/dL at stroke onset
• Fever, the elevation of body core temperature above 37.5 C, is commonly associated with neurological deterioration and increased duration of stay in
Creating and Maintaining a Comprehensive Stroke Program: Opportunities and Challenges – An Administrator’s Perspective

Liz Youngblood, RN, MBA

Discussion Items

• What is a comprehensive stroke program?
  – History
  – Elements
• Why have a comprehensive stroke program?
• Certification programs
• Hub and spoke Telestroke
• BSWH North Texas Division (NTXD)
  – Experience
  – Outcomes
• The future of comprehensive stroke programs

Elements of a Comprehensive Stroke Program - History

A comprehensive stroke program……

• Does not equal Joint Commission (JC), Health Facilities Accreditation Program (HFAP) or Det Norske Veritas (DNV) certification but does include certification.

History:
• 2005 Brain Attack Coalition released a consensus statement for Comprehensive Stroke Centers
  – Recommendations:
    • Health-care personnel with specific expertise in neurosurgery and vascular neurology
    • Advanced neuroimaging capabilities (e.g. MRI and various types of cerebral angiography
    • Surgical and endovascular techniques (e.g. clipping and coiling intracranial aneurysms, carotid endarterectomy and intra-arterial thrombolytic therapy), and
    • Other specific infrastructure and programmatic elements (e.g. Neuro ICU and stroke registry
  • All of the above elements should be integrated into a coordinated program or system.
Elements of a Comprehensive Stroke Program – History

- 2011 American Heart Association utilized the Brain Attack Coalition recommendations and proposed a multi level approach to the care of stroke patients – similar to the trauma level system.
  - From these recommendations primary and comprehensive stroke center recommendations were made.
  - JC and eventually other accrediting bodies then took these recommendations and created a set of standards by which organizations must meet in order to obtain that accreditation.
  - The recommendations stated that most patients could appropriately be cared for at Primary Stroke Centers (PSCs) however some patients required more comprehensive care and specialized techniques that are not available at most PSCs but instead would be available at Comprehensive Stroke Centers (CSCs).

Elements of any Comprehensive Stroke Program Today

- Elements:
  - Stroke specialists available 24/7 with immediate availability
  - Designated stroke units with appropriately trained staff
  - National certification by approved regulatory body
    - Outlines the facility guidelines
    - Ensures standardization of best practices
  - Data collection, analysis and benchmarking
  - Ongoing staff education with specific competencies
  - Ongoing case and peer review (focus on education not punitive)
  - Standardized order sets, protocols, processes, tools and guidelines
  - Outcomes measurements with associated process improvements
  - Integration and standardization of care across the hospital/system
  - Formal quality improvement program with standardized metrics, benchmarking and performance improvement activities
  - Complete transparency from all participants
Why have a Comprehensive Stroke Program?

- Clinical Case
  - Opportunities:
    - Standardization of care
    - Improved clinical outcomes
      - Improved access to services
      - Improved support for stroke care
  - Challenges:
    - Can be difficult to get agreement on standards of care, protocols and processes
    - Shortage of stroke specialists

- Medical Economic Considerations:
  - Opportunities:
    - Drives increases in volume (marketing, EMS, reputation, etc.)
    - Reduced mortality resulting impacting value based purchasing results
    - Increase in case mix index (CMI)
  - Challenges:
    - Variety of payors each with different levels of reimbursement
    - Expensive to have all services needed to have a comprehensive program-staffing, technology, database, certification, support services
    - Costs associated with physician coverage
    - Cost of dedicated nursing unit (needed for standardization and increased competency)
    - DRG based reimbursement can be risky if do not have good standardization and processes of care in place

Certification Programs

- Gold Standard
  - Joint Commission
    - Primary
    - Comprehensive
    - And now…….. Acute Stroke Ready Hospital Certification is available starting July, 2015

- DNV & HFAP may be considered alternative models
**Creating and Maintaining a Comprehensive Stroke Program: Opportunities and Challenges - An Administrator's Perspective**

Liz Youngblood, RN, MBA

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### Program Concept: AMH

<table>
<thead>
<tr>
<th>Program</th>
<th>ADN</th>
<th>BSN</th>
<th>CCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td>Model</td>
<td>Model</td>
<td>Model</td>
</tr>
<tr>
<td>Medical Staff</td>
<td>Sufficient knowledge of neurological anatomy</td>
<td>Sufficient knowledge of neurological anatomy</td>
<td>Sufficient knowledge of neurological anatomy</td>
</tr>
<tr>
<td>Stroke Team</td>
<td>24/7 on-site, at least one registered nurse</td>
<td>24/7 on-site, at least one registered nurse</td>
<td>24/7 on-site, at least one registered nurse</td>
</tr>
<tr>
<td>Emergency Medical Services</td>
<td>Access to protocols used by EMS</td>
<td>Access to protocols used by EMS</td>
<td>Access to protocols used by EMS</td>
</tr>
<tr>
<td>ED Staff</td>
<td>On-site, designated teams for inpatient and outpatient patients</td>
<td>On-site, designated teams for inpatient and outpatient patients</td>
<td>On-site, designated teams for inpatient and outpatient patients</td>
</tr>
<tr>
<td>ED Assessment</td>
<td>Emergency Department evaluation, as physician availability permits</td>
<td>Emergency Department evaluation, as physician availability permits</td>
<td>Emergency Department evaluation, as physician availability permits</td>
</tr>
<tr>
<td>Transfer Protocols</td>
<td>CT, MRI, late 12/17</td>
<td>CT, MRI, late 12/17, WIS, vendor imaging, 2017</td>
<td>CT, MRI, late 12/17, WIS, vendor imaging, 2017, WIS, vendor imaging, 2017</td>
</tr>
</tbody>
</table>

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### Program Concept: AMH

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</thead>
<tbody>
<tr>
<td>Program</td>
<td>Model</td>
<td>Model</td>
<td>Model</td>
</tr>
<tr>
<td>Neurological Acuity</td>
<td>24/7 on-site, in person or telephone</td>
<td>24/7 on-site, in person or telephone</td>
<td>24/7 on-site, in person or telephone</td>
</tr>
<tr>
<td>Neurovascular Strokes</td>
<td>Stroke, surgery, thrombolysis, available within 60 minutes</td>
<td>Stroke, surgery, thrombolysis, available within 60 minutes</td>
<td>Stroke, surgery, thrombolysis, available within 60 minutes</td>
</tr>
<tr>
<td>Intravenous</td>
<td>Within 24/7 hours</td>
<td>Available 24/7 hours</td>
<td>Available 24/7 hours</td>
</tr>
<tr>
<td>Combined Capabilities</td>
<td>In cerebrovascular emergencies, vascular and neurosurgeons have worked to improve care</td>
<td>In cerebrovascular emergencies, vascular and neurosurgeons have worked to improve care</td>
<td>In cerebrovascular emergencies, vascular and neurosurgeons have worked to improve care</td>
</tr>
<tr>
<td>Transfer Protocols</td>
<td>ADN on site or BSN</td>
<td>ADN on site or BSN</td>
<td>ADN on site or BSN</td>
</tr>
</tbody>
</table>

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### Program Concept: AMH

<table>
<thead>
<tr>
<th>Program</th>
<th>ADN</th>
<th>BSN</th>
<th>CCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff Education Requirements</td>
<td>10 staff or minimum of hours a year</td>
<td>10 staff or minimum of hours a year</td>
<td>10 staff or minimum of hours a year</td>
</tr>
<tr>
<td>Functions of Educational Activities</td>
<td>Provides educational opportunities in neurological medicine</td>
<td>Provides educational opportunities in neurological medicine</td>
<td>Provides educational opportunities in neurological medicine</td>
</tr>
<tr>
<td>Clinical Performance Measures</td>
<td>National Standards, 5/2013, minimum of 75%</td>
<td>National Standards, 5/2013, minimum of 75%</td>
<td>National Standards, 5/2013, minimum of 75%</td>
</tr>
<tr>
<td>Research</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Staffing</td>
<td>One RN/week, one day</td>
<td>One RN/week, one day</td>
<td>One RN/week, two days</td>
</tr>
</tbody>
</table>
Hub and Spoke Telestroke

• Clinical Case (to develop or to utilize)

Opportunities:
– Integration and Standardization of Care in all Telestroke hospitals
  • Increase tPA usage
  • Decrease door to needle time
  • Decrease stroke onset to thrombolysis decision
  • Increase percentage of spoke initiated Stroke Neurologist consults
  • Increase timeliness of consults
  • Increases timeliness of patient transfer for neuro interventional procedures
  • Increase patient and family satisfaction with care

– Integration and Standardization of Care (cont’d)
  • Improvement of 24/7 stroke neurology coverage for all hospitals
    – Shortage of neurologists currently exists – not enough graduating to provide care (12% shortage now in 5-10 years estimated will be 22%)
    – Previous model of outpatient neurologists providing coverage is decreasing (timeliness of care)
  • Mortality improvement
  • Standardization of quality across the covered system
  • Improved patient retention rates
  • Improved access to complex services
  • Constant access to Stroke Neurologist to support ongoing stroke care

• Challenges:
  • Not all physicians unanimously support the hub and spoke model
  • Not all administrators initially understand the model
  • Technology does cost money
  • Requires education and coordination with multiple stakeholders (ED physicians and staff, neurologists, neuro hospitalist, neuro interventionists, medical hospitalists, nursing staff, radiology staff, transfer center staff…)
  • Requires sufficient critical mass of available Neuroradiologists (IR) and Stroke Neurologists
Hub and Spoke Telestroke

- Medical Economic Considerations
  - Opportunities:
    - Better care = Better outcomes
      - Better outcomes impact value based purchasing reimbursement models
    - Case mix index increases at spoke hospitals by reducing unnecessary transfers to hub (note: ethically and morally better if patient not expected to survive, less expensive, patient cared for closer to home where support system etc.)
    - Goal: keep patient at the spoke hospital
  - Challenges:
    - Movement of cases when necessary from spoke hospital does =
      - lower reimbursement at spoke
      - Competitive hospitals

Comprehensive Stroke Program
A Phased Approach for BSWH NTXD

- Phase 1 (Focus on initial ischemic stroke care) - 2010
  - Provide tPA timely and transport if necessary
  - Established system wide Neuroscience Practice Council
    - Multi disciplinary
    - Each hospital has full representation of key physicians, stroke coordinators and administrators
  - Started with a pilot at our Waxahachie hospital
    - Goal: Every Baylor acute care hospital would be able to initiate tPA within 3 hours of onset of symptoms

- Phase 2 (Focus on ischemic stroke care) - 2011
  - Provide tPA timely and provide continued acute stroke care when appropriate
  - Goal: Provide neurology consultation, education/tools and timely transfer processes to facilitate continued acute stroke care when needed

- Phase 3 (Focus on hemorrhagic stroke) – 2012
  - Implement hub and spoke telestroke technology and processes
  - Phased approach- spoke hospital by spoke hospital
BSWH NTXD
Outcomes & JC National Certification

• Sampling of Outcomes
  – Stroke volumes
  – Door to needle
  – Standardized stroke order set utilization
  – Core stroke all or none bundle

• Obtain Primary Stroke Certification
  • 7 hospitals NTXD
  • 3 hospitals CTXD

• Obtain JC Comprehensive Stroke Certification
  • BUMC in progress this FY

Stroke Volumes

门到针

Door to Needle

Baylor University Medical Center
Emergency Department
Acute Stroke Patients
TAT: Arrival to Drug (IV tPA)

TARGET 60 MIN
The Future of Comprehensive Stroke Programs (an administrators perspective)

• There will be a time when neurology call coverage for ED will no longer meet the 24/7 demands. Telestroke will fill this gap.

• Telestroke will eventually expand to telemedicine coverage for certain diagnosis easing the burden on neurology shortage.

• Telestroke coverage will be used for many hospitals to provide needed stroke coverage without the full cost burden of having their own program.

• Increase in interventional neuroradiology studies due to recent studies demonstrating efficacy.
The Future of Comprehensive Stroke Programs (an administrators perspective)

- Tough decisions about where care should and should not be provided
- State wide and eventually nation wide standardization of certain metrics of care
  - Based upon state wide and national database outcome metrics
- Reimbursement based on outcomes
  - VBP - already hospital based, but diagnosis based is coming soon
- Improved outcomes with improved care
  - New procedures / New techniques
  - Standardization of care to best practices
  - Consolidation of services and service locations based upon national guidelines & state regulations

The end results of these efforts is:
Improved quality of care for stroke patients

Questions & Comments?