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Comprehensive Stroke Centers: Key Personnel and Infrastructure

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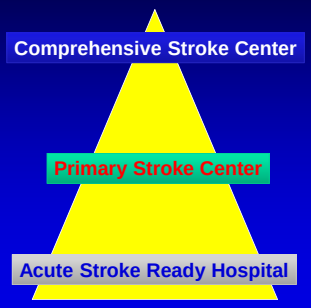
Levels and Types of Stroke Centers



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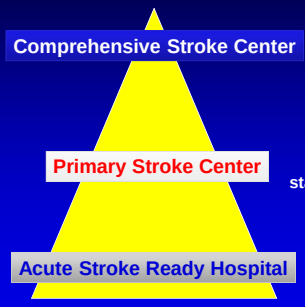
Characteristics of Different Stroke Centers



Academic Medical Center
Tertiary Care facility

Wide range of hospitals; standard stroke care; stroke unit; use TPA

Rural hospitals; basic care; drip and ship; use tele-technologies

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Numbers of Various Types of Stroke Centers

Comprehensive Stroke Center — 75 to 200 total

Primary Stroke Center — Final count 1000-1200

Acute Stroke Ready Hospital — Perhaps 1200-1800

> 5000 total acute care hospitals in the U.S.

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Patient Types at a Comprehensive Stroke Center

- Large complex ischemic strokes
  - Endovascular therapy
  - Hemicraniectomy
  - Systemic disease with multi-organ involvement
  - High ICP
  - Cryptogenic etiology
- Intracerebral hemorrhage
  - ICU level care
  - Neurosurgical interventions
- Subarachnoid hemorrhage
  - ICU level care
  - Endovascular and neurosurgical therapies
  - Vasospasm treatments

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Key Elements of a Comprehensive Stroke Center

- All components of a Primary Stroke Center, plus
  - Availability of advanced imaging techniques
    - MRI/MRA, CTA, DSA, TCD
  - Availability of personnel trained in vascular neurology, neurosurgery, endovascular techniques
  - 24/7 availability of personnel, OR, and endovascular facilities
  - ICU/Neuroscience ICU
  - Stroke registry
  - Experience and expertise treating patients with large strokes, ICH, SAH

DSA = digital subtraction angiography; TCD = transcranial Doppler.
Alberts MJ. et al. *Stroke.* 2005:36:1597-1618.

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Imaging Modalities at a CSC

- MRI and MRA (head and neck)
  - Very sensitive to image acute strokes and cerebral vasculature
  - Can also be used for perfusion studies and to identify areas of mis-match
- CT Angiography (head and neck)
  - Useful to cerebral vasculature for detection of stenosis, aneurysms, dissection
  - Needed in patients who cannot undergo MRI and MRA
- CT or MR perfusion
  - Being used widely to help identify ischemic penumbra
- Cerebral Angiogram (DSA)
  - Often considered the 'Gold Standard'
- **MRI, along with MRA or CTA are now recommended for PSCs**

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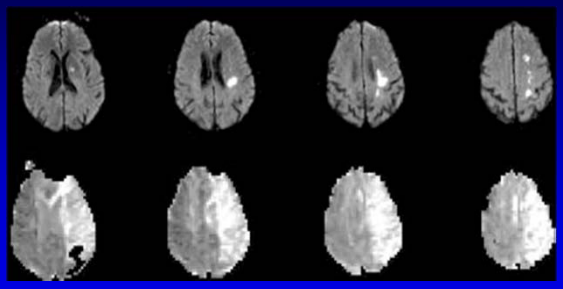
MRI showing acute strokes



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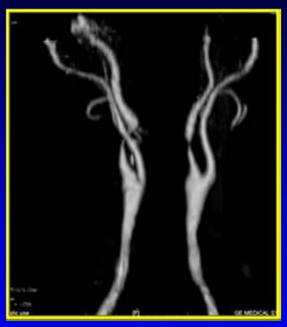
MR Angiogram



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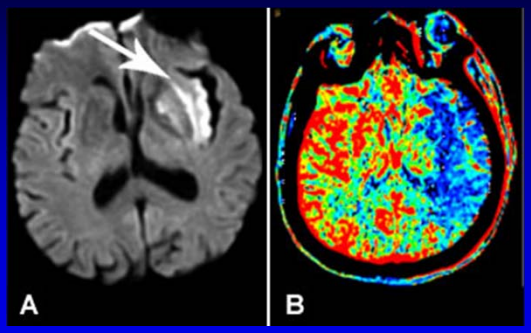
MRI showing perfusion/diffusion mismatch



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CT Angiogram of the Brain

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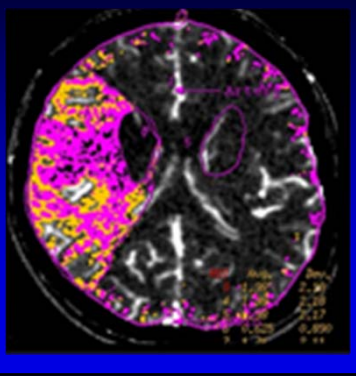
CT Perfusion in Stroke



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Key Personnel at a CSC

- CSC Director—most likely an MD with advanced training in vascular neurology or neurosurgery, others
- Neurosurgeon(s) with training in vascular neurosurgery
- Endovascular expertise for lytic/mechanical therapy, coiling, stenting, etc.
- Intensivist/Neuro-intensivist for ICU staffing
- Nursing personnel for stroke unit, ICU/NICU, endovascular, OR, etc.
- Advanced practice nurses for stroke registry, education, referrals, possible NICU coverage
- Therapists and pharmacists--patient care and research studies

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Telemedicine at a CSC

- Most CSCs will have some type of telemedicine arrangement
  - Telephone consults
  - Full video conferencing with radiology feeds
  - Remote robotic interactions
- Link CSC to PSCs and ASRHs in their network
- Pre-arranged consultations and transfers
  - Specify vendors, logistical issues, platforms, reimbursement, legal issues
  - Decide who to transfer and how to transfer
- The CSC should act as a resource for various referring hospitals
  - Consultations, education, support, etc.

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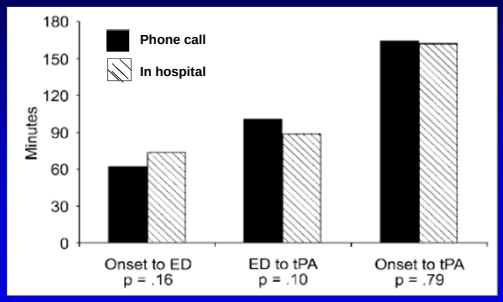
Administering TPA via Telephone at a CSC

53 patients Rx via phone; 73 in-house



Frey et al, Neurology, 2005

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Telemedicine for Stroke

Table 2 Main results comparing telephone consultation (TC) and remote video examination (RVE)

	RVE	TC	
Number	77	74	
Total time for consultation (min)	49.8	27.2	P < 0.01
Length of stay, days	11.4	12.3	n.s.
Admission to stroke ward, % of pts.	59.7	45.9	n.s.
Transfer to stroke center % of pts.	9.1	14.9	P < 0.05
Diagnosis corrected + % of pts.	7.1	17.6	P < 0.05
Outcome 10 days after stroke, %			
Mortality	1.3	6.8	P < 0.05
Institutional care	2.6	5.4	n.s.

Handschu et al, J Neurol, 2008

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Stroke Centers in Europe

- Survey of hospitals in Germany and Austria
  - 42% response rate
- 178 total hospitals
  - > 54,000 patients admitted per year
  - Average of 376 stroke patients/yr/hospital
- 7.3% met criteria for a CSC
- 8.4% met criteria for PSC
- 48% had basic care offered
- 36% lacked basic services

Ringelstein et al., Cerebrovascular Disease, 2009

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Importance of a Neurocritical Care Team

- Physician expertise in NCC
- Care protocols
- Coordinated rounds
- 2381 patients
- Significant decline in mortality
- Almost 2 day decrease in LOS

Suarez et al, CCM, 2004

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Impact of a Neurointensivist on Mortality

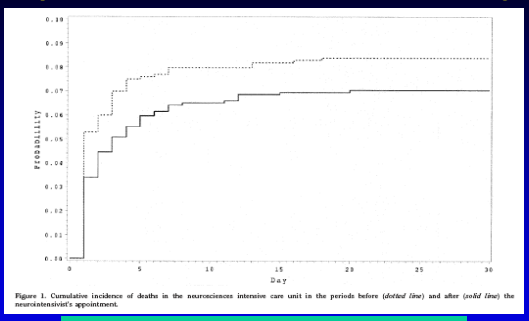

Figure 1. Cumulative incidence of deaths in the neurosciences intensive care unit in the periods before (*dotted line*) and after (*solid line*) the neurointensivist's appointment.

PROBLEM: Not enough neurointensivists for 24/7 coverage

Varelas et al, CCM, 2004

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Neurocritical Care Team

Table 3. Relationship between neurosurgical and neurological patients and availability of neurosciences critical care unit team (team)

Features	No Team, n = 796	Team Available, n = 763	*p* Value[a]
Neurosurgical			
Age, yrs, mean ± SD	57.9 ± 17.5	59.4 ± 17.2	.08
Elective admission, n (%)	182 (23)	172 (22.5)	.8
Death rate, n (%)[b]	78 (9.8)	53 (6.9)	.04
Hospital length of stay, mean ± SD	9.8 ± 7.7	8.4 ± 6.4	<.01
ICU length of stay, mean ± SD	4.4 ± 4.3	4.0 ± 3.8	<.01
Discharged home, n (%)	453 (56.9)	448 (58.7)	.5
Neurologic			
Age, yrs, mean ± SD	62.1 ± 18.3	61.7 ± 16.5	.7
Elective admission, n (%)	0	0	—
Death rate, n (%)[b]	49 (12.1)	44 (10.6)	.5
Hospital length of stay, mean ± SD	10.0 ± 8.6	8.4 ± 7.8	<.01
ICU length of stay, mean ± SD	3.7 ± 3.2	3.1 ± 3.5	<.01
Discharged home, n (%)	193 (48.6)	220 (52.8)	.14

Suarez et al, CCM 2004

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Care at a CSC vs General Hospital Finnish Experience

Table 3. Characteristics of Care

	CSC (n=20 045)	PSC (n=10 749)	GH (n=30 891)	Total (n=61 685)
Length of stay in days at CSC/PSC/GH, median (IQR)	7 (4–11)	5 (2–8)	8 (4–18)	7 (4–14)*
Total length of stay, median (IQR)	11 (6–35)	10 (4–30)	13 (5–39)	12 (5–36)*
CEA performed, n (%)	712 (3.6)	251 (2.3)	472 (1.5)	1285 (2.4)*
Thrombolytic therapy, n (%)	437 (2.2)	79 (0.7)	34 (0.1)	550 (0.9)*

Meretoja et al, Stroke, 2010

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Outcomes at a CSC: Finland Study

Table 4. Outcome of Finnish Patients With Ischemic Stroke

	CSC (n=20 045)	PSC (n=10 749)	GH (n=30 891)
Unadjusted outcome, no. (%)			
Case-fatality by 1 year	3321 (16.6)	2051 (19.1)	8428 (27.3)
Institutional care at 1 year	1773 (8.8)	1037 (9.6)	4071 (13.2)
Home at 1 year	14 951 (74.6)	7661 (71.3)	18 392 (59.5)
Outcome adjusted for patient demographics, OR (95% CI)			
Case-fatality by 1 year	0.84 (0.80–0.89)	0.89 (0.84–0.94)	1
Institutional care at 1 year	0.87 (0.82–0.93)	0.89 (0.83–0.96)	1
Home at 1 year	1.22 (1.17–1.28)	1.16 (1.10–1.23)	1

Meretoja et al, Stroke, 2010

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Outcomes at a CSC vs Community Hospital

	CSC	Community	
Neuro exam	69.5	105	p < 0.001
Door to Needle	60	54	p =0.1
Onset to TPA	135	165	p < 0.001
Protocol Dev	10.2%	6.7%	NS
Sx ICH	4.7%	14%	p = 0.04
Neuro Improve	59%	37%	p = 0.014

Perez de la Ossa J Neurol 2009

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Outcomes and Admission to a CSC

Table 4 Predictors of good outcome at 90 days: logistic regression analysis

	OR [95% CI]
NIHSS at baseline	0.86 [0.80–0.92], $p < 0.001$
Prebolus glycemia	0.99 [0.98–1.00], $p = 0.04$
Clinical history of atrial fibrillation	1.60 [0.69–3.66], $p = 0.26$
Direct admission to the CSC (vs. initial attention at an unspecialized hospital)	2.48 [1.04–5.88], $p = 0.03$

Perez de la Ossa J Neurol 2009

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Staffing of a CSC

- **Medical Director**
  - Vascular neurology, critical care, vascular neurosurgery
  - Must be available 24/7
  - Reachable by phone within 20 min; in house within 45 minutes
- Neuro-interventionalists available 24/7
  - **One person cannot cover multiple hospitals (if far apart)**
- Expertise in critical care and neurology staff in the ICU
- Neurosurgeon available 24/7; must be in house within 30 minutes
- Diagnostic radiologist available 24/7
- Certified radiology technologist available 24/7
  - Includes technologists to assist with MRI and cerebral angiography

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CSC Requirements for Personnel

- **RNs with expertise in stroke nursing care**
  - **Assessment using scales (NIHSS)**
  - **Critical care skills for NICU nurses**
    - **Post-TPA; treatments for elevated ICP; post-surgery, etc.**
    - **Nursing care related to IR and NSGY are key!!**
- **APNs with advanced nursing skills for NICU care**
- **Nurse case managers and social workers with expertise related to:**
  - **Acute stroke care**
  - **Care coordination**
  - **Post-stroke care (including rehabilitation)**
  - **Community resources**

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Staffing at a CSC

- PT and OT should be available 6 days a week
  - But NOT 24/7
- Speech/swallowing services should be available 7 days a week
  - But NOT 24/7
  - Reflects importance of swallow evaluations
- NICU staffing is coming into focus
  - Neuro-intensivist is preferred, but general intensivist with NCC training/expertise is OK
  - NCC trained/experienced nurses, NPs, PAs, etc.
  - **NICU must be staffed IN-HOUSE 24/7**

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Proposed CSC Requirements for Procedures

- Comprehensive Neuro-imaging
  - MRI, MRA, CTA, catheter angiography, Doppler, TCD, TTE, TEE
- Most elements must be available 24/7
- CSC must be able to perform the following procedures:
  - CEA
  - Carotid stenting
  - Endovascular coiling of aneurysms

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Procedure Volumes

- Volumes for SAH, aneurysm coiling and clipping are likely to go up:*
  - At least 10 aneurysms Rx with clipping
  - At least 20 aneurysms Rx with coiling/endovascular
  - At least 35 aneurysmal SAH patients cared for each year
- At least 10 endovascular procedures for acute ischemic stroke/yr* (controversial at present)

* These numbers have not been approved by TJC at present

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Possible CSC Performance Metrics

- Rates of procedural complications (stroke, death)
  - CEA, CAS 30 day stroke/death rates
- Performance of stroke severity scales
  - NIHSS, Hunt and Hess, ICH score
- Time for beginning anticoagulation reversal in ICH
  - FFP, PCC, other agents
- 30 day modified Rankin
  - will not be severity adjusted
- Rates of cerebral bleeding after TPA, endovascular Rx
  - 36 hour time window, blood on head CT
- Nimodipine for SAH
  - Rx initiated within 24 hours
- Door to groin times for endovascular therapies

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Monitoring for Peri-Procedure Complications

- **30 day stroke and death rates for**
  - CEA (symptomatic and asymptomatic patients)
  - Carotid artery stenting (symptomatic and asymptomatic patients)
- **Strokes rates for diagnostic cerebral angiogram**
- **Infection rates for EVDs**

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Other Functions of a CSC

- Act as the "Hub" hospital to coordinate:
  - Emergent communications (telemedicine,telestroke, teleradiology, robots)
  - Emergent transfers (helicopter, ambulances)
  - Consultations, assistance, advice
- Public education
  - Risk factors, calling 911, etc.
- Act as a resource hospital or leader for various activities:
  - Research programs and studies
  - Educational programs for professional staff and lay public
- Act as a partner and advocate for:
  - Local and regional resources (money, ambulances, etc.)
  - Regional and state regulatory and legislative initiatives

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Certification of CSCs

- **Four organizations (JC, HFAP, DNV, others) plus some states are now involved in CSC certification**
- **Currently about 60-70 hospitals have been visited by the JC, of which about 40 are certified**
- **The JC site visit is very challenging and comprehensive**
  - **2 site visitors**
  - **2 day visit**
  - **Very in-depth**
- **Self-certification is not optimal**
  - **Inaccurate assessments**
  - **Lack the rigor of an independent review**

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Research at a CSC

- A CSC must be involved in at least one research project
- This is based on numerous studies showing that participation in clinical research improves overall outcomes
  - Research project must be patient oriented
  - Project must require IRB approval
  - Routine databases will not count as 'research'
  - This is a new requirement

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Potential Challenges Becoming a CSC

1. The major care elements must all be available on a 24/7 basis
   - Some hospitals that think of themselves as a CSC do not do this
   - Unclear if some hospitals can meet this requirement
2. EMS diversion or triage to CSCs may be a challenge
   - Cannot easily determine in ambulance type of stroke
   - May be able to assess stroke severity
3. Financial issues
   - Some procedures done at a CSC may not be well reimbursed in the future; bundling of fees
   - Unclear what the costs of CSC certification will be
   - These issues may be overcome by increased marketing, patient volume, and procedures

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Conclusions

- A Comprehensive Stroke Center will form the ‘HUB’ of any Stroke System of Care
- The CSC will provide comprehensive services for the most complicated stroke patients
- There are many important personnel and programmatic elements for a CSC
- A CSC must meet several unique performance metrics
- It is hoped that the growth and success of CSCs will mirror that of PSCs
- CSC certification began in 2012 and continues
- May have a total of 150-200 CSCs