Redefining the Future of Cancer Treatment

Student Research Day
Tennessee Technological University

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What is Research? - The Scientific Method

- **Research** and experimental development is formal work undertaken systematically to increase the stock of knowledge, including knowledge of humanity, culture and society, and the use of this stock of knowledge to devise new applications.

- **Scientific Method**
  - **Observations and Formation of the topic**: Consists of the subject area of ones interest and following that subject area to conduct subject related research.
  - **Hypothesis**: A testable prediction which designates the relationship between two or more variables.
  - **Conceptual definition**: Description of a concept by relating it to other concepts.
  - **Operational definition**: Details in regards to defining the variables and how they will be measured/assessed in the study.
  - **Gathering of data**: Consists of identifying a population and selecting samples, gathering information from and/or about these samples by using specific research instruments.
  - **Analysis of data**: Involves breaking down the individual pieces of data in order to draw conclusions about it.
  - **Data Interpretation**: This can be represented through tables, figures and pictures, and then described in words.
  - **Test, revising of hypothesis**
  - **Conclusion, reiteration if necessary**
Research + Development + Commercialization + 5(P) = SUCCESS

5 P’s of success

• Purpose
  - The secret of success is constancy of purpose. - Benjamin Disraeli

• Planning
  - In all things, success depends upon previous preparation, and without such preparation there is sure to be failure. - Confucius

• Positive Thinking
  - The difficult can be done immediately, the impossible takes a little longer. - Army Corp. of Engineers

• Passion
  - Do what you love.— Marsha Sinetar

• Persistence
  - Success is going from failure to failure without losing your enthusiasm. - Abraham Lincoln
Research Making a Difference – Cancer Care

**PET - Diagnosing Cancer**
(Positron Emission Tomography)

- Functional Imaging
- Early detection

**PT- Treating Cancer**
(Proton Therapy)

- Precision treatment
- Faster, safer
A Pioneering Community

**Knoxville-Oak Ridge Innovation Valley** is the hub for Radiological Science

- Oak Ridge National Laboratory
- Spallation Neutron Source
- Radiation Detection and Instrumentation
- PET & PET/CT Imaging, PET Cyclotrons
- Bio-Tracer Technology

- University of Tennessee
- Proton Therapy
- Cryo-magnetics
- Radioisotopes
- Scintillation
PET/CT impacts patient management 36% of the time compared to CT or PET alone.
microPET® Image Acquisition

- 34g mouse
- 1 bed position
- Variable time frames
- 1msec -static

Michael Kreissl MD, Hsiao-Ming Wu PhD, David Stout PhD, Patrick L Chow MS, Arion Chatziioannou PhD, Sung-Cheng Huang DSc, Heinrich R. Schelbert MD PhD, Crump Institute for Molecular Imaging
Combined Experience

ProNova has a strong History of Innovation

- Developed and commercialized PET & PET/CT technology
- One of the largest suppliers of Cyclotrons in the world

ProNova Solutions.com
Redefining the Future of Cancer Treatment

Proton Beam Radiation Therapy

- Research
- Development
- Commercialization
What is Proton Therapy?

- Protons deposit their maximum energy in the tumor and then stop.

- Conventional radiation therapy (photons or x-rays) deposits energy entering the tumor and exiting the tumor potentially damaging healthy tissue.

- Collateral tissue damage, side effects, secondary tumors, and total treatment costs are all reduced with proton therapy.

http://www.youtube.com/watch?v=OTd5dv3VDws
What Makes PT Different?

Protons deposit their maximum energy in the tumor and then stop.
Proton Therapy Improved Outcomes

<table>
<thead>
<tr>
<th>MODALITY</th>
<th>DOSE</th>
<th>RECURRENCE</th>
<th>COMPLICATIONS</th>
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<td>&lt;60GY</td>
<td>38%</td>
<td>22%</td>
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<td>Radiation</td>
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<tr>
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<tr>
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<tr>
<td>PROTONS</td>
<td>75GY</td>
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</table>

**Improvements in Prostate Cancer**
N. Mendenhall M.D.
**Presentation**
University of Florida, IBA

**Improvements in Lung Cancer**
J. Metz M.D.
*Reduced Normal Tissue Toxicity with Proton Therapy Comparative Effects for Lung Cancer Treatment. Oncolink 4.29.02*

**Improvements in Pediatric Cancer**
Head, Neck, & Chest. J. Metz M.D.
*Reduced Normal Tissue Toxicity with Proton Therapy Comparative Effects for Lung Cancer Treatment. Oncolink 4.29.02*
PT and PET Come Together

Offline PET/CT for scattered $p$ therapy at MGH

Clinical case of clival chordoma

Field 1: 0.87 Gy, $\Delta T_1 \sim 26$ min
Field 2: 0.87 Gy, $\Delta T_2 \sim 16$ min

Range monitoring: possible in well co-registered low perfused tissues
Challenges: washout, S/N, and (extra-cranial sites) motion, registration

Parodi et al Int J Rad Oncol Biol Phys 2007
U.S. Need for Proton Therapy

1.6 million people will be diagnosed with cancer in 2012

- 960,000 will receive radiation
- 60%
- 320,000 are candidates for proton therapy
- 20%
- 1,000 more treatment rooms are needed
- 11 existing centers have limited capacity & long waits
can treat only 12,900 patients a year.

Source: Technology Insights research, analysis, and treatment volume projections. Advisory Board Outpatient Market Estimator
What we are doing in Knoxville...

**Proton Therapy Equipment Manufacturer**
- PT 2-room compact system
- PT Research & Development
- PT Manufacturing
- High resolution imaging
- Superconducting magnets

**Proton Therapy Clinical Provider**
- Provision Center for Proton Therapy (PCPT)
- Provision RT Facility
- 1st ProNova customer
- Administrative services
Compact ProNova SC360 System

- One-half the size
- One-half the power
- One-tenth the weight
Trending Smaller – Making Compromises

• Competitive compact systems
  - IBA - Proteus One
  - Mevion - Monarch 250
  - Protom - Radiance 330

• Compromises to get compact
  - Reduced treatment angle
  - Reduced patient access
  - Limited treatment options
  - Limited imaging capability
  - Limited upgradeability
  - Limited access for maintenance
  - Limited treatment capacity
ProNova’s No Compromise Solution

Full featured and future-proofed

- Maintain 360° treatment angle
- Direct Pencil Beam Scanning and Uniform Beam Scanning
- Intensity Modulated (IMPT), Image Guided (IGPT), and Hypo-Fractionation capable
- Workflow that mimics radiation therapy
- Cone Beam CT with Optional PET and multi-slice CT at isocenter
- Cantilever head allowing full access to patient
- 30% more room in treatment area
Leveraging Technology

• Superconducting magnets have multiple benefits
  - Dramatically smaller size, weight, and power
  - 2X higher magnetic field, 0.5X bend radius

• ProNova leverages superconducting magnet technology
  - Maintains 360° rotation similar to radiation therapy
  - Ample room for full ring imaging at isocenter
  - Simplified shipping and installation reducing cost and time to market
Multi-Slice CT and PET at Iso-center

- Cantilevered Head
- 360 Degree Rotation
- UBS and PBS
- Retracting Nozzle
- 2D/3D imaging at Isocenter w/ range verification
- Independent imager rotation
Gantry Assembly has started...
The Future of ProNova

- **Concept Development**: 2011
- **Development and system integration testing**: 2012
- **Sub-system testing, secured intellectual property and calibration partnerships**: 2013
- **FDA 510(k) clearance**: 2014
- **First produced units assembled and shipped**: 2015
- **First clinical treatment**: 2015
Provision Center for Proton Therapy
Knoxville, TN 2014

ProNova R&D and Manufacturing
Alcoa, TN 2014
Ongoing PT Research & Development

- Imaging
  - Use of imaging at isocenter
  - High resolution CT & CBCT
  - PET panels, full ring PET
  - Workflow
- Control and Planning Software
  - User Interfaces
  - Planning software interfaces
  - Re-planning
- Patient Positioning
  - PT specific patient couch
  - Workflow with pre-positioning
  - Workflow with CT and PET
- Dose Delivery
  - PBS techniques
  - PBS with collimators and compensators
  - Dosimetry
- Advanced Manufacturing
- Beam Delivery
  - Cyromagnetic developments
  - High efficiency energy selection
  - Permanent magnet technology
  - Rapid switching, simultaneous delivery
- Pre-Clinical
  - Hypofractionation studies
  - Range verification
  - PET tracers for response to therapy
- Clinical – Provision
  - Expand database of dual treatment plans
  - Refer patients to utilize advanced imaging
- Training
  - Physician, Med Physicist, Dosimetrist
  - Operations
  - Scientific
  - Simulator Development
- Market Development & Finance
Thank You!

Passion & Persistence make a difference