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Working Group: *#13 Bioengineering, Biotechnology, and Imaging*

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Working Group Members

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Research Areas

- Luminal structures
  - Surveillance and detection
  - Ablation/resection/excision
  - New technologies for imaging and treatment
- Solid organ structures
  - Procedural planning
  - Procedural guidance
  - Interventional technologies
  - Detection and targeting
- Imaging
  - Image enhancement
  - Molecular imaging
  - Remote endoscopy
  - Virtual endoscopy
- Emerging technologies
  - NOTES
  - Robotics
- Tissue engineering/regenerative medicine
- Simulation – training - competency

Research
Major Overarching Goals

- Create a registry and multi-center consortium of expert sites using advanced/novel technologies for evaluation and treatment of luminal disease by disease group to enhance RCT design/accrual/assessment
  - Barrett's-esophageal neoplastic disorders
  - Benign foregut disorders
    - GERD, gastroparesis, obesity, hemorrhagic lesions
  - Gastric neoplasia
  - Colorectal neoplasia
    - Polyps, dysplasia, flat lesions, hemorrhagic lesions, cancers
  - Small bowel
    - Neoplasms, Crohn's, inflammation, hemorrhagic lesions, malabsorptive conditions
  - IBD
    - Disease activity/dysplasia
  - Bile duct and pancreatic duct
    - Cholangiocarcinoma, stricture, IPMN

Blue Font = Most Important Goals

Research
Overarching Goals

- Determine optimal structure and process for NIH funded investigators and industry to partner in research: manage conflict of interest, intellectual property

- Define interface of research vs development and recognize role of NIH and funded investigators in development and testing of new devices and technologies in partnership with industry

- Develop and fund multidisciplinary centers for technology design, development and testing to foster scientific investigation between all relevant areas of expertise: GI medicine and surgery, engineering, imaging, chemistry, computer science, etc. *focusing on including those scientific expertise conventionally outside of biomedical sciences*

Research
Overarching Goals

- Convene an NIH – sponsored session for early assessment of data on promising new technologies by experts to address key questions and studies that need to be done over the ensuing 3-7 years, followed by an RFA in targeted areas

- Randomized trials of endoscopic therapy vs. minimal access surgical technologies for conditions amenable to either approach
  - Efficacy/outcome measures
  - Cost analysis
  - QOL
  - Complete rigorous studies of physiologic and immunologic response to minimal access surgery to determine if biologic advantage may exist for these procedures

Luminal Disease Technologies: Specific Goals

- Develop and validate a method to perform a “molecular” biopsy of luminal abnormalities in real time
- Develop improved endoscopic instrumentation for therapeutic endoscopy
- Develop improved technology to access the luminal space of the GI tract: virtual endoscopy
- Define mechanisms of scar tissue formation in the gastrointestinal tract
- Improve stent design, materials and technology

TE/RM Specific Goals

- Identify and isolate local stem cell populations in the GI tract for tissue engineering applications
- Develop scaffolds, both naturally occurring and synthetic, to support growth and differentiation of cell populations indigenous to the gastro-intestinal tract
- Develop TE/RM methods for esophageal and small bowel disorders
- Create awareness of TE/RM applications in the GI tract in the clinical community

Imaging – Therapeutics Interface Goals

- **Image-guided therapeutics: enhance interface between imaging and therapeutic interventions in GI tract: specific goals**
  - Continue to develop percutaneous and external beam energy source for tissue ablation
  - Extend radiologic virtual endoscopy to therapeutic interventions (VR image guided biopsy/polypectomy/ablation)
  - Develop technologies for real time stereotaxis with image superimposition for accurate surgeries
  - Develop optically-based intraoperative imaging such as with fluorescent antibodies, fluorescent metabolic probes to distinguish tumor from vital structures in order to allow safer and more efficacious minimally invasive surgery

Imaging – Therapeutics Interface Goals

- Develop new PET tracers for clinical use including markers of proliferation, tumor specific antigens, markers of apoptosis, and inflammation
- Develop intraoperative high energy gamma and beta detectors to enhance intraoperative localization
- Develop navigation and control devices to allow single port laparoscopic procedures, intraluminal procedures, and natural orifice surgeries

Procedural Technology Innovation: Specific Goals

- Develop expanded capsule endoscopy applications to allow therapeutic intervention
- Develop 3-D, robotic flexible operating systems
- Develop wireless, robotic driven remote endoscopy
- NOTES technology
  - Large scope design
  - Triangulation
  - Microrobotics for accurate complex end effector control
  - Control of video horizon
  - Instrument design (surgical tools for flexible endoscopes: graspers, scissors, clips, suturing machines, staplers, hemostatic energy sources)

Simulation and Workforce Preparation Goals

- **Validate simulation training for surgical endoscopy (laparoscopy and flexible)**
- **Epidemiologic validation of simulation (team and individual) as a way to reduce medical error**
- **Develop high definition VR simulation for skills acquisition and mastery**
- **Design and validate curriculum that optimizes skills transfer**
- **Scientific expertise to develop GI and surgical simulation is outside medical workforce – atypical collaborations**
- **Validation of clinical impact : does this type of training translate into superior learning curve ,error reduction, cost effectiveness, return on investment**
- **Facility infrastructure to support training for new trainees and re-tooling physician – dated workforce**

Simulation and Workforce: Major Challenges Steps To Achieve Goals

- Cost of simulation development is high relative to market return
  - Scientific expertise to develop GI and surgical simulation is outside medical workforce – atypical collaborations
  - Validation of clinical impact : does this type of training translate into superior learning curve ,error reduction, cost effectiveness, return on investment
  - Facility infrastructure to support training for new trainees and re-tooling physician – dated workforce

Major Challenges
Steps To Achieve Goals

- Funding Issues
  - Few mechanisms of funding for translational clinicians (physicians who have the patient volume who understand and can bridge the basic science question and technologies) and clinical research
  - Lack of support of RCTs as part of the tradition of the NIH
  - Lack of clear support from NIH for endoscopic clinical trials
  - and technology Need a new line of training grants for technology feasibility/assessment implementation/training
  - Few endoscopists or surgeons, if any, on NIH study sections
- Cost of research development in imaging is extraordinary – need cooperative ventures between NIH and industry to establish centers for advanced and intraoperative imaging to facilitate rapid progress.

Major Challenges
Steps To Achieve Goals

- Technology Issues
  - Technologic design requires expertise outside of medicine: engineering, computer science. Effective collaboration between clinicians and these types of scientists are not common.
  - Device industry do not invest resources to prove the efficacy of their device.
  - Market forces drive research and development by industry – rather than seeking the scientific cutting edge
  - New techniques are not reimbursable slowing adaptation of proven technologies – how can we get improve delivery of valuable new technology to the patient?

Major Challenges
Steps To Achieve Goals

- All new tracers will likely require IND's. Having the NIH hold IND's for promising tracers for molecular imaging and help in clinical grade agent production with help in advancement of this field.
- Establishing national reference preclinical toxicology laboratories to perform preclinical testing to facilitate development of molecular imaging reagents and novel anti-neoplastic agents.
- Small tech companies trying to develop imaging or intraprocedural guidance technology usually do not have sufficient capitalization and value is based primarily on a small amount of academically based intellectual property. Prioritize more academic-small industry funding to foster development of the products from this type of direct translational research.

Major Challenges
Steps To Achieve Goals

- Difficulties in Conducting Research
  - Problems with principal investigators and COI
  - Intellectual property concerns
  - Difficulties in conducting research in U.S. with HIPPA regulations
  - Difficulties in conducting research in U.S. with medical malpractice concerns
  - Definitive studies will require multisite collaboration to sufficiently power studies
  - Declining interest in research career due to financial disincentive: raise NIH salary cap

Major Challenges
Steps To Achieve Goals

- Difficulties in Conducting Research (cont'd)
  - IRBs are very reluctant to allow investigation of new technologies that have any risk to the patients. These technologies are being studied in other countries
  - Ethical implications of introducing new technologies: patient safety; incremental vs transforming technologies

Major Challenges
Steps To Achieve Goals

- The gastrointestinal tract has not been pursued in TE/RM investigations relative to other tissues. *Opportunity: Funding via RFPs to support targeted areas of development and early efforts to support early clinical translation could yield proportionally greater impact on the field over the next 5-10 years*.