POSITRON EMISSION TOMOGRAPHY (PET/CT)

Cost-Effectiveness Analysis

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CT
Structural Imaging

- Alteration in usual attenuation pattern of different organs
- Alterations in size and form
- Classification based on structural information
- Last generation equipments
- Superb spatial resolution (0.3 mm)

- Advances in technology provides higher efficiency than surpass the extra cost?
PET Molecular Imaging

MEASUREMENT OF BIOCHEMICAL PROCESSES

- Compounds that mimic endogenous substrates
- Quantification of specific metabolic pathways
- Volumetric whole body acquisition
- Uptake reflects cellular proliferation rate

- Metabolic information bears enough incremental diagnostic and prognostic value that justifies its cost?
Clinical Applications
FDG

ONCOLOGY

80 a 90% of procedures worldwide

(epilepsy, dementia)
Clinical Applications
FDG

ONCOLOGY

- Diagnosis (differential between Malignant x Benign)
- Staging / Restaging
- Monitor therapy response
Incidence of Malignant Tumors per 100,000 inhabitants

São Paulo – approximately 55 / 100,000 inhabitants
Patients in Ambulatory Treatment
High Complex Procedures / 100,000 inhab.
Death per malignant tumors in Brazil (x1.000)

(Source: DATASUS & INCA)
Deaths per malignant tumor/mortality

- 1975: 12%
- 1980: 8%
- 1985: 10%
- 1990: 12%
- 1995: 19%
- 2000: 15%
Estimative of Oncology Costs in Public Health Care System
(hospitalization + QT + RT)

<table>
<thead>
<tr>
<th>Year</th>
<th>Millions</th>
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<tbody>
<tr>
<td>1994</td>
<td>46.7</td>
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<tr>
<td>1995</td>
<td>54.3</td>
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<td>1996</td>
<td>57.5</td>
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<td></td>
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<tr>
<td>1999</td>
<td></td>
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<tr>
<td>2000</td>
<td>87.1</td>
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Introduction of New Diagnostic Methods

- Evaluation of the method
  - Safety (morbidity)
  - Sensitivity
  - Prediction value

- Evaluation of social and economical parameters:
  - Incremental value in cost/effectiveness (cost increment in proportion of unity of added efficiency)
  - Gain in survival with good quality of life
  - Reduction of costs without loss in efficacy
Factors to be Considered

1- Benefits to the patient

(ex: Brazil U$2,000)
Cost/Effectiveness Analysis

Cost-effectiveness of PET: 281 references

- Epidemiology
- Characteristics of different methods (meta-analysis)
- Therapeutic alternatives
- Very low randomized and controlled trials available
Evidence

Past (references > 4 years old)

• Present (references < 3 years old)
PAST
Cost/Effectiveness Analysis
Solitary Pulmonary Nodule

Gambhir: J Clin Oncol 1998

• Strategy of CT + PET was the one with the best cost/benefit ratio (pre-test probability of 0.12 - 0.69)
• Saved cost ranged from US$ 91 up to US$ 2,200.
• Annual cost savings: approximately of US$ 62.7 millions.
Cost/Effectiveness Analysis
Solitary Pulmonary Nodule


- Computerized tomography, FDG-PET, Transthoracic needle biopsy, surgery, and clinical surveillance.
- Costs, years of survival adjusted for incremental cost/benefit and quality of life gained.

is cost-effective only when discrepancies exist between pre-test probability and CT findings, or when the patient presents with intermediate pre-test probability but also strict restrictions to undergo surgery.
Solitary Pulmonary Nodule
Solitary Pulmonary Nodule
Solitary Pulmonary Nodule
Comparison of Different Diagnostic Algorithms

Conventional x Replaced by PET

<table>
<thead>
<tr>
<th>Procedures Avoided with PET</th>
<th>Chest &amp; Abdomen CT</th>
<th>Needle Biopsy</th>
<th>Surgical Resection</th>
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</thead>
<tbody>
<tr>
<td>91,390</td>
<td>17,821</td>
<td>10,126</td>
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</table>
Decision Strategies for Lung Cancer thoracic

*Gambhir 1998 - Ann Thorac Surg*

- 5 associated schemes PET and CT
- Goal: Avoid surgery if there are mediastinal or contra lateral involved lymph nodes
- Conducting PET after a negative CT is more adequate than CT only or routine PET
- Cost U$ 25,000 / year per life saved
Therapeutic Impact in Initial Staging


- PET promoted positive changes in the therapy planning in 50%.
- Surgery was suspended in 35% of patients (M1).
Cost-Effectiveness Analysis
Lung Cancer


- Strategy based on CT only
- Strategy based on CT + PET
- Cost savings of 1455 Canadian Dollars / patient
- Increase in life expectancy of 3.1 days
Cost-Effective Analysis

- French System
- Four strategies:
  - CT only
  - PET for negative CT
  - PET for all with anatomical CT
  - CT and PET for all

- 70% reduction in relative need for surgery in patients with metastasis in mediastinal lymph nodes.
- Higher cost-effective ratio comparing to PET for negative CT (average savings/patient = 61 euros)

Alzahouri, Clin Radiol 2005; 60: 479-92

- **Target:**
  - Patients with tumor recurrence in liver, candidates to surgical resection
- **CT + FDG-PET incremented cost in US$ 429,00, comparatively to strategy of CT only.**
- **Average life expectancy increased in a significant way. (9,0 days/patient)**
- **Incremental value of cost-efficiency:** US$ 16.437 per life expectancy of 1 year of life saved; Accepted value is of US$ 50.000,00
Cost-Effectiveness Analysis
Colorectal Cancer

- 9.0 days of average life expectancy gain
- Imagining that approximately 6,000 patients would be granted by this modality:

6,000 x 9 = 54,000 days (148 years)
Significant average of prolonged life effect

- Incremental value of cost-efficiency:
  US$ 16.437 per life expectancy of 1 year of life saved
  Accepted value is of US$ 50,000,00
Cost-Effectiveness Analysis

Lymphomas


- Evaluation of performance in 22 patients.
- Cost of CT: 391 euros
- Cost of PET: 961 euros
- Efficacy of CT: 81.8%
- Efficacy of PET: 100.0%

- Gain in relation to cost-effectiveness:
  - CT vs non diagnostic = 478 euros
  - PET vs CT = 3133 euros

- Gain in long range?
- Effects of better accuracy in staging?
PRESENT
Clinical Impact


- PET/CT was the best predictor of TNM stage
  - T (65% vs 58%)
  - N (78% vs 65%)

- Therapeutic planning changed in 66/161 (41%)
- Unknown mets detected in 16%
Head and Neck

- body 18F-FDG PET are cost-effective

Uyl-de Groot CA et al.

- 145 patients with scamous cell carcinoma
- High risk for metastasis (21%)
  - SENSITIVITY PET >> CT (53% vs 37%)
  - SENSITIVITY PET + CT (63%)

- Cost savings (1 year):
  - CT + PET = US$ 303,00 a US$ 903,00, with higher efficiency
Melanoma

- **Cost-effectiveness analysis of FDG PET-CT in the management of pulmonary metastases from malignant melanoma.** Krug B et al.

Data from published studies provided probabilities estimation
Life-months gained (LMG)
Cost-effectiveness ratio = Euros/LMG

Conventional imaging strategy = 86.08 at discounted cost of 5.022
PET strategy = 86.29 at discounted cost of 3.974

PET resulted in cost savings of 1.048 Euros, and 0.2 LMG
The impact of positron emission tomography (PET) on expected management during cancer treatment: findings of the National Oncologic

- Hillner BE, Siegel BA, Shields AF, Liu D, Gareen IF, Hanna L, Stine SH, Coleman RE.
- Department of Internal Medicine and the Massey Cancer Center, Virginia Commonwealth University, Richmond, Virginia 23298-0170, USA. hillner@vcuedu

- Management changed in 26-28%
- Future tests avoided in 91%
Transposition of Cost Analysis Data difficult:

- Differences in population
- Different medical strategies and Health Care Systems
- Procedure costs
Lymphoma

Oncol. 2010 Feb 8. [Epub ahead of print]

- **Cost Effectiveness of Positron Emission Tomography in Patients With Hodgkin's Lymphoma in Unconfirmed Complete Remission or Partial**

  Cerri JJ, et al.

- 127 patients evaluated with PET after concluding first-line therapy

  - \[\text{Success rate} = 100\%, 92\%, 92.3\%, 100\%\]
  - Restaging costs without PET = US$ 350,050.00
  - Restaging costs with PET = US$ 283,262.00
  - Incremental Cost-Effectiveness ratio = US$ 3,268.00
  - Cost saving (total) = US$ 516,942.00
Impact on Cost

- Activity-based costing evaluation of a [(18)F]-fludeoxyglucose positron emission tomography study.
- Krug B, Van Zanten A, Pirson AS, Crott R, Borght TV

- The major impact is from cost of radiopharmaceutical
Anatomical & Structural features

Cellular Metabolic Changes