Economic Impact of IMRT with modest socio-economic comments

Michael Gillin, Ph.D.
Chief of Clinical Physics

The Inverse, the Converse, and the Perverse
Eli Gladstein, M.D.

• Cost Considerations Negative

• “It should be obvious to all that IMRT is expensive in terms of (1) the space, hardware, and software that are required; (2) the time involved in preparation of plans and execution of treatment; (3) the manpower available to carry out such planning and treatment; and (4) the expenditures that go along with all of those resources.”

Health Care Costs

• NCI estimated that in 1994 cancer care represented 5% of all health care costs or $41B of the approximate $834B. One rough estimate is that approximately 10% of cancer care costs are spent on radiation oncology or approximately $5B.
• In the 2000’s, Medicare costs for Radiation Oncology represent approximately 8% of the Medicare expenditures or approximately $9B.
• 2002: ACS estimates $60.9B spent on cancer care, which means, after applying the 10% rule, approximately $6B on radiation oncology.

Radiation Oncology Costs

• As a rough estimate, it appears that radiation oncology costs in the early 2000’s are between $5B to $10B per year.
• Less than half of this amount is paid to UT MDACC.

Intensity-Modulated Radiation Therapy: The Inverse, the Converse, and the Perverse
Eli Gladstein, M.D.

• Seminars in Radiation Oncology, Vol. 12. No 3 (July) 2002
• “The present euphoria surrounding IMRT is difficult to dissect. IMRT has been heavily touted by both vendors and investigators, although actual clinical data for analysis have so far been sparse.”

Health Care Costs 2000 Consumers Union

• 1996: 7.9% of household income was spent on health care
• 2000: 8.6% of household income was spent on health care
• 44 million uninsured
• In 1998 18.4% of the people under 65 years old were uninsured.
Radiation Oncology Costs

- Costs vs. Charges - An important distinction
- What must an institution charge per hour or per treatment to collect its costs for providing external beam radiation treatments?
- What is the charge per hour to collect costs for providing external beam planning?

Cost Accounting in Radiation Oncology: A Computer-Based Model for Reimbursement

Carlos A. Perez, M.D. et al.
Vol. 25, 895-906, 1993

Cost Accounting: Perez

- 1991 Project - a procedure level cost accounting system of all of the costs involved in providing radiation oncology services
  - Cost type: direct variable (labor and supplies), direct fixed (equipment), indirect variable (medical records), indirect fixed (building - exam rooms and offices, administration, computers, etc.)

Cost Accounting: Perez

Average time per patient 1991

<table>
<thead>
<tr>
<th>Activity</th>
<th>CMD</th>
<th>PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>65 min</td>
<td></td>
</tr>
<tr>
<td>Complex Ex Beam</td>
<td>47 min</td>
<td></td>
</tr>
<tr>
<td>Intern. Ex. Beam</td>
<td>21 min</td>
<td></td>
</tr>
<tr>
<td>Cont. Med. Physics</td>
<td>4.4 min 3.4 min</td>
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</table>

Cost Accounting: Perez

Average MD time per patient 1991

<table>
<thead>
<tr>
<th>Activity</th>
<th>Minutes</th>
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<tbody>
<tr>
<td>Consultation Complex</td>
<td>67</td>
</tr>
<tr>
<td>Consultation Interm</td>
<td>54</td>
</tr>
<tr>
<td>Sim. Complex</td>
<td>50</td>
</tr>
<tr>
<td>Rx Planning Complex</td>
<td>45</td>
</tr>
<tr>
<td>Review dosimetry</td>
<td>8</td>
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</table>

Cost Accounting: Perez

Cost per procedure 1991

<table>
<thead>
<tr>
<th>Activity</th>
<th>MD Professional</th>
<th>Planning Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sim. Interm.</td>
<td>$188</td>
<td>$640</td>
</tr>
<tr>
<td>Rx Planning/ Isodose Complex</td>
<td>$147</td>
<td>$618</td>
</tr>
</tbody>
</table>
Cost Accounting: Perez
Technical cost per Rx procedure 1991

Rx Intern. $182
Rx Complex $220
Gyn Implant $1557

A Comparison of Two Methods for Estimating the Technical Costs of External Beam Radiation Therapy
James A. Hayman, M.D. M.B.A. et al.
University of Michigan

Estimating the Technical Costs of External Beam Radiation Therapy

• 1997 Data

• Cost Effective Analysis (CEA) estimates the additional cost per unit benefit associated with the use of a given intervention as compared to the most reasonable alternative strategy

• Int. J. Radiation Oncology Biol. Phys. 47, 461-467, 2000

Estimating the Technical Costs of External Beam Radiation Therapy

• Cost-to-Charge Ratios (CCR)
• Institution’s annual operating costs
• CCR for therapeutic radiology 0.4542
• Cost Accounting Systems (CAS)
• CAS uses a bottom up approach to estimate the cost of labor, capital equipment, and overhead necessary to provide a particular service.

Estimating the Technical Costs of External Beam Radiation Therapy

• Four typical treatment approaches:
  – Simple palliative - 6 MV single field, simulation
  – Complex palliative - 10 MV POP, simulation, blocking
  – Breast - tangents + electron boost, simulation
  – Prostate - 35 Fx’s 10 MV 4-field + CT simulation

<table>
<thead>
<tr>
<th>Activity</th>
<th>CCR Cost Est.</th>
<th>CAS Cost Est.</th>
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</thead>
<tbody>
<tr>
<td>Palliative – S</td>
<td>$1285</td>
<td>$1195</td>
</tr>
<tr>
<td>Palliative – C</td>
<td>$2345</td>
<td>$1769</td>
</tr>
<tr>
<td>Curative Breast</td>
<td>$6757</td>
<td>$4850</td>
</tr>
<tr>
<td>Curative Prostate</td>
<td>$9453</td>
<td>$7498</td>
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</tbody>
</table>
Estimating the Technical Costs of External Beam Radiation Therapy

- The underlying cause of the difference between the two methods was primarily due to the estimated cost of delivering a daily treatment.

Comparison of Two Institutions

<table>
<thead>
<tr>
<th>Institution</th>
<th>Year</th>
<th>Rx Complex</th>
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<tbody>
<tr>
<td>MIR</td>
<td>1991</td>
<td>$221/fx</td>
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<tr>
<td>U of Michigan</td>
<td>1997</td>
<td>Rx Complex</td>
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<tr>
<td></td>
<td></td>
<td>CAS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$256/fx*</td>
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<tr>
<td></td>
<td></td>
<td>$200/fx*</td>
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<tr>
<td></td>
<td></td>
<td>*Estimated cost of CT study $500</td>
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</tbody>
</table>

Comparing the costs of radiation therapy and radical prostatectomy for the initial treatment of early-stage prostate cancer

Burkhardt et al. (ACR)
J Clin Oncol 2002 20(12):2869-75

Comparing the costs of radiation therapy and radical prostatectomy

- 1992 and 1993 Medicare approved payment amounts
- Direct medical costs
- Patients 65 and older and coded by the Surveillance, Epidemiology, and End Results (SEER) Registry

Comparing the costs of radiation therapy and radical prostatectomy

Average direct medical costs
- External beam RT
  - $14,048 (95% CI, $13,765 to $14,330)
- Assuming 35 Fx’s, then the average direct medical cost per fraction is $400.

Average direct medical costs
- Radical prostatectomy
  - $17,226 (95% CI, $16,891 to $17,560)

Modeling Direct Costs for RT Rx

<table>
<thead>
<tr>
<th>Item</th>
<th>Initial Costs</th>
<th>Cost per Year</th>
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</thead>
<tbody>
<tr>
<td>Rx Room</td>
<td>$150,000</td>
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<tr>
<td>600 sq.ft at</td>
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</tr>
<tr>
<td>Accelerator</td>
<td>$2,000,000</td>
<td>$300,000</td>
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<tr>
<td>Maintenance</td>
<td>$200,000</td>
<td></td>
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<tr>
<td>2 RTT’s</td>
<td>$150,000</td>
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<tr>
<td>0.5 Physicist</td>
<td>$62,500</td>
<td></td>
</tr>
<tr>
<td>Approximate</td>
<td></td>
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<tr>
<td>cost per hour</td>
<td></td>
<td>$350</td>
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</tbody>
</table>
Modeling Direct Costs for RT Rx

<table>
<thead>
<tr>
<th>Direct costs per hour</th>
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<tbody>
<tr>
<td>Overhead</td>
<td>$350</td>
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<tr>
<td>Total</td>
<td>$525</td>
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<tr>
<td>Collection rate</td>
<td>50%</td>
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<tr>
<td>Charge per hour for a Rx room</td>
<td>$1,050</td>
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<tr>
<td>Charge per Rx (4 patients/hour)</td>
<td>$262</td>
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</tbody>
</table>

Average Treatment Times
Prostate
- Conventional 10 min
- 3D-CRT 15 min
- IMRT - SMLC 20 min

Head and Neck
- Conventional 15 min
- 3D-CRT 20 min
- IMRT - SMLC 25 min

Modeling Direct Costs for RT Planning

<table>
<thead>
<tr>
<th>Item</th>
<th>Initial Cost</th>
<th>Cost per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room, 225 ft² at $200 ft²</td>
<td>$45,000</td>
<td>$6,500</td>
</tr>
<tr>
<td>Planning System</td>
<td>$300,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>Software support</td>
<td>$50,000</td>
<td></td>
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<tr>
<td>Dosimetrist</td>
<td>$100,000</td>
<td></td>
</tr>
<tr>
<td>0.5 Physicist</td>
<td>$62,500</td>
<td></td>
</tr>
<tr>
<td>Approximate direct cost/hour</td>
<td>$150</td>
<td></td>
</tr>
</tbody>
</table>

Average Treatment Times MIR*

- Conventional 10 min
- 3D CRT 18 min
- IMRT - MiMiC 30 min
- IMRT - SMLC 19 min

* J. Michalski M.D. Target Delineation Symposium, January, 2003

At the risk of stating the obvious with a simple model, if the treatment time is doubled between conventional treatments and IMRT treatments, as is the case at UT MDACC, the cost of delivering such treatments will double.

Treatment room time is expensive.
Average Planning Times*

**UT MDACC**

**Prostate**

- Conventional: 3.0 hours
- 3D-CRT: 6.0 hours
- IMRT-DMLC: 8.0 hours

*Average planning times are very difficult to estimate. Time = Time(definition of task, learning curve, specific patient, etc.) Planning time has decreased as a result of the use of a template and the electronic chart.

**Average Planning Times**

**UT MDACC**

**Head and Neck**

- 3D CRT Initial effort: 2.0 days
  Rework effort: 1.5 days
- IMRT Initial effort: 3.0 days
  Rework effort: 2.0 days

One accepted plan per week from a CMD for H&N.

*Times are difficult to estimate, but UT MDACC is averaging between two to three plans per week per dosimetrist.

Survey of Physics Time per Patient Procedure

- 2001 survey data from 30 institutions (11 academic and 19 community or free standing)
- Average qualified medical physicist hours per patient for IMRT - 12 hours. This is divided between planning and QA
- Reimbursement versus Effort in Medical Physics Practice in Radiation Oncology, Herman, Mills, and Gillin, JACMP, March 2003

Survey of Physics Time per Patient Procedure

**Abt 2003 Survey**

- Procedure Median QMP Total Time
  - 77315 Complex: 0.83 hours
  - 77301 IMRT: 5.53 hours
  - 77370 Consultation: 5.60 hours
  - 773xx IMRT Consultation: 6.00 hours

Physics Time per IMRT Patient

- Two independent surveys indicate that on the average physicists are spending 12 hours per patient.
- The cost of physics time depends upon the assumption of the number of hours worked per week.
- Assuming $50/hr for physics time, then the cost of physics effort per IMRT patient is approximately $600.

Staffing Patterns Abt 2003

<table>
<thead>
<tr>
<th>Overall</th>
<th>Com Hosp</th>
<th>Academic</th>
<th>Phys Con</th>
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<tbody>
<tr>
<td>Patients</td>
<td>1080</td>
<td>816</td>
<td>1500</td>
</tr>
<tr>
<td>MD's</td>
<td>4.0</td>
<td>2.8</td>
<td>7.5</td>
</tr>
<tr>
<td>Physicists</td>
<td>3.5</td>
<td>2.0</td>
<td>5.4</td>
</tr>
<tr>
<td>CMD/Jr P</td>
<td>2.5</td>
<td>1.9</td>
<td>4.0</td>
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<tr>
<td>Phy Asst</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td>RTT's</td>
<td>7.0</td>
<td>6.0</td>
<td>10.5</td>
</tr>
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</table>
### Staffing Patterns Abt 2003

<table>
<thead>
<tr>
<th>Overall</th>
<th>Com Hos</th>
<th>Academic</th>
<th>Phy Con</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>1080</td>
<td>816</td>
<td>1500</td>
</tr>
<tr>
<td>Patients/Physicist</td>
<td>309</td>
<td>408</td>
<td>278</td>
</tr>
</tbody>
</table>

### IMRT Start Up Costs

- **MCW**
  - Physics commissioning time: 1 yr
  - Planning system: $170K
  - QA Equipment: $20K
  - Delivery System: $0 - Existing equipment used

- **UT MDACC**
  - Physics commissioning time: 1 - 2 yrs.
  - Planning systems: >$500
  - QA Equipment: $20K
  - Delivery Systems: >$300K - Mimic purchased

### Estimated Added Cost for IMRT at UT MDACC

- Corvus Planning System(s): $40K/yr/system (9 clinical systems)
- MiMiC (Used for < 3 years): $90K/yr
- QA Equipment: $20K/yr
- MLC’s (Also used for 3D CRT): $125K/yr
- QA Specialists: 2 FTE/yr

Perform routine QA which is required for every patient.

### Estimated Added Cost for IMRT at UT MDACC/Year

- Planning Computers: $360K (9 ea x $40K)
- Labor: $640K (2 QA specialists, 1 additional engineer, 2 additional dosimetrists, 2 additional physicists)

Total: $1M+

Rough estimate of the additional costs above existing costs for IMRT.

### UT MDACC IMRT

Are the added costs recovered?

- This is very difficult to know for sure
- Substantial charges are generated
- If the added expenses are $1M/year, and if the service is offered on 5 Rx units, then an additional $100/hr/machine must be collected, so $200/hr must be billed
- Charge per hour per machine has increased by > 20% for IMRT services.

### 2003 Medicare Payments for HOPPs

<table>
<thead>
<tr>
<th>APC</th>
<th>Description</th>
<th>Payment Rate</th>
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<tbody>
<tr>
<td>0300</td>
<td>Level I, RT</td>
<td>$82.37</td>
</tr>
<tr>
<td>0301</td>
<td>Level II, RT</td>
<td>$164.73</td>
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<tr>
<td></td>
<td>IMRT</td>
<td>$400</td>
</tr>
<tr>
<td>0305</td>
<td>Level II, RT Prep</td>
<td>$190.51</td>
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<td>0310</td>
<td>Level III, RT Prep</td>
<td>$712.51</td>
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<td>IMRT Dose Plan</td>
<td>$875</td>
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**Socio-Economic Considerations**

- **UT MDACC Planning Activity**
  - **Appropriate use of technology, April, 2003**
    - IMRT Plans per Service
    - CNS 4%
    - GU 46%
    - GYN 13%
    - H&N 29%
    - THORACIC 8%

- **UT MDACC Planning Activity**
  - **Appropriate use of technology, March, 2003**
    - Complex 175 47%
    - 3D 155 42%
    - IMRT 40 11%
  - **April, 2003**
    - Complex 170 42%
    - 3D 175 44%
    - IMRT 55 14%

- **Economic Considerations**
  - Is the added cost in terms of time in the treatment room, time in the planning, time in QA, and additional equipment required by IMRT reimbursed by Medicare 2003 rates?
  - Possibly, depending on time spent delivering treatment and time spent in planning.

- **UT MDACC Costs versus 2003 Medicare Payment Schedule**
  - Medicare IMRT Planning $875
  - H&N Planning Labor Costs 5 days of CMD time $2,000
  - H&N Planning Computer Costs/week $1,000
  - $3,000 vs $875
  - More efficiency is needed, e.g.

- **Socio-Economic Considerations**
  - The appropriate allocation of cancer care, which is based upon cost-effectiveness or efficacy, is a very challenging exercise. In a 1992 JAMA article Eddy identified the 4 toughest problems:
    1. Defining an understandable benefit, e.g. lives saved
    2. Dealing with inadequate information
    3. Measuring the costs of care
    4. Defining the treatment efficacy outside of a clinical trial, i.e. clinical trial results may not transfer directly to the community setting.
Socio-Economic Considerations

- For the purposes of discussion, assume that IMRT long term outcomes are equal to 3D-CRT outcomes, but have a 50% lower complication rate for prostate cancer patients with Gleason 7 and PSA < 15
- Also assume that the technical treatment costs for IMRT are double than of 3D-CRT, $10K to $20K
- From a socio-economic perspective, can the added cost to lower the complications be justified?

Economic Burden of Cancer

- Consider a H&N patient, who is receiving IMRT.
- Assume the cost of IMRT over 3D CRT is 1.3 times greater.
- If the principle benefit to the patient is continued saliva product and if there is a 1 in 2 chance of this benefit, can the added cost (>4K) be justified?
- If Yes, should the patient, as opposed to insurance, be expected to pay for this additional cost?

ACS Data

- 2002 NIH estimates overall annual cost of cancer:
  - Direct $60.9B
  - Morbidity Costs $15.5B
  - Mortality Costs $95.2B

  It is interesting to note that the largest component in the cost of cancer is the cost of productivity due to premature death.

Economic Burden of Cancer

- In 1997 four cancer sites, lung, prostate, breast, and colon/rectum accounted for 52% of the estimated new cancers and 55% of the estimated cancer deaths. The relative 5 year survival rates are 93% for prostate, 86% for breast, 61% for colorectal and 14% for lung.
- Will IMRT make a significant survival contribution to any of these sites besides prostate with its 93% 5 year survival?
Socio-Economic Considerations

• The potential economic gains from any new, effective cancer therapy are substantial

• For example, a 2% increase in the cure rate, 10,000 lives, could save $1B (1/75 of the total cost of cancer care in 2000), assuming that the cost of care for these patients as their disease progresses through end of life is $100,000

Socio-Economic Considerations

• One fundamental economic fact that perseveres in cancer management is that an expensive cure is far less costly in the long run than a treatment failure.

Socio-Economic Considerations

• “… we could save more quality-adjusted years of life - five times as many in this example - if mammograms were done every two years and the money saved was spent on giving every woman a colonoscopy every 5 to 10 years. But at the present time, more women get annual mammograms than ever get screened for colon cancer.”

IMRT and Mesothelioma

30 Gy Yellow, 50 Gy Blue

Socio-Economic Considerations

• Houston Chronicle June 8, 2003  
  Milton Weinstein - Kaiser Professor of Health Policy and Management at Harvard School of Public Health

• “We now ration health care, so why not do it rationally?”

• Quality-adjusted life years - QALYs

Socio-Economic Considerations

• The New York Times NATIONAL  

• “After signing his third tax cut into law last month and plunging into Middle East peacekeeping this past week, Mr. Bush is now making Medicare his focus. …”
Socio-Economic Considerations

- When will Medicare apply a QALY's analysis on the treatment of patients with lung cancer?
- Stage III Lung Cancer -
  - Workup includes multiple CT exams and now PET.
  - Treatment may soon include an IMRT, gated, guided with multiple image sets treatment with protons.
  - Survival < 10%