

VASARI Prototype MRI Data Collection PACS Interface Phase I

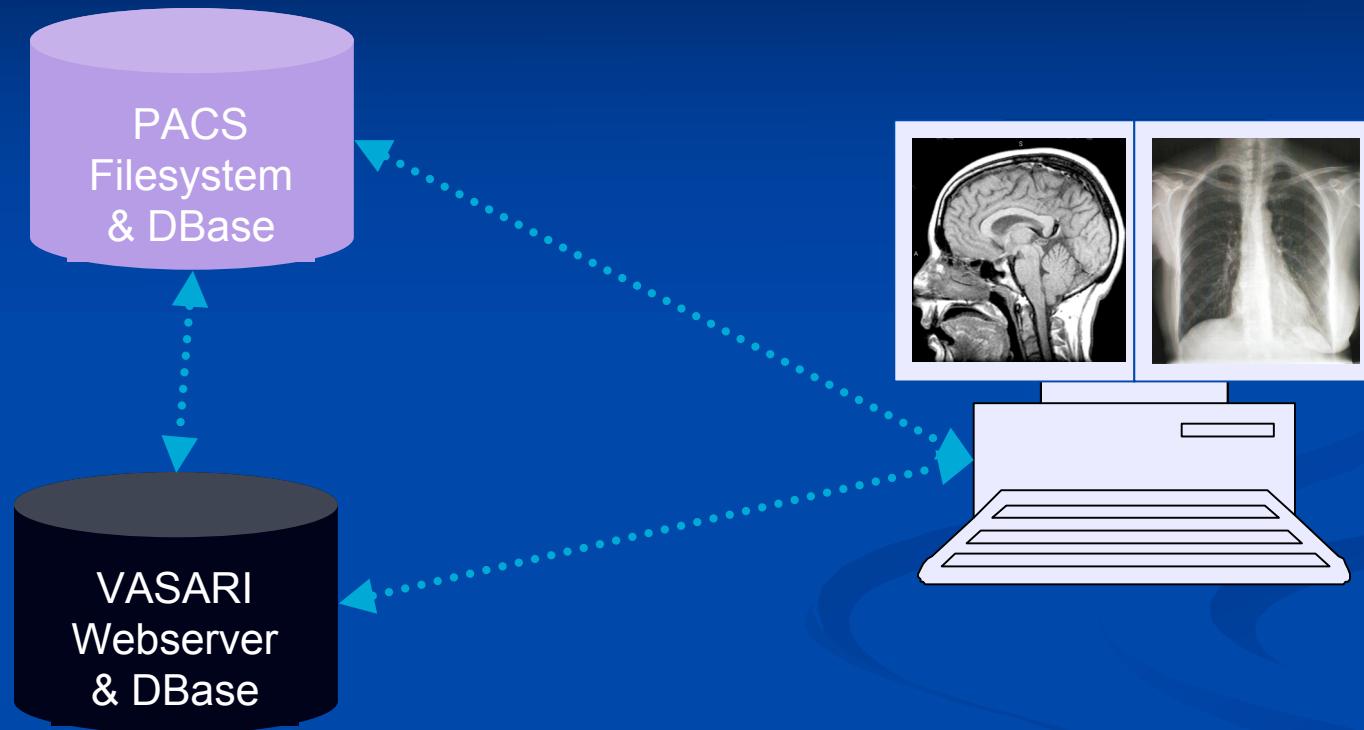
Thomas Jefferson University Hospital



Overview

- This is an overview of a prototype data entry mechanism for independent review of MRI data for the VASARI project using the existing TJUH PACS.
- A custom application was created using the Stentor Philips API to facilitate review of MR data using the familiar PACS interface.
- Resides as an application layer on top of the clinical PACS system.
 - Interacts with PACS database and custom research database.
- Application was built using a combination of Javascript and ASP with MS Access serving as the data repository.
- Database contains two relational tables:
 - A table which holds information about the MR studies.
 - A table which contains interpretation data from each reader.

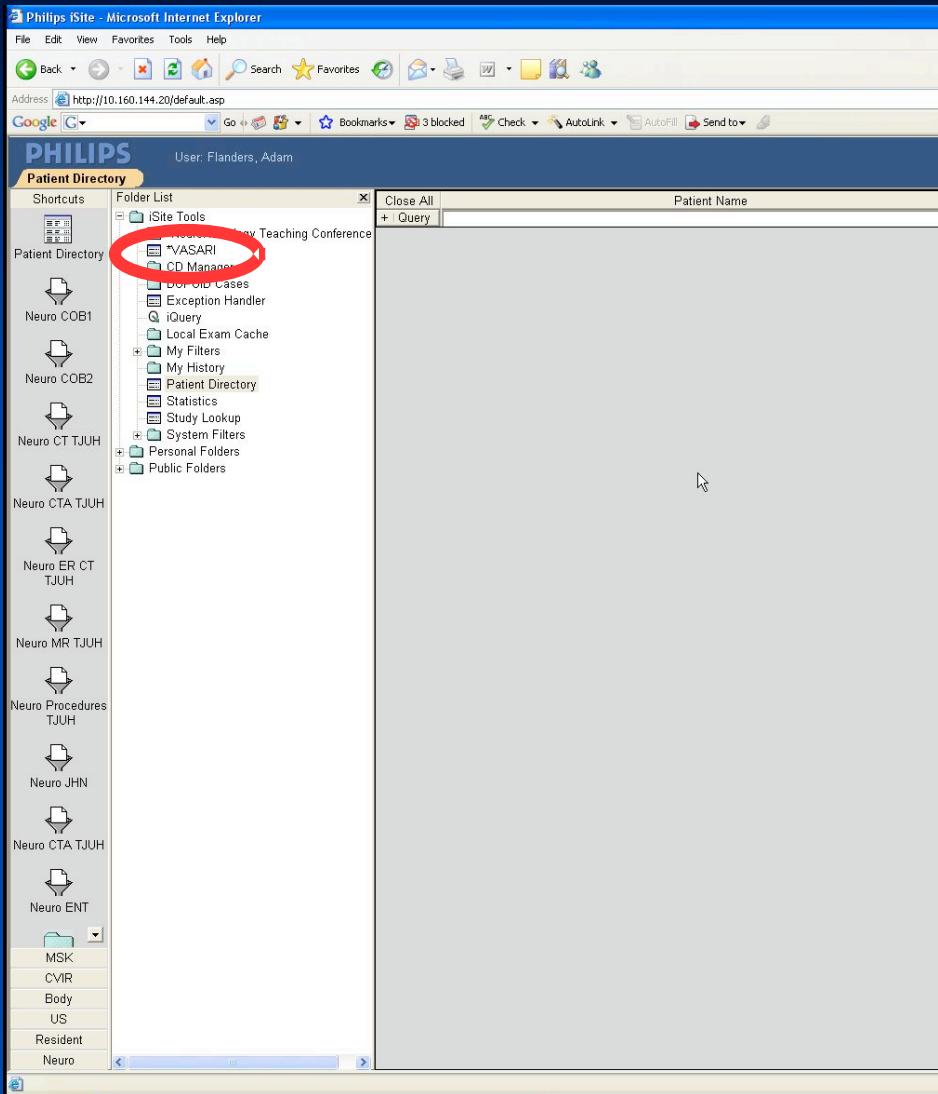
Application Schema



- Software resides as an application layer over conventional PACS software.
- Application communicates to the PACS client workstation and back office through the API.
- Application also communicates with research database through a webserver.



- Investigator logs into the TJUH Enterprise PACS system in the usual fashion



- User is brought to the standard clinical query page.
- Investigators that are authorized to participate in VASARI have a new worklist selection displayed in their clinical folder list.
- Selecting VASARI takes user to the research worklist.

Philips iSite - Microsoft Internet Explorer

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PHILIPS

User: Flanders, Adam

VASARI

Shortcuts

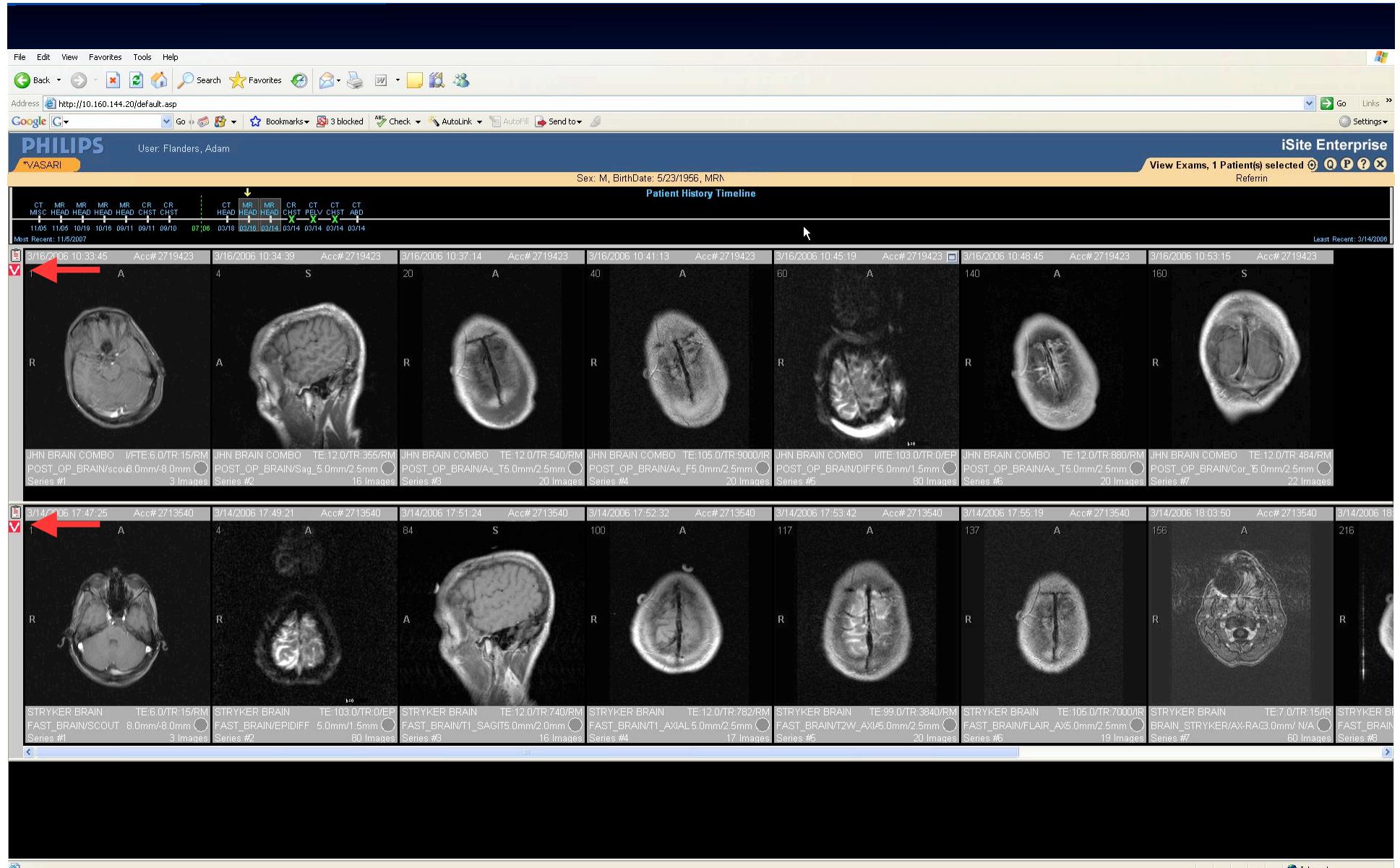
- Patient Directory
 - Neuro COB1
 - Neuro COB2
 - Neuro CT TJUH
 - Neuro CTA TJUH
 - Neuro ER CT TJUH
 - Neuro MR TJUH
 - Neuro Procedures TJUH
 - Neuro JHN
 - Neuro CTA TJUH
 - Neuro ENT
- iSite Tools
 - *NeuroRadiology Teaching Conference
 - VASARI**
 - CD Manager
 - DUPUID Cases
 - Exception Handler
 - iQuery
 - Local Exam Cache
 - My Filters
 - My History
 - Patient Directory
 - Statistics
 - Study Lookup
 - System Filters
 - Personal Folders
 - Public Folders
- MSK
- CVIR
- Body
- US
- Resident
- Neuro

Folder List

Update List VASARI Case List 17:06:20

ID	Click to Load	GMDI Number	Baseline MR Date	1st Post-op MR Date
5	Load Study	900-00-5316	3/14/2006	3/16/2006
6	Load Study	900-00-5317	3/14/2006	3/16/1968
7	Load Study	900-00-5338	4/23/2006	4/29/2006
8	Load Study	900-00-5339	5/8/2006	5/10/2006
9	Load Study	900-00-5341	5/8/2006	5/10/2006
10	Load Study	900-00-5342	5/6/2006	5/8/2006
12	Load Study	900-00-5346	6/1/2006	6/3/2006
13	Load Study	900-00-5379	5/27/2006	6/1/2006
14	Load Study	900-00-5380	5/23/2006	5/27/2006
15	Load Study	900-00-5381	6/3/2006	6/5/2006
16	Load Study	900-00-5382	6/6/2006	9/7/2006
17	Load Study	900-00-5384	6/26/2006	6/28/2006
18	Load Study	900-00-5385	6/27/2006	6/29/2006
19	Load Study	900-00-5393	6/19/2006	6/26/2006
20	Load Study	900-00-5396	7/3/2006	7/7/2006
21	Load Study	900-00-5404	7/24/2006	7/27/2006
22	Load Study	900-00-5406	7/31/2006	8/2/2006
24	Load Study	900-00-5413	8/7/2006	8/12/2006
25	Load Study	900-00-5414	8/15/2006	8/17/2006
26	Load Study	900-00-5445	8/16/2006	8/19/2006
27	Load Study	900-00-5458	10/12/2006	10/14/2006
28	Load Study	900-00-5459	10/12/2006	10/14/2006
29	Load Study	900-00-5462	10/17/2006	10/19/2006
30	Load Study	900-00-5468	10/16/2006	10/18/2006
31	Load Study	900-00-5476	10/25/2006	10/28/2006
32	Load Study	900-00-5477	10/17/2006	10/19/2006
33	Load Study	900-00-5487	10/31/2006	4/5/2007
34	Load Study	900-00-5488	11/2/2006	11/4/2006
35	Load Study	900-00-5489	11/16/2006	11/18/2006
36	Load Study	900-00-5540	12/9/2006	12/13/2006
37	Load Study	900-00-5541	2/13/2007	2/16/2007
38	Load Study	900-00-5542	12/19/2006	12/21/2006

- User is presented with a custom list of the TJUH study patients identified by an ID number, GMDI number and the dates of the two key studies: pre-operative (baseline) and first post-operative study.
- User selects exam from list by clicking “Load Study” link.



- The two key exams (baseline & first post-operative exam) are automatically loaded into the PACS review palette for the investigator.
- The two key exams are also annotated with a red “V” icon to distinguish the exams from others that appear on the timeline.

http://10.163.22.60 - VASARI Prototype Imaging Form - Microsoft Internet Explorer

VASARI Imaging Evaluation Worksheet			
	Reviewer:	aflanders	Patient #:
	Baseline Study Date:	2006-03-14 17:46:00	Initial Post Op Study Date:
Feature	Feature Description	Rating	
LESION LOCATION			
Tumor Location:	Location of lesion epicenter.	<input type="checkbox"/> Frontal <input type="checkbox"/> Temporal <input checked="" type="checkbox"/> Parietal <small>(1) (select all which apply)</small>	
Side of Tumor Epicenter:	Side of lesion epicenter	<small>(2)</small> <input type="button" value="-"/> <input type="button" value="+"/>	
Eloquent Cortex:	Eloquent cortex involved (motor, language, vision)	<small>(3)</small> <input type="button" value="-"/> <input type="button" value="+"/>	
Lesion Size:	Largest perpendicular cross sectional diameter (if tumor enhances, measure central focus of enhancement; otherwise measure non-enhancing component that is not edema).	<small>(29/30)</small> <input type="button" value="-"/> <input type="button" value="+"/> <input type="button" value="x"/> <input type="button" value="?"/>	
MORPHOLOGY OF LESION SUBSTANCE			
Enhancement Quality:	[None, Mild, Moderate, Marked] Qualitative degree of contrast enhancement is defined as having all or portions of the tumor that demonstrate significantly higher signal on the postcontrast T1W images compared to precontrast T1W images.	<small>(4)</small> <input type="button" value="-"/> <input type="button" value="+"/>	
Proportion Enhancing:	[Indeterminate, none, <25%, 26-49%, 50-74%, 75-99%, 100%] What proportion of the entire tumor is enhancing. (Assuming that the the entire abnormality is comprised of: (1) an enhancing component, (2) a non-enhancing component, (3) a necrotic component and (4) a edema component.)	<small>(5)</small> <input type="button" value="-"/> <input type="button" value="+"/>	
Proportion nCET:	[Indeterminate, none, <25%, 26-49%, 50-74%, 75-99%, 100%] What proportion of the entire tumor is non-enhancing? Nonenhancing tumor is defined as regions of T2W hyperintensity (less than the intensity of cerebrospinal fluid, with corresponding T1W hypointensity) that are associated with mass effect and architectural distortion, including blurring of the gray-white interface. (Assuming that the the entire abnormality is comprised of: (1) an enhancing component, (2) a non-enhancing component, (3) a necrotic component and (4) a edema component.)	<small>(6)</small> <input type="button" value="-"/> <input type="button" value="+"/>	
Proportion Necrosis:	[Indeterminate, none, <25%, 26-49%, 50-74%, 75-99%, 100%] (Necrosis is defined as a region within the tumor that does not enhance or shows markedly diminished enhancement, is high on T2W and proton density images, is low on T1W images, and has an irregular border). (Assuming that the the entire abnormality is comprised of: (1) an enhancing component, (2) a non-enhancing component, (3) a necrotic component and (4) a edema component.)	<small>(7)</small> <input type="button" value="-"/> <input type="button" value="+"/>	
Cyst(s):	Cysts are well defined, rounded, often eccentric regions of very bright T2W signal and low T1W signal essentially matching CSF signal intensity, with very thin, regular, smooth, nonenhancing or regularly enhancing walls, possibly with thin, regular, internal septations.	<small>(8)</small> <input type="button" value="-"/> <input type="button" value="+"/>	
Multifocal or Multicentric:	Multifocal is defined as having at least one region of tumor, either enhancing or nonenhancing, which is not contiguous with the dominant lesion, and is outside the region of signal abnormality (edema) surrounding the dominant mass. This can be defined as those resulting from dissemination or growth by an established route, spread via commissural or other pathways, or via CSF channels or local metastases, whereas Multicentric are widely separated lesions in different lobes or different hemispheres that cannot be attributed to one of the previously mentioned pathways. Gliomatosis refers to generalized neoplastic transformation of the white matter of most of a hemisphere.	<small>(9)</small> <input type="button" value="-"/> <input type="button" value="+"/>	
T1/FLAIR RATIO:	Tumor feature summary. [Mixed, expansive or infiltrative]. <i>Expansive</i> = size of pre-contrast T1 abnormality = size of FLAIR abnormality. <i>Mixed</i> = Size of T1 abnormality slightly less than FLAIR envelope; <i>Infiltrative</i> = Size of pre-contrast T1 abnormality much smaller than size of FLAIR abnormality.	<small>(10)</small> <input type="button" value="-"/> <input type="button" value="+"/>	
MORPHOLOGY OF LESION MARGIN			
Thickness of enhancing margin:	The scoring is not applicable if there is no contrast enhancement. If most of the enhancing rim is thin, regular, and has homogenous enhancement, the tumor receives a score of 1. If most of the rim demonstrates nodular and/or thick enhancement, the score is 2. If there is only solid enhancement and no rim, the score is 0.	<small>(11)</small> <input type="button" value="-"/> <input type="button" value="+"/>	
Definition of the enhancing margin:	The scoring is not applicable (NA) if there is no contrast enhancement. If most of the outside margin of the enhancement is <u>well defined</u> , the tumor is scored 1, otherwise 0.	<small>(12)</small> <input type="button" value="-"/> <input type="button" value="+"/>	
Definition of the non-enhancing margin (e.g. CSF):	If most of the outside nonenhancing margin of the tumor is well defined and smooth (geographic), the tumor is scored 0. If the margin is ill-defined, the tumor is scored 1 - irregular.	<small>(13)</small> <input type="button" value="-"/> <input type="button" value="+"/>	

- The VASARI data entry form window automatically loads in the foreground along with the associated MRI studies.
- This data form is used by each reviewer to enter responses for the thirty MRI features.
- Each feature is listed on a separate row with a brief description.
- All responses are made through the use of pull-down menus.

Recurrent or Multicentric:	spread via commissural or other pathways, or via CSF channels or local metastases, whereas <i>Multicentric</i> are widely separated lesions in different lobes or different hemispheres that cannot be attributed to one of the previously mentioned pathways. <i>Gliomatosis</i> refers to generalized neoplastic transformation of the white matter of most of a hemisphere.	(9) Multifocal
T1/FLAIR RATIO:	Tumor feature summary. [Mixed, expansive or infiltrative]. <i>Expansive</i> = size of pre-contrast T1 abnormality = size of FLAIR abnormality. <i>Mixed</i> = Size of T1 abnormality slightly less than FLAIR envelope; <i>Infiltrative</i> = Size of pre-contrast T1 abnormality much smaller than size of FLAIR abnormality.	(10) Expansive (T1=FLAIR)
MORPHOLOGY OF LESION Margin		
Thickness of enhancing margin:	The scoring is not applicable if there is no contrast enhancement. If most of the enhancing rim is thin, regular, and has homogenous enhancement, the tumor receives a score of 1. If most of the rim demonstrates nodular and/or thick enhancement, the score is 2. If there is only solid enhancement and no rim, the score is 0.	(11) n/a
Definition of the enhancing margin:	The scoring is not applicable (NA) if there is no contrast enhancement. If most of the outside margin of the enhancement is well defined, the tumor is scored 1; otherwise 0.	(12) n/a
Definition of the non-enhancing margin (e.g. Grade III):	If most of the outside nonenhancing margin of the tumor is well defined and smooth (geographic), the tumor is scored 0. If the margin is ill-defined, the tumor is scored 1 - irregular.	(13) Irregular
ALTERATIONS IN VICINITY OF LESION		
Proportion of Edema:	What proportion of the entire abnormality is comprised of: (1) an enhancing component and (2) a non-enhancing component?	(14) n/a
Edema Crosses Midline:	Edema spans white matter commissures (exclusive of herniated ipsilateral tissue).	(15) n/a
Hemorrhage:	Intrinsic hemorrhage in the tumor.	(16) No
Diffusion:	Facilitated or restricted diffusion (e.g., restricted diffusion on DWI).	(17) n/a
Pial invasion:	Enhancement of the overlying pia mater.	(18) Yes
Ependymal invasion:	Invasion of any adjacent ependymal surface in continuity with enhancing or non-enhancing tumor matrix - characterized by enhancement of the ependyma.	(19) Yes
Cortical involvement:	Non-enhancing or enhancing tumor extending to the cortical mantle, or cortex is no longer distinguishable relative to subjacent tumor.	(20) Yes
Deep WM invasion:	Enhancing or nCET tumor extending into the internal capsule or brainstem.	(21) No
nCET tumor Crosses Midline:	nCET crosses into contralateral hemisphere through white matter commissures (exclusive of herniated ipsilateral tissue).	(22)
Enhancing tumor Crosses Midline:	Enhancing tissue crosses into contralateral hemisphere through white matter commissures (exclusive of herniated ipsilateral tissue).	(23) Yes
Satellites:	A satellite lesion is within the region of signal abnormality surrounding the dominant lesion but not contiguous with any part of the major tumor mass.	(24) No
Calvarial remodeling:	Erosion of inner table of skull (possibly a secondary sign of slow growth)	(25) No
EXTENT OF RESECTION		
Extent of resection of enhancing tumor:	[NA, <20%, 20%-89%, 90%-99%,100%] Using the first postoperative scan (contrast-enhanced MR imaging) assessed for tumor residual. Estimate the proportion of enhancing tumor removed. Total resection of component should be scored 100%. Subtotal resection of enhancing tissue should be scored accordingly.	(26) 100%
Extent resection of nCETs:	[NA, <20%, 20%-89%, 90%-99%,100%] Using the first postoperative scan (contrast-enhanced MR imaging) assessed for tumor residual. Estimate the proportion of non-enhancing tumor removed. Total resection of component should be scored 100%. Subtotal resection of enhancing tissue should be scored accordingly.	(27)
Extent resection of vasogenic edema:	[NA, <20%, 20%-89%, 90%-99%,100%] Using the first postoperative scan (contrast-enhanced MR imaging) assessed for tumor residual. Estimate the proportion of edema removed. Total resection of enhancing nodule should be scored 100%. Subtotal resection of enhancing tissue should be scored accordingly.	(28) -
Comments:		<input type="button" value="Submit"/>

- In order to minimize incomplete entries, the form is *automatically* checked prior to accepting data in the database.
- Any incomplete form value is highlighted in red and an alert message is presented to the user.
- Once the form is complete, selecting the submit button on a stores the values in the database and closes the form window.
- User can select another patient from worklist.

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PHILIPS User: Flanders, Adam

VASARI PARKINSON, Lawrence

CT MR MR MR CR CR
MISC HEAD HEAD HEAD CHST CHST
11/05 11/05 10/09 10/16 09/11 09/11 09/10 07/08 03/08 03/08 03/08 03/08 03/08 03/08 03/08

3/16/2006 10:33:45 Acc#2719423 3/16/2006 10:34:39 Acc#2719423 3/16/2006 10:37:14 Acc#2719423

My Recent: 11/6/2007

1 A 4 S 20 A

JHN BRAIN COMBO TE 6.0/TR 15/RM POST_OP_BRAIN/scout 0mm/8.0mm Series #1 3 Images

JHN BRAIN COMBO TE 12.0/TR 355/RM POST_OP_BRAIN/Sag_5.0mm/2.5mm Series #2 16 Images

JHN BRAIN COMBO TE 12.0/TR 355/RM POST_OP_BRAIN/Ax_15.0mm/2.5mm Series #3 16 Images

3/14/2006 17:47:25 Acc#2713540 3/14/2006 17:49:21 Acc#2713540 3/14/2006 17:51:24 Acc#2713540

1 A 4 A 84 S

STRYKER BRAIN TE 6.0/TR 15/RM FAST_BRAIN/SCOUT 8.0mm/8.0mm Series #1 3 Images

STRYKER BRAIN TE 103.0/TR 0/EP FAST_BRAIN/EPIDIFF 5.0mm/1.5mm Series #2 60 Images

STRYKER BRAIN TE 12.0/TR 355/RM FAST_BRAIN1_SAGIT5.0mm/2.5mm Series #3 60 Images

http://10.163.22.60 - VASARI Prototype Imaging Form - Microsoft Internet Explorer

MULTICENTRIC: spread via commissural or other pathways, or via CSF channels or local metastases, whereas **Multicentric** are widely separated lesions in different lobes or different hemispheres that cannot be attributed to one of the previously mentioned pathways. **Gliomatosis** refers to generalized neoplastic transformation of the white matter of most of a hemisphere.

T1/FLAIR: Tumor feature summary. [Mixed, expansive or infiltrative]. **Expansive** = size of pre-contrast T1 abnormality = size of FLAIR abnormality. **Mixed** = Size of T1 abnormality slightly less than FLAIR envelope; **Infiltrative** = Size of pre-contrast T1 abnormality much smaller than size of FLAIR abnormality.

MORPHOLOGY OF LESION MARGIN:

Thickness of enhancing margin: The scoring is not applicable if there is no contrast enhancement. If most of the enhancing rim is thin, regular, and has homogenous enhancement, the tumor receives a score of 1. If most of the rim demonstrates nodular and/or thick enhancement, the score is 2. If there is only solid enhancement and no rim, the score is 0.

Definition of the enhancing margin: The scoring is not applicable (N/A) if there is no contrast enhancement. If most of the outside margin of the enhancement is well defined, the tumor is scored 1, otherwise 0.

Definition of the non-enhancing margin (en Grade III): If most of the outside nonenhancing margin of the tumor is well defined and smooth (geographic), the tumor is scored 0. If the margin is ill-defined, the tumor is scored 1 - irregular.

ALTERATIONS IN VICINITY OF LESION:

Proportion of Edema: What proportion of the entire abnormality is vasogenic edema? (Assuming that the the entire abnormality is comprised of: (1) an enhancing component, (2) a non-enhancing component, (3) a necrotic component and (4) a edema component.)

Edema Crosses Midline: Edema spans white matter commissures extending into contralateral hemisphere, (exclusive of herniated ipsilateral tissue).

Hemorrhage: Intrinsic hemorrhage in the tumor matrix.

Diffusion: Facilitated or restricted diffusion (Based on ADC map). Equivocal or none is N/A.

Pial invasion: Enhancement of the overlying pia in continuity with enhancing or non-enhancing tumor

Ependymal invasion: Invasion of any adjacent ependymal surface in continuity with enhancing or non-enhancing tumor matrix - characterized by enhancement of the ependyma.

Cortical involvement: Non-enhancing or enhancing tumor extending to the cortical mantle, or cortex is no longer distinguishable relative to subjacent tumor.

Deep WM invasion: Enhancing or nCET tumor extending into the internal capsule or brainstem.

nCET tumor Crosses Midline: nCET crosses into contralateral hemisphere through white matter commissures (exclusive of herniated ipsilateral tissue).

Enhancing tumor Crosses Midline: Enhancing tissue crosses into contralateral hemisphere through white matter commissures (exclusive of herniated ipsilateral tissue).

Satellites: A satellite lesion is within the region of signal abnormality surrounding the dominant lesion but not contiguous in any part with the major tumor mass.

Calvarial remodeling: Erosion of inner table of skull (possibly a secondary sign of slow growth)

EXTENT OF RESECTION:

Extent of resection of enhancing tumor: [NA, <20%, 20%-89%, 90%-99%, 100%] Using the first postoperative scan (contrast-enhanced MR imaging) assessed for tumor residual. Estimate the proportion of enhancing tumor removed. Total resection of component should be scored 100%. Subtotal resection of enhancing tissue should be scored accordingly.

Extent of resection of nCET with nCET: [NA, <20%, 20%-89%, 90%-99%, 100%] Using the first postoperative scan (contrast-enhanced MR imaging) assessed for tumor residual. Estimate the proportion of non-enhancing tumor removed. Total resection of component should be scored 100%. Subtotal resection of enhancing tissue should be scored accordingly.

Extent of resection of vasogenic edema: [NA, <20%, 20%-89%, 90%-99%, 100%] Using the first postoperative scan (contrast-enhanced MR imaging) assessed for tumor residual. Estimate the proportion of edema removed. Total resection of enhancing nodule should be scored 100%. Subtotal resection of enhancing tissue should be scored accordingly.

Comments:

Submit **Internet**

Done **Internet**

Start Philips iSite - Microsoft... http://10.163.22.60... iFanView VASARIdemo

5:11 PM

Study display with evaluation form in the foreground.

Database Extract

ID	examnum	radiologist	comments	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12	f13	f14	f15	f16	f17	f18	f19	f20	f21	f22	f23	f24	f25	f26	f27	f28	f29	f30
56	1	aflanders	hemorrhage in surgical bed post-op.	1, 2	1	1	1	1	6	1	1	1	1	1	1	2	3	2	1	1	1	1	1	1	2	1	1	1	1	4	2	11	7
60	2	aflanders		2	2	1	3	3	3	4	1	1	2	4	2	2	3	2	2	2	1	1	2	2	2	2	1	4	3	2	11	9	
61	1	rjg143	for location I would add insular	1, 2	1	1	1	1	6	1	1	1	1	1	1	2	2	1	1	2	1	1	2	1	1	1	1	1	5	1	11	7	
62	3	aflanders		2	1	1	3	4	3	3	1	1	3	3	2	2	3	2	1	1	1	1	1	1	2	2	1	1	7	5	2	7	7
63	1	dxf113		1, 2	1	1	1	1	6	1	1	1	1	1	1	2	2	1	1	2	1	1	2	1	1	1	1	4	1	11	7		

- Data is stored by a unique entry ID and exam number.
- Keyed by radiologist identifier and exam number.
- Thirty MRI features stored f1 - f30.
- Data can be exported in multiple formats and joined to demographic table to extract GMDI number etc.

Other Details

- Application was designed to work on ubiquitous Enterprise PC systems instead of dedicated clinical PACS in order to minimize barriers to participation.
- Application is hidden from other users.
- Feature variables are stored as ordinal, categorical or boolean values.
- Editing of data submission is not permitted.
- Previously reviewed studies automatically disappear from the VASARI worklist and cannot be re-evaluated.

Status

- Application completed and tested.
- All imaging data loaded into clinical PACS and tested for integrity.
- The three evaluators have performed a trial run of the software to assess performance.
 - Modifications made to data form based upon suggestions by reviewers.
- Pilot assessment of five cases will complete last week of March.
- Pilot data to be analyzed/validated prior to completion of entire cohort.