Quick-Brain MRI for VP Shunt Evaluation

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Disclosure

- Dr. Selden has no relevant disclosures

Background

- In CSF shunt dependent children, shunt failure is common
- Shunt malfunction symptoms are protean, and additional negative work-ups for failure are also common

Background

- Standard work-up for CSF shunt malfunction includes:
  - Brain CT (non-contrast)
  - Shunt series radiographs

- Sensitivity of brain CT for shunt malfunction is 54 to 83%
  - History and clinical evaluation remain critical

Background

Significant radiation exposure accrued over lifetime with frequent brain CTs

- Radiation-induced cancer

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Background

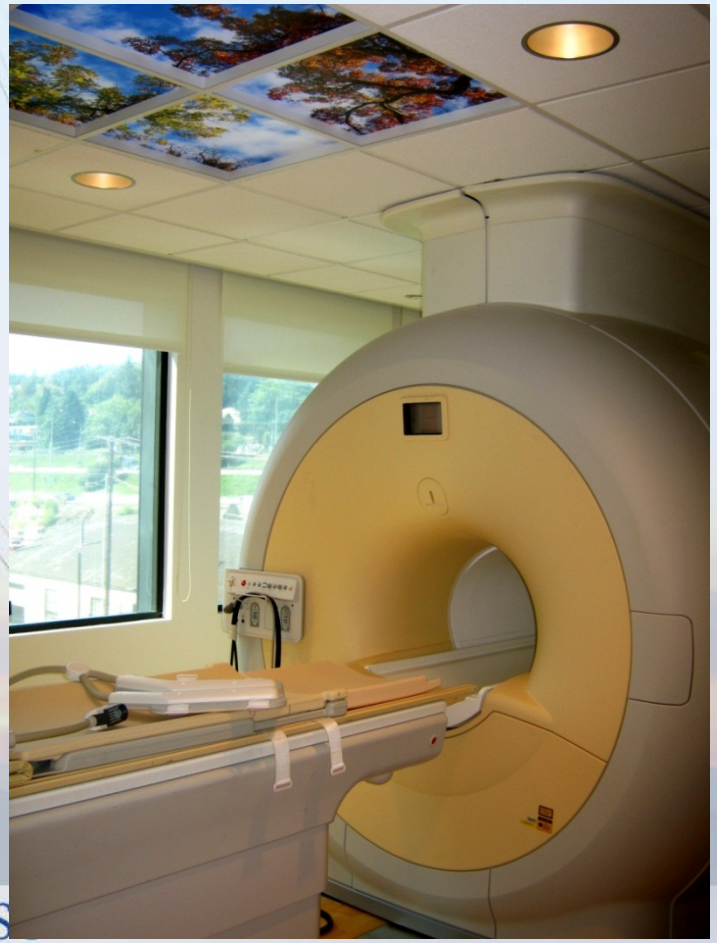
Significant radiation exposure accrued over lifetime with frequent brain CTs

– Radiation-induced cancer

2 – 5 mSv dose for each brain CT

3 mSv background radiation each year at sea level
0.01 mSv for 1 chest radiographs
200-400 chest radiographs for 1 brain CT

Quick Brain MRI



- Introduced in 2002
- Images within seconds
- Sedation rarely needed
- No ionizing radiation

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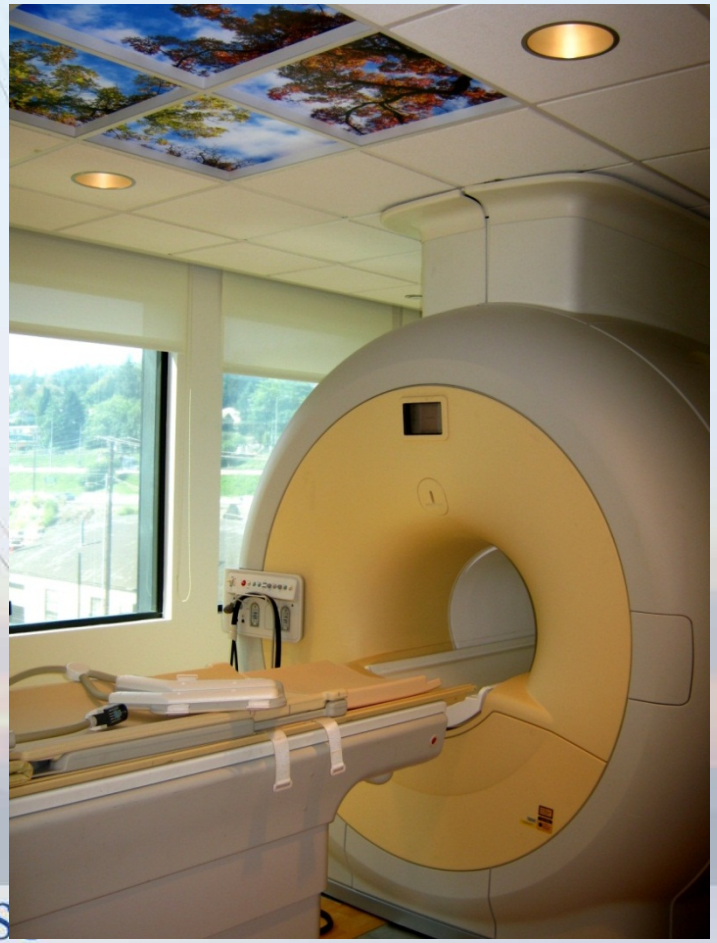
Quick Brain MRI

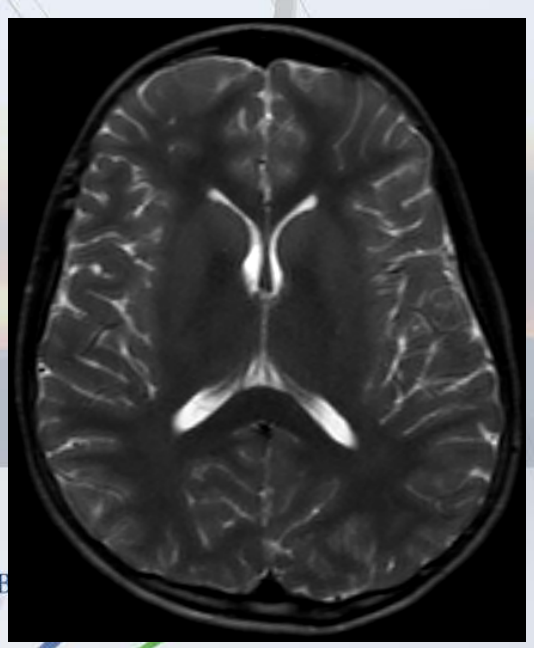


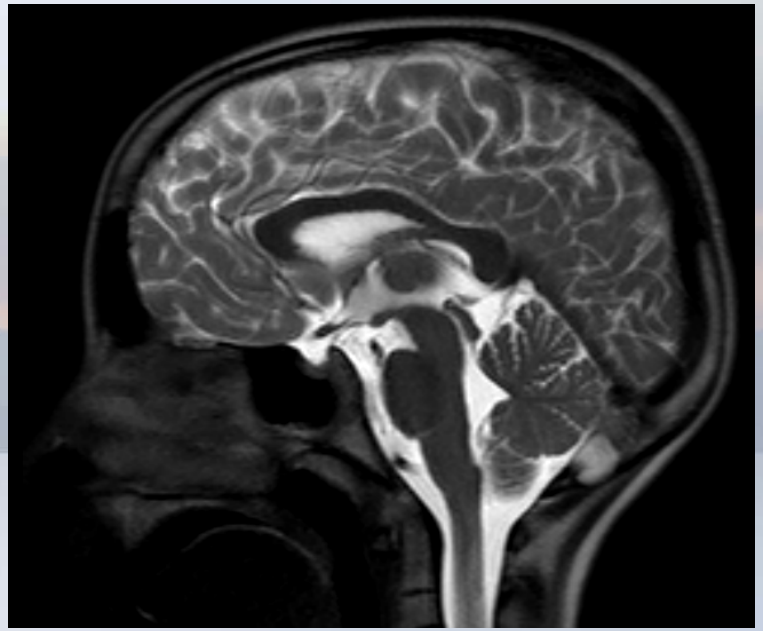
- Introduced in 2002
- Images within seconds
- Sedation rarely needed
- No ionizing radiation
- *Is QB MRI as accurate as CT?*

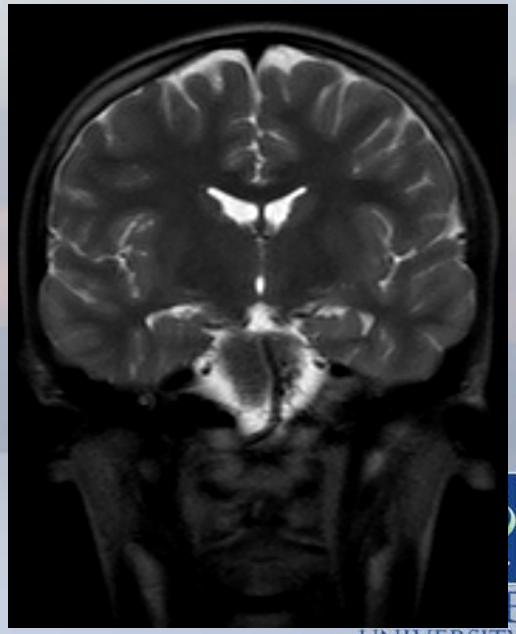
Quick Brain MRI

localizer – 3 plane scout

axial, sagittal & coronal - T2 weighted fast spin echo images



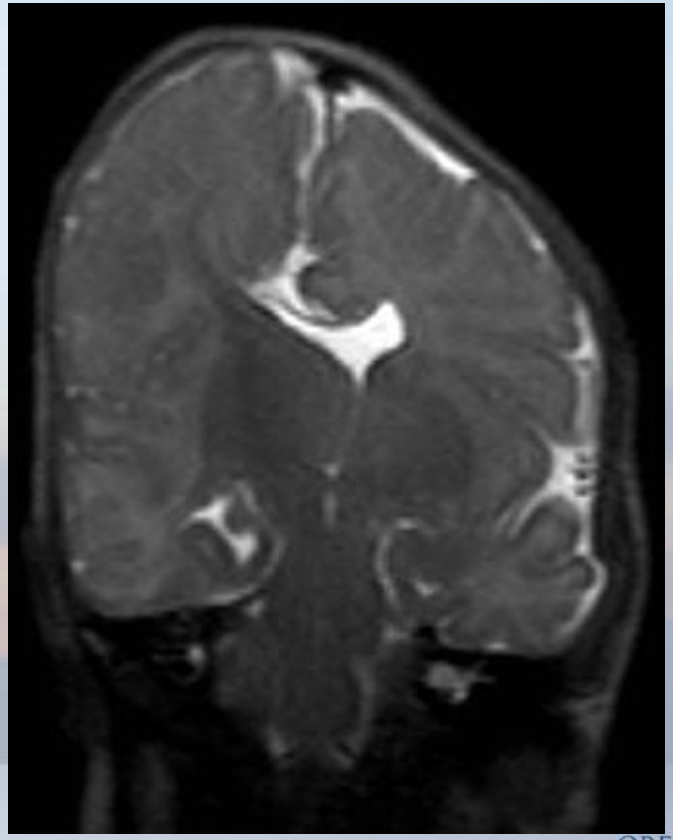




QB-MRI

Pre-shunt placement

Post-shunt placement



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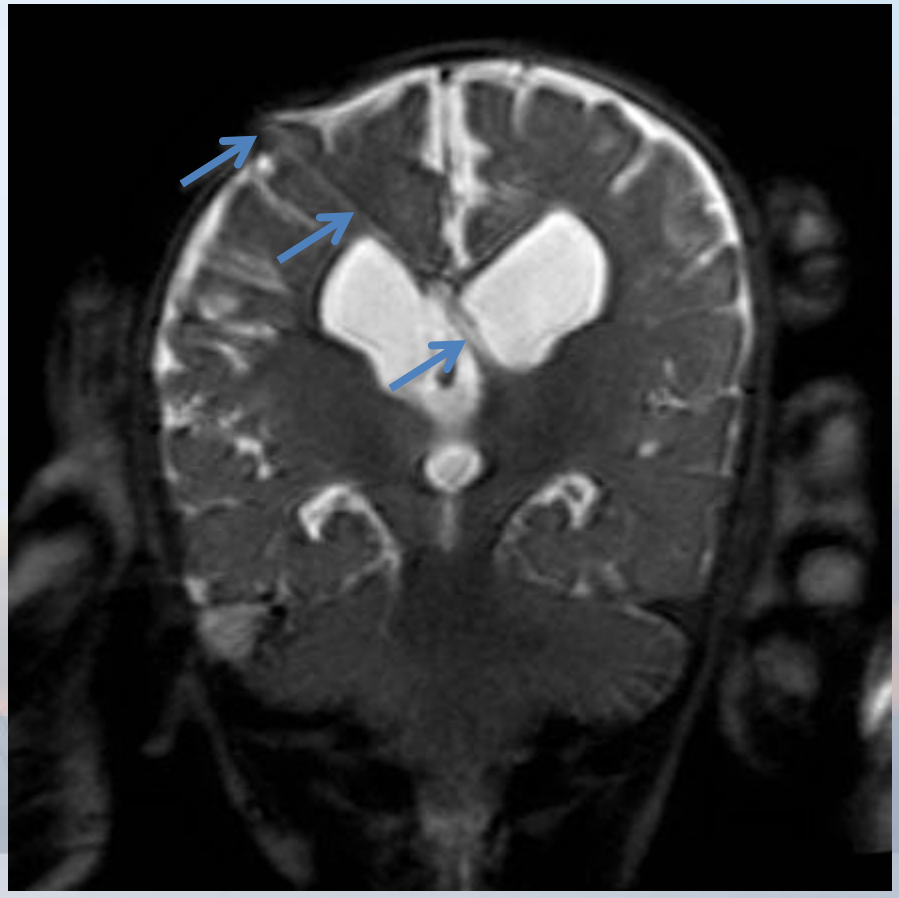
QB-MRI



Visible Shunt

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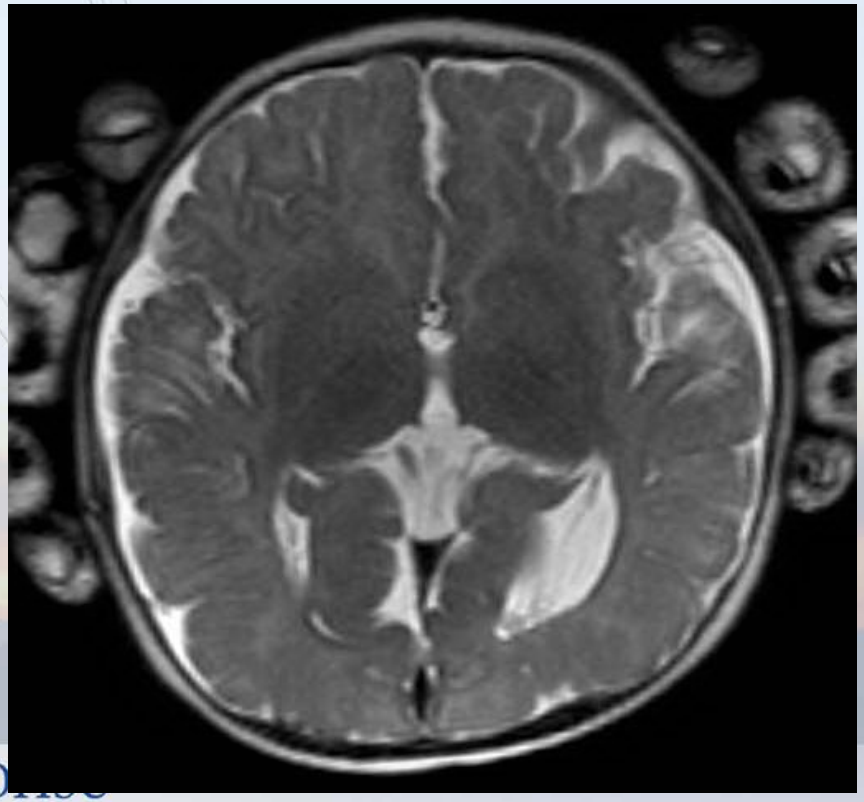
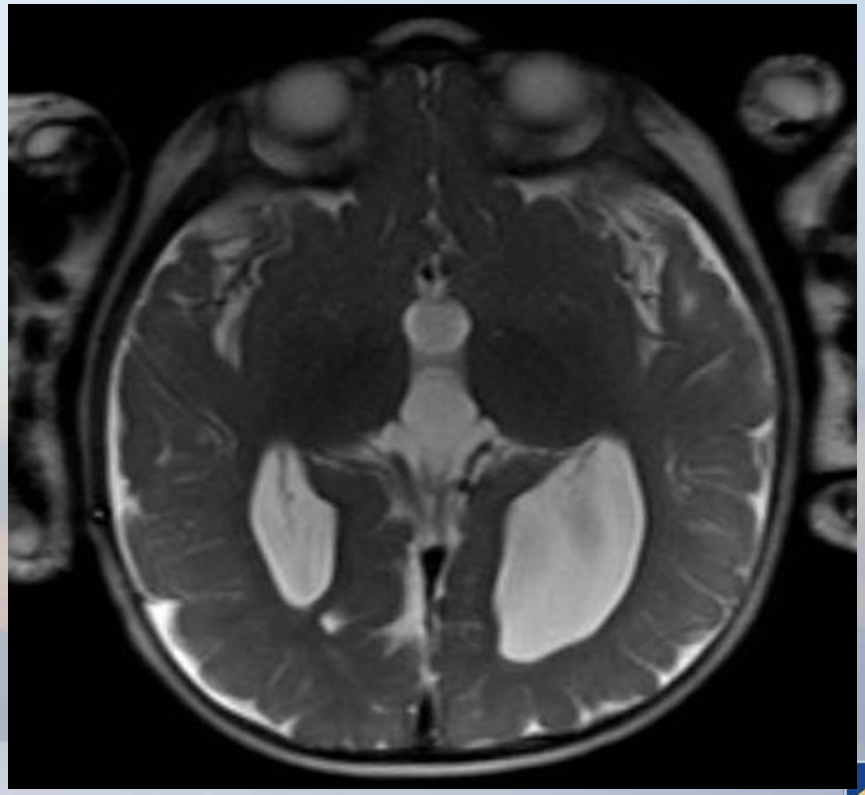
QB-MRI

Baseline Scan



Failure Scan



Quick Brain MRI At OHSU

- Children with suspected CSF shunt malfunction
  - ≥ 200 annual ED visits

- Clinical Pathway modified in Aug 2009
  - QB-MRI **within 60 min of presentation**
  - Brain CT w/o contrast – as needed if unstable
  - Shunt series radiographs
  - Neurosurgical consultation

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Study Objectives

- To compare QB-MRI and brain CT for CSF shunt malfunction evaluation
  - Accuracy
  - Time from presentation to imaging completion
  - Time from presentation to QB-MRI completion before and after shunt pathway established
- To compare sedation use for QB-MRI and brain CT imaging

Methods

- Design: Retrospective study
- Location: Two pediatric EDs in Portland
- Review of all QB-MRI and Brain CT images from hospital and ED databases
- Population: < 18 years of age
- Duration of study: July 2008 - June 2012

Results

- 1435 cases reviewed, 438 excluded
- 997 cases included 273 CT and 724 QB-MRI

	Number of Cases
Emanuel CT	134
OHSU CT	139
OHSU QB-MRI	724

Results

- Mean age 7.1 years (range 22d – 17.9y)
- 37% girls, 63% boys
- Rates of Shunt Failure
  - CT (27.3%) vs. QB-MRI (26%) P=0.74

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Results: Accuracy

Shunt revision in 235 of 997 patients (23.6%)

	CT (OHSU + Emanuel)	QB-MRI (OHSU only)	
Sensitivity	**53.2%** (38.1% - 67.9%)	**58.5%** (51.1% - 65.6%)	*P*=0.51
Specificity	**95.6%** (92% - 97.9%)	**93.3%** (90.8% - 95.3%)	*P*=0.23

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Results: Accuracy

Shunt revision in 235 of 997 patients (23.6%)

	CT (OHSU + Emanuel)	QB-MRI (OHSU only)	
PPV	**71.4%**	**75.3%**	*P*=NS
NPV	**90.8%**	**86.5%**	*P*=NS

PPV = ‘Precision rate’

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Results: Accuracy

Shunt revision in 235 of 997 patients (23.6%)

	CT (OHSU + Emanuel)	QB-MRI (OHSU only)	
Positive LR	**12.02**	**8.71**	*P*=NS
Negative LR	**0.49**	**0.44**	*P*=NS

LR = Likelihood Ratio

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OHSU Time Intervals

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OHSU QB-MRI Time Intervals

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Sedation or Anxiolysis

3.7% of CTs and 4.4% of QB-MRI (*P*=0.74)

	CT	QB-MRI
Intranasal Midazolam	0	9
Intranasal Fentanyl	0	0
IV Lorazepam	1	2
IV Midazolam	4	6
IV Ketamine	1	0
IV Propofol	1	2
Oral Lorazepam	0	0
Oral Midazolam	3	12
	10 of 273 patients	32 of 724 patients

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Conclusions

- CT and QB-MRI have similar accuracy
- CT is completed 32 min faster than QB-MRI
- Clinical pathway reduces total time by 20 minutes
- CT and QB-MRI require similar, rare use of sedation
- QB-MRI may be used in the evaluation of ventricular shunt malfunction to avoid radiation exposure

Adoption

Results of a North American survey of rapid-sequence MRI utilization to evaluate cerebral ventricles in children

Clinical article

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Object. Growing concern about potential adverse effects of ionizing radiation exposure during imaging studies is particularly relevant to the pediatric population. To decrease radiation exposure, many institutions use rapid-sequence (or quick-brain) MRI to evaluate cerebral ventricle size. There are obstacles, however, to widespread implementation of this imaging modality. The purpose of this study was to define and quantify these obstacles to positively affect institutional and governmental policy.

Methods. A 9-question survey was emailed to pediatric neurosurgeons who were either members or candidate members of the American Society of Pediatric Neurosurgeons at every one of 101 institutions in the US and Canada having such a neurosurgeon on staff. Responses were compiled and descriptive statistics were performed.

Results. Fifty-six institutions completed the survey. Forty-four (79%) of the 56 institutions currently have a rapid-sequence MRI protocol to evaluate ventricle size, while 36 (64%) use it routinely. Of the 44 institutions with a rapid-sequence MRI protocol, 29 (66%) have had a rapid-sequence MRI protocol for less than 5 years while 39 (89%) have had a rapid-sequence MRI protocol for no more than 10 years. Thirty-six (88%) of 41 rapid-sequence MRI users responding to this question obtain a T2-weighted rapid-sequence MRI while 13 (32%) obtain a T1-weighted rapid-sequence MRI. Twenty-eight (64%) of 44 institutions never use sedation while an additional 12 (27%) rarely use sedation to obtain a rapid-sequence MRI (less than 5% of studies). Of the institutions with an established rapid-sequence MRI protocol, obstacles to routine use include lack of emergency access to MRI facilities in 18 (41%), lack of staffing of MRI facilities in 12 (27%), and the inability to reimburse a rapid-sequence MRI protocol in 6 (14%). In the 12 institutions without rapid-sequence MRI, obstacles to implementation include lack of emergency access to MRI facilities in 8 (67%), lack of staffing of MRI facilities in 7 (58%), the inability to reimburse in 3 (25%), and lack of administrative support in 3 (25%). To evaluate pediatric head trauma, 53 (96%) of 55 institutions responding to this question use noncontrast CT, no institution uses rapid-sequence MRI, and only 2 (4%) use standard MRI.

Conclusions. Many North American institutions have a rapid-sequence MRI protocol to evaluate ventricle size, with most developing this technique within the past 5 years. Most institutions never use sedation, and most obtain T2-weighted sequences. The greatest obstacles to the routine use of rapid-sequence MRI in institutions with and in those without a rapid-sequence MRI protocol are the lack of emergency access and staffing of the MRI facility during nights and weekends.

(http://thejns.org/doi/abs/10.3171/2014.2.PEDS13567)

Key Words • **rapid sequence MRI** • **radiation** • **hydrocephalus** • **ventricles** • **technique**

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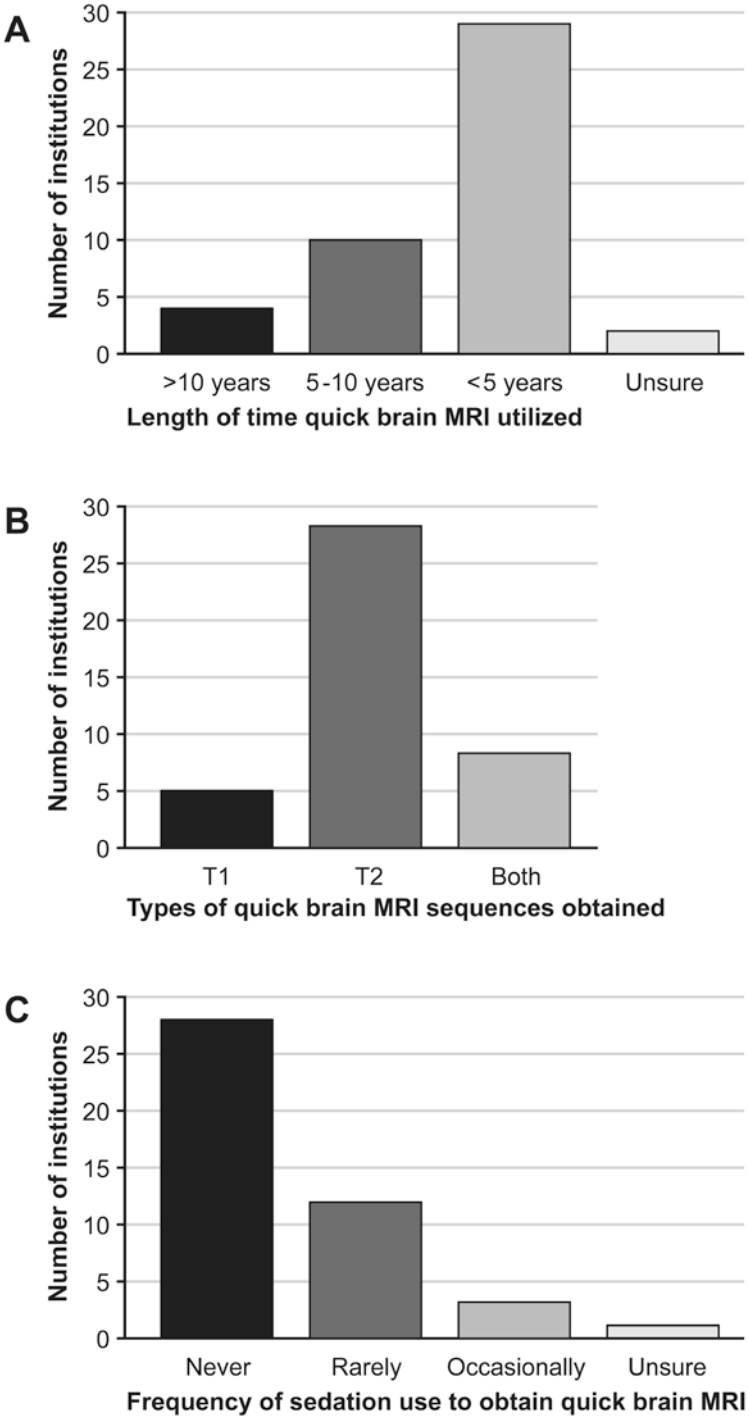
Adoption



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