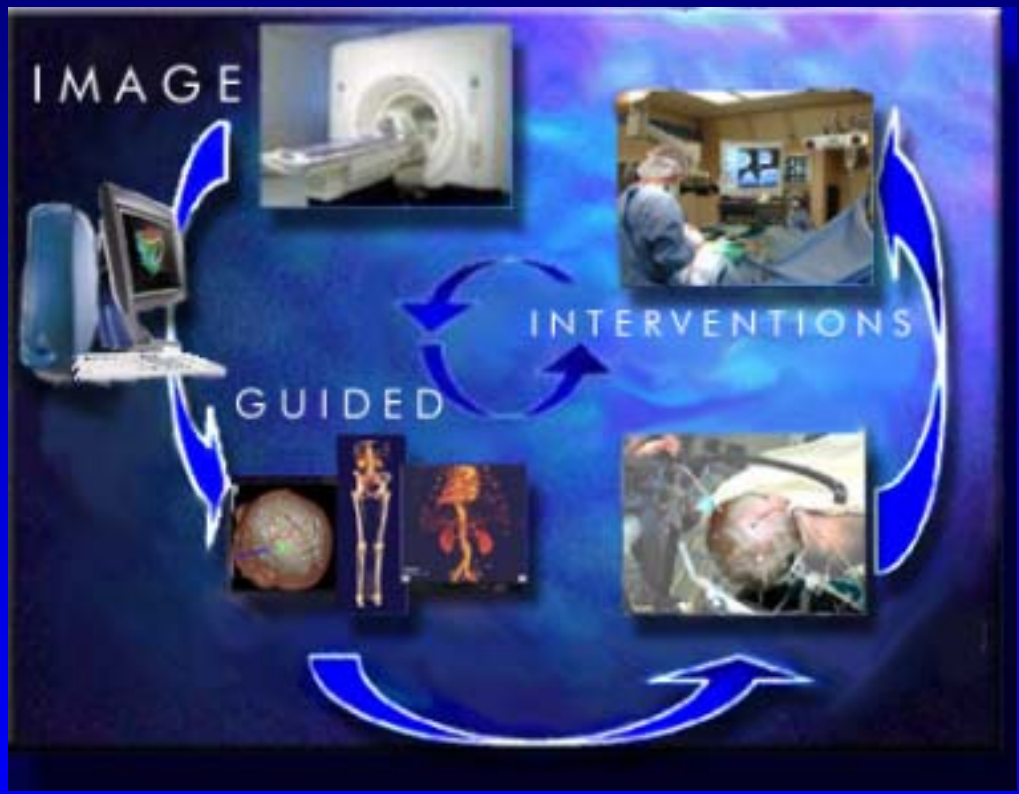
Image Guided (Neuro)surgery: Technical Requirements and Barriers



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“A License to Cut is a License to Create Havoc” (Tom Starzl)

Three Types of IGS

a) Map preoperative image(s) to patient and instruments.

b) Intraoperative imaging (generally lower quality images)

c) Combine a) and b)

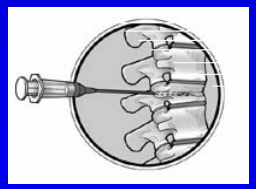
Technical Requirements of IGS

- Speed and accuracy (Variable!)
- Needs for methodological development
- Validation and assessment of uncertainty

Speed and Accuracy: Speed

General point: Speed requirement depends upon how often a process must be performed. Example: Register preoperative 3D image to patient.

Stereotactic frame: 1 hour set-up time OK



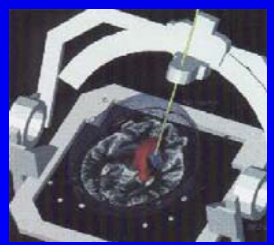
Streaming video: at least 7.5 frames/second.

Procedural interruption: 1-5 minutes

Speed and Accuracy: Accuracy

General point: Accuracy requirements depend on extent of other corroborative methods and on consequences of error.

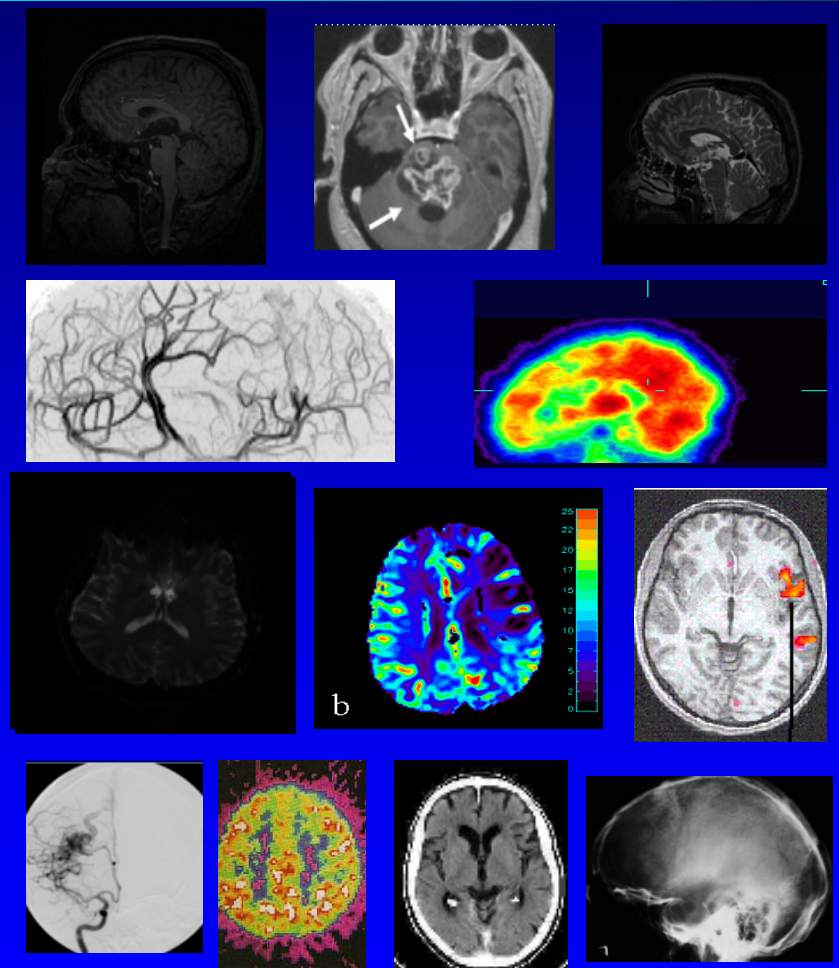
Endoscopy (abdominal, spine, intraventricular): Small view in a big field. Accuracy: ~5mm – 1 cm for orientation.



Stereotactic/percutaneous: “Pin the tail on the donkey”. Accuracy: 2mm or less if structures sensitive.

Requirements: Needs for Development—1/5

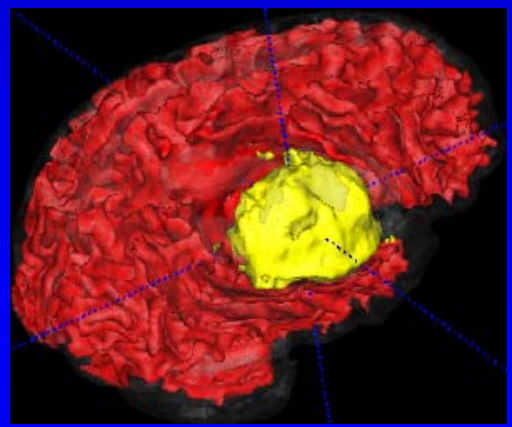
Better, faster, standardized methods of combining useful information from multiple imaging sources.



Requirements: Needs for Development—2/5

Accurate segmentation and registration!

Methods need to address segmentation of pathology and relationship of a lesion to other anatomical structures.



Requirements: Needs for Development—3/5

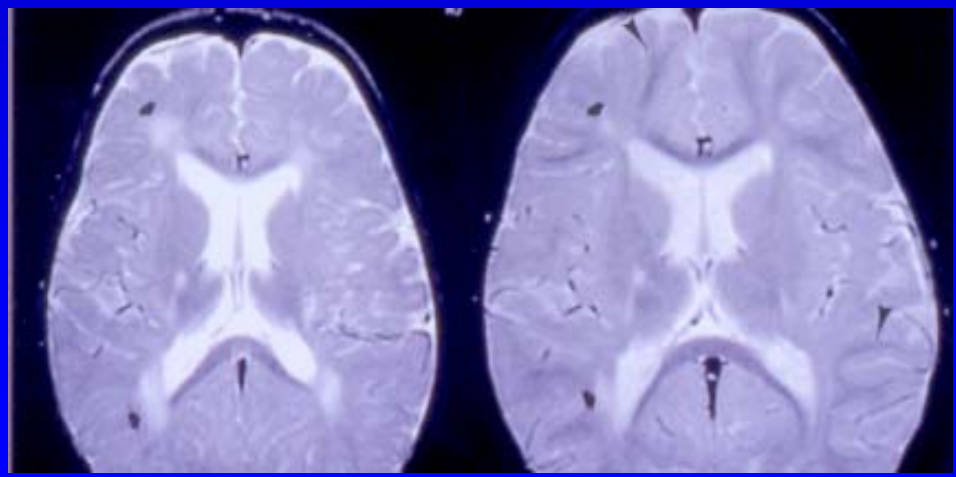
Deformable registration of intraoperative anatomy to preoperative images.

This need requires intraoperative imaging.

Requirements: Needs for Development 4/5

New markers for directed therapy and new methods of image analysis

Example: where do intravenously injected stem cells go?

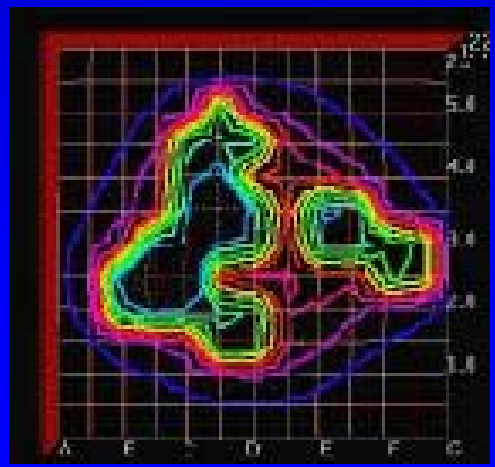


Requirements: Needs for Development 5/5

Validation

No standardized means to evaluate segmentation/registration

Expressions of uncertainty



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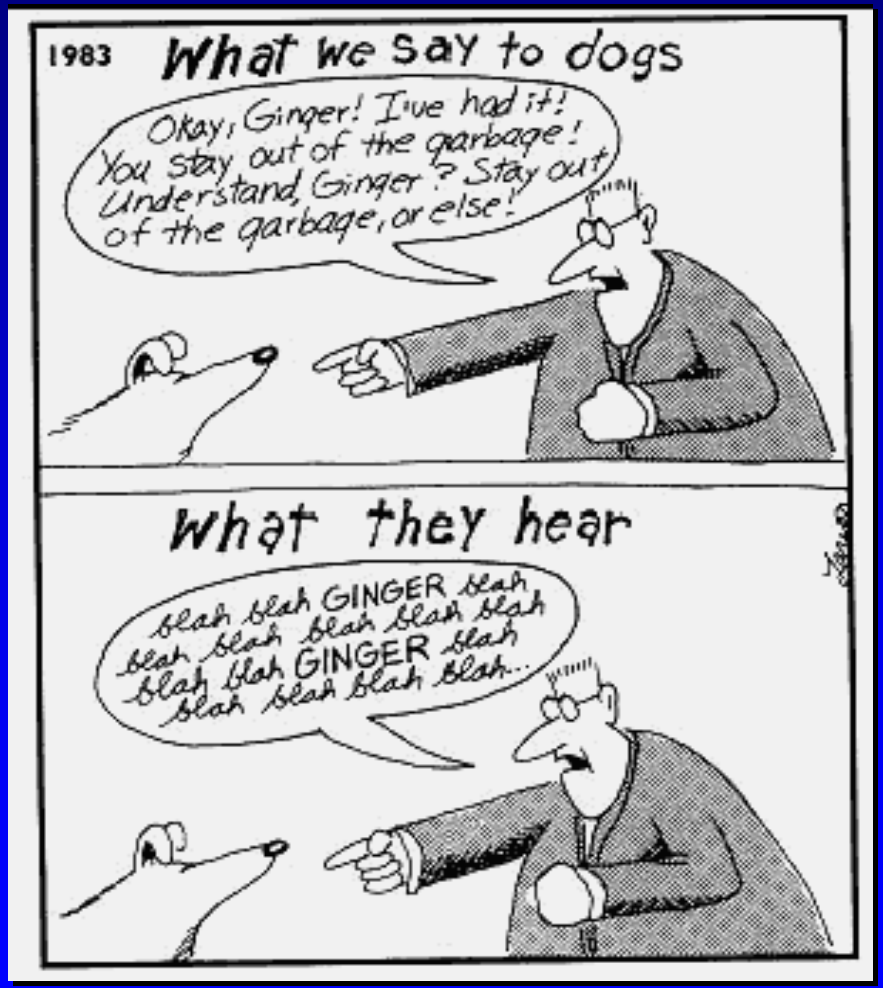
Technical Requirements and Barriers

Barriers

1. Cross-disciplinary communication is tough!

2. Changing social/clinical environment makes it increasingly difficult for physicians to collaborate

Communication Between Disciplines



1. Clinicians and engineers speak in different tongues (frustration may make the other seem like a dog)
2. Clinicians may not know what is technically possible; engineers may not know the problems.
3. Continued, ongoing collaboration essential

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Problems for Collaborating Clinicians

1. FINANCIAL: A clinician must bill ~5x his/her salary to break even for the department. NIH does not cover malpractice insurance etc.

2. TIME: Changing environment for medicine. Billing codes, resident rules.

Summary