Economical perspectives of PET in lymphoma

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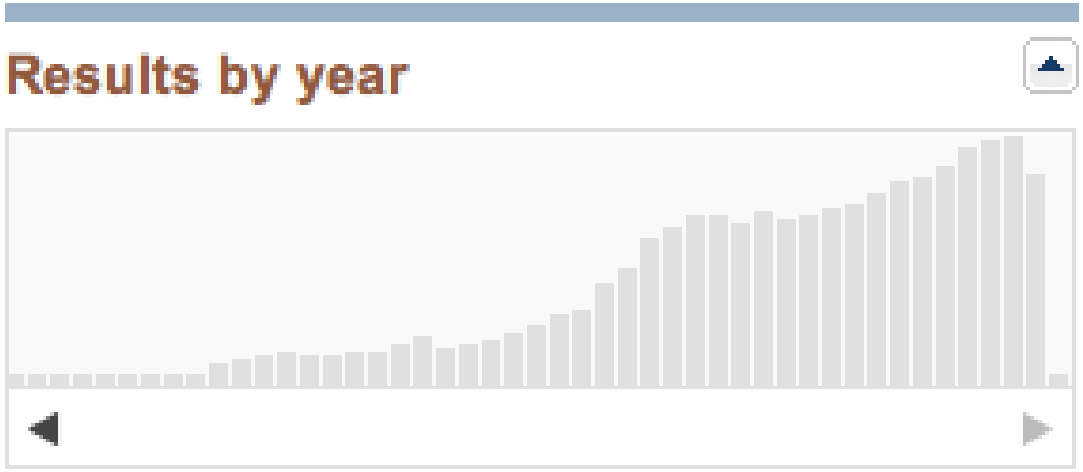
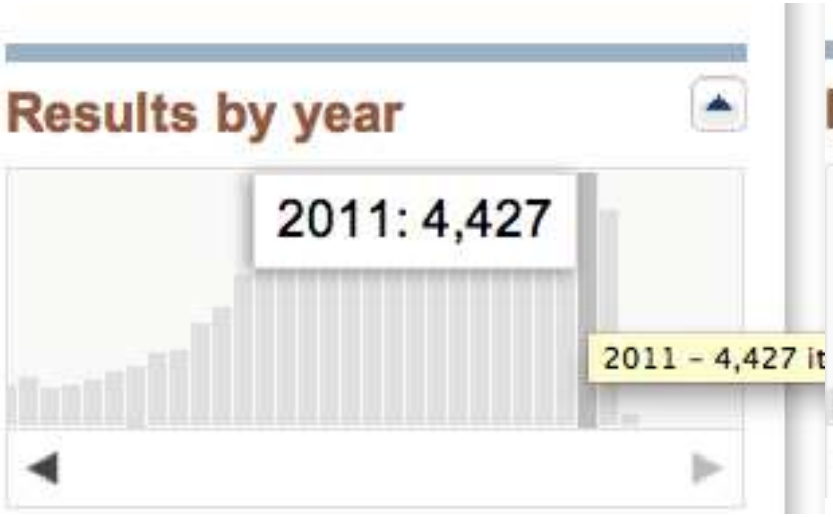
Outline

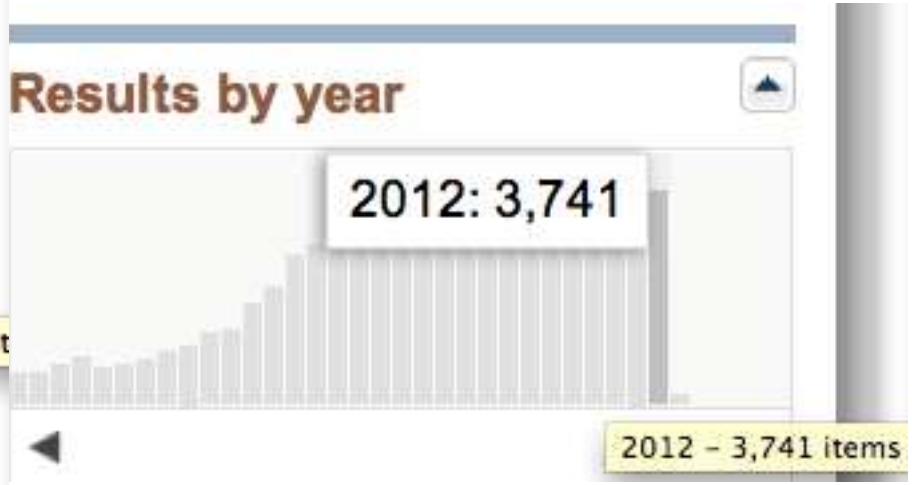
- Introduction to cost-effectiveness
- ICER
- QALY
- Literature review

Cost-effectiveness in Pubmed

- Cost effectiveness: 76866
- Cost-effectiveness ratio: 5980
- Incremental cost-effectiveness ratio: 2387

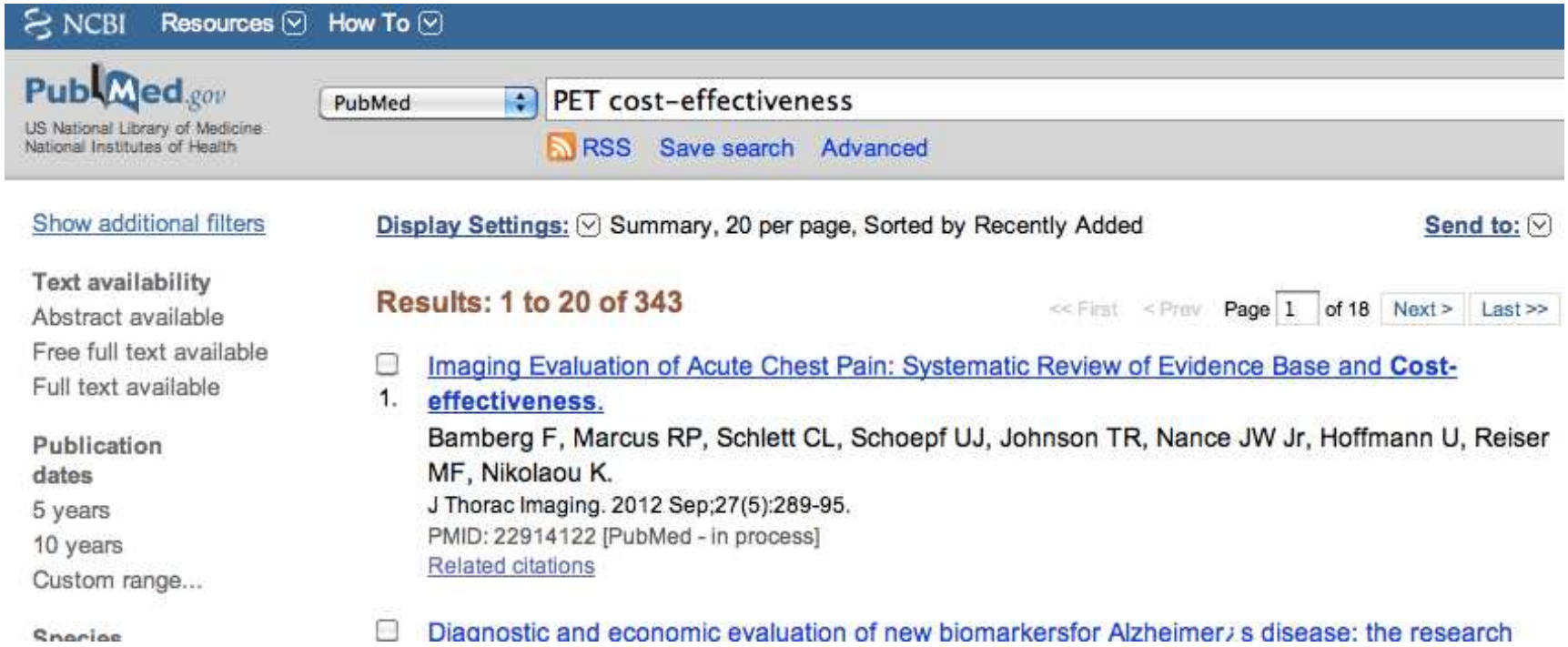

Results by year


Results by year
2011: 4,427
2011 – 4,427 it


Results by year
2012: 3,741
2012 – 3,741 items

PET Cost-effectiveness in Pubmed

- Cost-effectiveness: 343
- Cost-effectiveness ratio:38
- Incremental cost-effectiveness ratio: 22



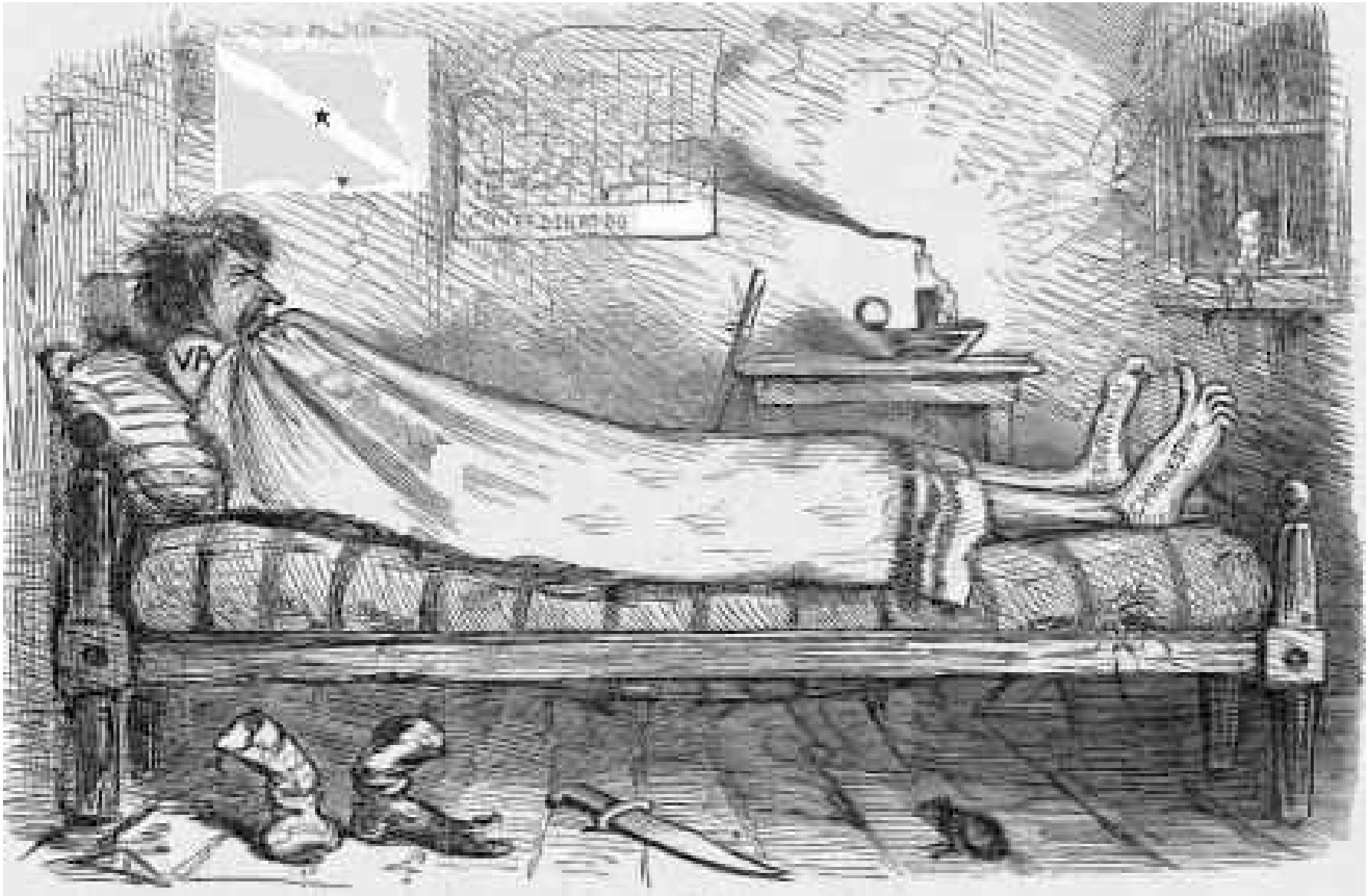
Cost-effectivenes of PET in Lymphoma in Pubmed

- Cost-effectivenes: 27
- Cost-effectivenes ratio: 3
- Incremental cost-effectivenes ratio: 3

Dilemma

- Patient care vs Care costs

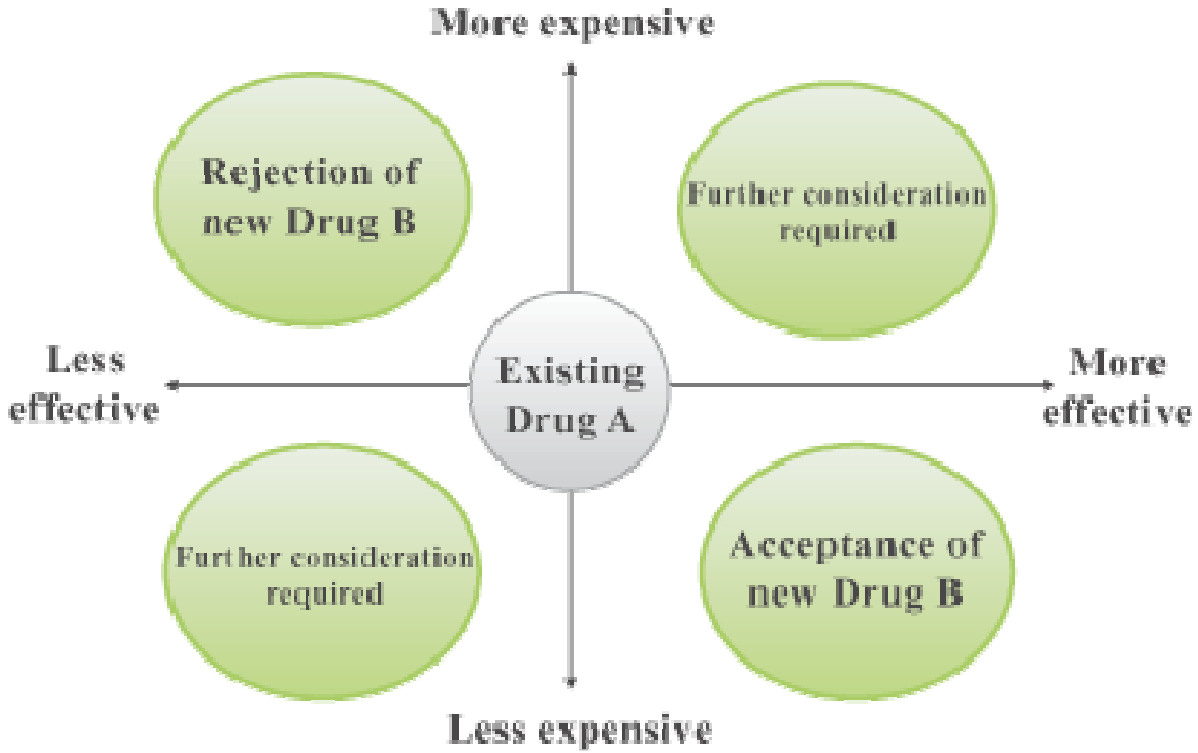
Short Blanket



Cost-Effectiveness

- Money can only be spent once

- If a particular service is not achieving what it sets out to do that money could be better spent in future



- Best scenario: → intervention is effective and cost-saving
- Worst scenario: → intervention is worse than usual care and costs more
- Most common scenario: → intervention is more effective than usual care and costs more

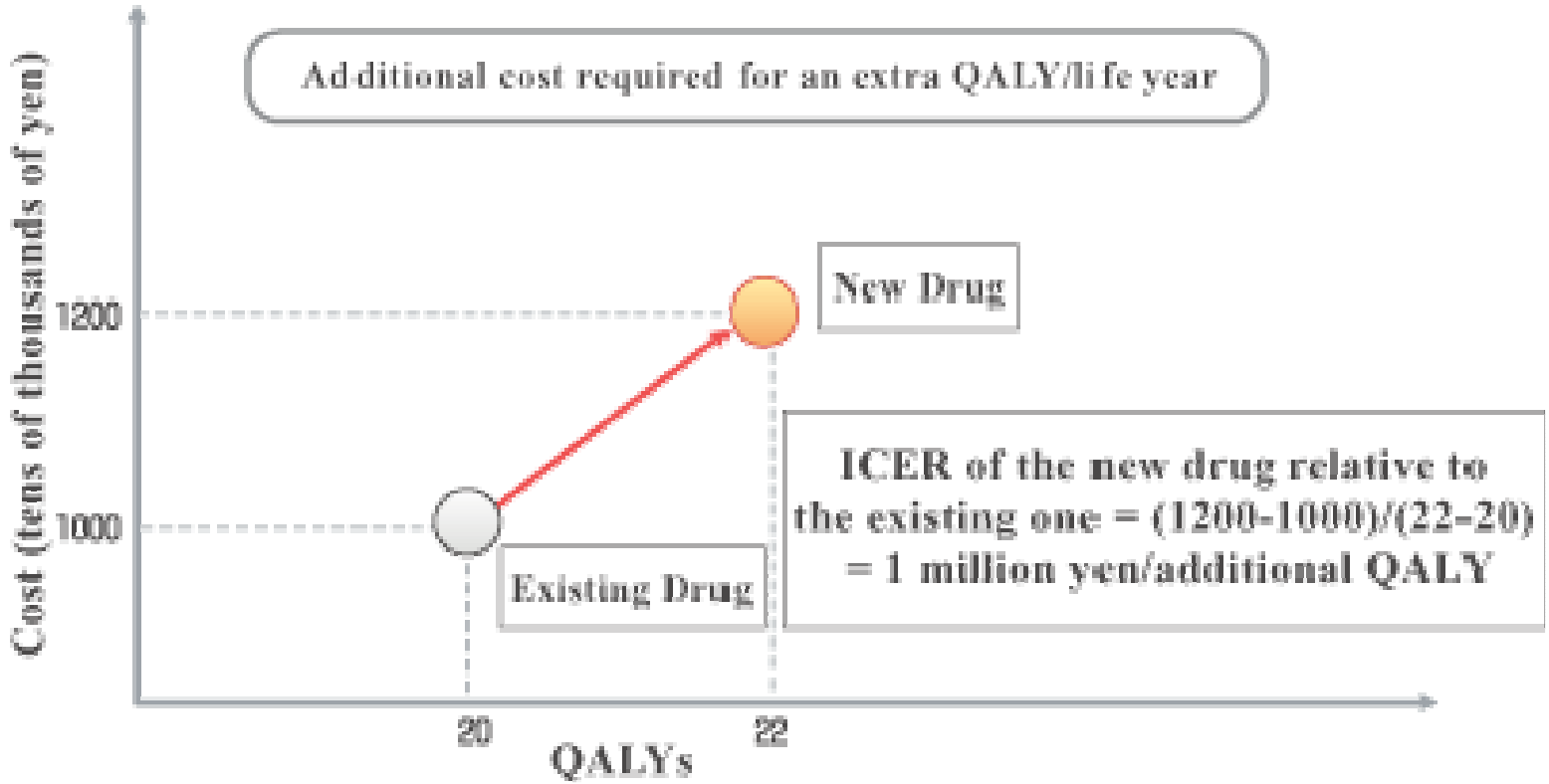
Incremental Cost-Effectiveness ratio - ICER

- ICER is the ratio of the change in costs to incremental benefits of a therapeutic intervention or treatment.
  (meaning, to compare alternatives, ICER is calculated).

- It shows the additional costs caused by the implementation of a new diagnostic test or intervention and relates them to the health outcome
- Acceptable ICER thresholds for reimbursement differ between countries according to wealth and societal preferences.
- Gross national product/person

Quality-adjusted life-years (QALYs)

- The **quality-adjusted life year** (QALY) is a measure of disease burden, including both the quality and the quantity of life lived.
- It is used in assessing the value for money of a medical intervention.


Additional cost required for an extra QALY/life year
Cost (tens of thousands of yen)
1200
1000
New Drug
Existing Drug
ICER of the new drug relative to the existing one = (1200-1000)/(22-20) = 1 million yen/additional QALY
20
22
QALYs

Initial staging

J Nucl Med. 1997 Mar;38(3):343-8.

Whole-body FDG-PET imaging for staging of Hodgkin's disease and lymphoma.

Hoh CK, Glaspy J, Rosen P, Dahlbom M, Lee SJ, Kunkel L, Hawkin RA, Maddahi J, Phelps ME.

Department of Molecular and Medical Pharmacology, Crump Institute of Biological Imaging, Los Angeles, California, USA.

Abstract

Accurate staging of Hodgkin's disease (HD) and non-Hodgkin's lymphoma (NHL) is important for treatment management. In this study, the utility of 2-[18F]fluoro-2-deoxy-D-glucose (FDG) whole-body PET was evaluated as an imaging modality for initial staging or restaging of 7 HD and 11 NHL patients.

METHODS: Whole-body PET-based staging results were compared to the patient's clinical stage based on conventional staging studies, which included combinations of CT of the chest, abdomen and pelvis, MRI scans, gallium scans, lymphangiograms, staging laparatomies and bone scans.

RESULTS: Accurate staging was performed in 17 of 18 patients using a whole-body PET-based staging algorithm compared to the conventional staging algorithm in 15 of 18 patients. In 5 of 18 patients, whole-body PET-based staging showed additional lesions not detected by conventional staging modalities, whereas conventional staging demonstrated additional lesions in 4 of 18 patients not detected by whole-body PET. The total cost of conventional staging was $66,292 for 16 CT chest scans, 16 CT abdominal/pelvis scans, three limited MRI scans, four bone scans, five gallium scans, two laparotomies and one lymphangiogram. In contrast, scans cost $36,250 for 18 whole-body PET studies and additional selected correlative studies: one plain film radiograph, one limited CT, one bone marrow scan, one upper GI and one endoscopy.

CONCLUSION: A whole-body FDG-PET-based staging algorithm may be an accurate and cost-effective method for staging or restaging HD and NHL.

In 1997, the study carried out by Hoh et al evaluated 7 HL and 11 NHL patients in initial staging or at restaging.
The strategy based on PET with radiological testes performed only in selected cases increased the diagnostic accuracy from 83% to 94% and reduced costs for tumor staging by approximately $1,669 per patient.

Eur J Nucl Med. 2000 Oct;27(10):1457-64.

Primary staging of lymphomas: cost-effectiveness of FDG-PET versus computed tomography.

Klose T, Leidl R, Buchmann I, Brambs HJ, Reske SN.

Department of Health Economics, University of Ulm, Germany.

Abstract

The objective of this study was to measure the incremental cost-effectiveness of 2-(fluorine-18) fluorodeoxyglucose positron emission tomography (FDG-PET) versus computed tomography (CT) as diagnostic procedures in the primary staging of malignant lymphomas. The study was based on 22 patients of a clinical study who underwent the diagnostic procedures at Ulm University Hospital between April 1997 and May 1998. Direct costs of FDG-PET and CT, including staff, materials, investment, maintenance and overheads, were valued using a micro-costing approach. The effectiveness of both diagnostic procedures was measured as the percentage of correctly staged patients, given a gold standard for staging. The incremental cost-effectiveness ratio was the main outcome measure. Costs per patient of FDG-PET were 257 euros for FDG production and 704 euros for the FGD-PET scan, thus totalling 961 euros (in 1999 prices). The cost per patient of CT scans was found to be 391 euros. Verified PET findings induced an upstaging in four patients such that the effectiveness was 81.8% (18/22) for CT and 100% (22/22) for PET. Incremental cost-effectiveness ratios (interpreted as the additional costs of a more effective diagnostic strategy per additional unit of effectiveness, i.e. additionally correctly staged patient, achieved) were 478 euros per correctly staged patient for CT versus "no diagnostics" and 3133 euros for FDG-PET versus CT. Great potential for cost saving was identified in sensitivity analyses for FDG-PET. It is concluded that diagnostic accuracy and the costs of the diagnostic procedures could be measured precisely. FDG-PET was more accurate than CT. Decision-makers who consider savings in treatment costs significant may find the cost-effectiveness ratio of PET to lie within an acceptable range. However, more research is needed to assess the long-term treatment and cost effects of more accurate staging. There is significant potential to improve the technical efficiency of PET.

- CT and PET in the initial staging of 22 malignant lymphoma patients.
- PET increased the diagnostic accuracy from 82% to 100% and also increased overall costs for staging.
- ICER of PET was E$ 3,133, in an acceptable range.

Clin Lymphoma Myeloma Leuk. 2011 Aug;11(4):314-20.

Consistency of FDG-PET accuracy and cost-effectiveness in initial staging of patients with Hodgkin lymphoma across jurisdictions.

Cerci JJ, Trindade E, Buccheri V, Fanti S, Coutinho AM, Zanoni L, Linardi CC, Celli M, Delbeke D, Pracchia LF, Pitela FA, Soares J Jr, Zinzani PL, Meneghetti JC.

Department of Nuclear Medicine, University of São Paulo Medical School, São Paulo, Brazil. cercijuliano@hotmail.com

Abstract

INTRODUCTION: Two hundred ten patients with newly diagnosed Hodgkin's lymphoma (HL) were consecutively enrolled in this prospective trial to evaluate the cost-effectiveness of fluorine-18 ((18)F)-fluoro-2-deoxy-D-glucose-positron emission tomography (FDG-PET) scan in initial staging of patients with HL.

METHODS: All 210 patients were staged with conventional clinical staging (CCS) methods, including computed tomography (CT), bone marrow biopsy (BMB), and laboratory tests. Patients were also submitted to metabolic staging (MS) with whole-body FDG-PET scan before the beginning of treatment. A standard of reference for staging was determined with all staging procedures, histologic examination, and follow-up examinations. The accuracy of the CCS was compared with the MS. Local unit costs of procedures and tests were evaluated. Incremental cost-effectiveness ratio (ICER) was calculated for both strategies.

RESULTS: In the 210 patients with HL, the sensitivity for initial staging of FDG-PET was higher than that of CT and BMB in initial staging (97.9% vs. 87.3%; $P < .001$ and 94.2% vs. 71.4%, $P < 0.003$, respectively). The incorporation of FDG-PET in the staging procedure upstaged disease in 50 (24%) patients and downstaged disease in 17 (8%) patients. Changes in treatment would be seen in 32 (15%) patients. Cumulative cost for staging procedures was $3751/patient for CCS compared to $5081 for CCS + PET and $4588 for PET/CT. The ICER of PET/CT strategy was $16,215 per patient with modified treatment. PET/CT costs at the beginning and end of treatment would increase total costs of HL staging and first-line treatment by only 2%.

CONCLUSION: FDG-PET is more accurate than CT and BMB in HL staging. Given observed probabilities, FDG-PET is highly cost-effective in the public health care program in Brazil.

PET+ CT leads to an absolute 35% increase of total costs in the staging program.
PET/CT leads to an absolute 22% increase of total costs in the staging program.

- However, 80% of costs of staging and 1st line therapy are related to chemo and radiotherapy.
- The impact of PET/CT both in initial and in the end of first line 2% increase in costs.
- A cost-effective Brazilian ICER should be less than $ 15,240.
- ICER $4,650 PET/CT in the initial and end treatment staging of HL is acceptable for the public health system economy.

Interim PET

Ann Oncol. 2007 Apr;18(4):658-64. Epub 2007 Feb 17.

Cost-effective therapy remission assessment in lymphoma patients using 2-[fluorine-18]fluoro-2-deoxy-D-glucose-positron emission tomography/computed tomography: is an end of treatment exam necessary in all patients?

Strobel K, Schaefer NG, Renner C, Veit-Haibach P, Husarik D, Koma AY, Hany TF.

Department of Nuclear Medicine, University Hospital Zurich, Ramistrasse 100, CH-8091 Zurich, Switzerland. klaus.strobel@usz.ch

Abstract

BACKGROUND: The aim of this study was to evaluate the necessity of 2-[fluorine-18]fluoro-2-deoxy-D-glucose-positron emission tomography/computed tomography (FDG-PET/CT) after end of treatment in lymphoma patients who had an interim FDG-PET/CT.

PATIENTS AND METHODS: In 38 patients with Hodgkin's disease (HD) and 30 patients with non-Hodgkin's lymphoma (NHL) interim PET/CT (intPET) after two to four cycles of chemotherapy and PET/CT after completion of first-line treatment (endPET) were carried out. Cost reduction was retrospectively calculated for the potentially superfluous endPET examinations.

RESULTS: In 31 (82%) HD patients, intPET demonstrated complete remission (CR) which was still present on endPET. The remaining seven HD patients (18%) had partial remission (PR) on intPET. For NHL, 22 (73%) patients had CR on intPET analysis which was still present on endPET. In the remaining eight NHL patients, intPET revealed PR in seven and stable disease in one patient. None of all intPET complete responders progressed until the end of therapy. Thus, of the 196 PET/CT's carried out in our study population, 53 endPET's (27.0%) were carried out in interim complete responders.

CONCLUSION: End-treatment PET/CT is unnecessary if intPET shows CR and the clinical course is uncomplicated. An imaging cost reduction of 27% in our study population could have been achieved by omitting end of treatment FDG-PET/CT in interim complete responders.

iPET-negative patients,
ePET is unnecessary if clinical course is uncomplicated.
Cost-saving of 27%.

Eur J Nucl Med Mol Imaging. 2008 Jun;35(6):1074-80. Epub 2008 Jan 25.

Non-Hodgkin lymphoma: retrospective study on the cost-effectiveness of early treatment response assessment by FDG-PET.

Moulin-Romsee G, Spaepen K, Stroobants S, Mortelmans L.

Department of Nuclear Medicine, KU Leuven, UZ Gasthuisberg, Herestraat 49, 3000, Leuven, Belgium.

Abstract

PURPOSE: Although lymphomas are very chemosensitive, 50% of patients with aggressive non-Hodgkin lymphoma (NHL) are not cured with standard first-line treatment. This consists of six cycles of doxorubicin, vincristine, prednisolone and cyclophosphamide (CHOP), recently complemented with rituximab. Preliminary studies show that PET mid-treatment is a good predictor of the remission status at the end of therapy. As patients with persistent FDG uptake after three cycles are unlikely to gain a complete remission, the remaining three cycles of chemotherapy are useless. We investigated the costs and benefits for the use of PET in this early treatment setting.

METHODS: We conceived a model using a conventional arm where patients receive the full regimen of six cycles of CHOP [-rituximab] and an experimental algorithm where patients receive either six cycles (PET response) or only three cycles (PET non-response). Based on a patient sample (2004-2006), we calculated the costs for hospitalisation and treatment. We took into account all costs accrued (including overhead costs). We used a sensitivity analysis by varying the most important parameters.

RESULTS: With a PET price of 700 euro and CHOP price (per cycle) of 1,829 euro , we can conclude to cost saving of 1,879 euro per patient. The PET price can increase up to 2,580 euro and the cost for one cycle of CHOP can decrease to 500 euro per cycle before cost savings are nil. The percentage of non-responders may be as low as 10%. The implementation of rituximab in first-line therapy only increases benefit (4,900 euro/pt).

CONCLUSION: We conclude to substantial cost savings if management of NHL patients is based on mid-treatment PET scan. The economical data we used seem to be comparable to those published in other European studies. Implementation of Mabthera in first line only increases cost savings.

iPET-negative: 3 cycles RCHOP
iPET-positive: 6 cycles RCHOP
Cost-savings, treatment modification needs to be proved.

End treatment staging

J Clin Oncol. 2010 Mar 10;28(8):1415-21. Epub 2010 Feb 8.

Cost effectiveness of positron emission tomography in patients with Hodgkin's lymphoma in unconfirmed complete remission or partial remission after first-line therapy.

Cerci JJ, Trindade E, Pracchia LF, Pitella FA, Linardi CC, Soares J Jr, Delbeke D, Topfer LA, Buccheri V, Meneghetti JC.

Department of Nuclear Medicine and Health Technology Assessment/Executive Direction, Heart Institute (InCor), University of SãoPaulo Medical School, São Paulo, Brazil. cercijuliano@hotmail.com

Abstract

PURPOSE: To assess the cost effectiveness of fluorine-18-fluorodeoxyglucose positron emission tomography (FDG-PET) in patients with Hodgkin's lymphoma (HL) with unconfirmed complete remission (CRu) or partial remission (PR) after first-line treatment.

PATIENTS AND METHODS: One hundred thirty patients with HL were prospectively studied. After treatment, all patients with CRu/PR were evaluated with FDG-PET. In addition, PET-negative patients were evaluated with standard follow-up, and PET-positive patients were evaluated with biopsies of the positive lesions. Local unit costs of procedures and tests were evaluated. Cost effectiveness was determined by evaluating projected annual economic impact of strategies without and with FDG-PET on HL management.

RESULTS: After treatment, CRu/PR was observed in 50 (40.0%) of the 127 patients; the sensitivity, specificity, and positive and negative predictive values of FDG-PET were 100%, 92.0%, 92.3%, and 100%, respectively (accuracy of 95.9%). Local restaging costs without PET were $350,050 compared with $283,262 with PET, a 19% decrease. The incremental cost-effectiveness ratio is -$3,268 to detect one true case. PET costs represented 1% of total costs of HL treatment. Simulated costs in the 974 patients registered in the 2008 Brazilian public health care database showed that the strategy including restaging PET would have a total program cost of $56,498,314, which is $516,942 less than without restaging PET, resulting in a 1% cost saving.

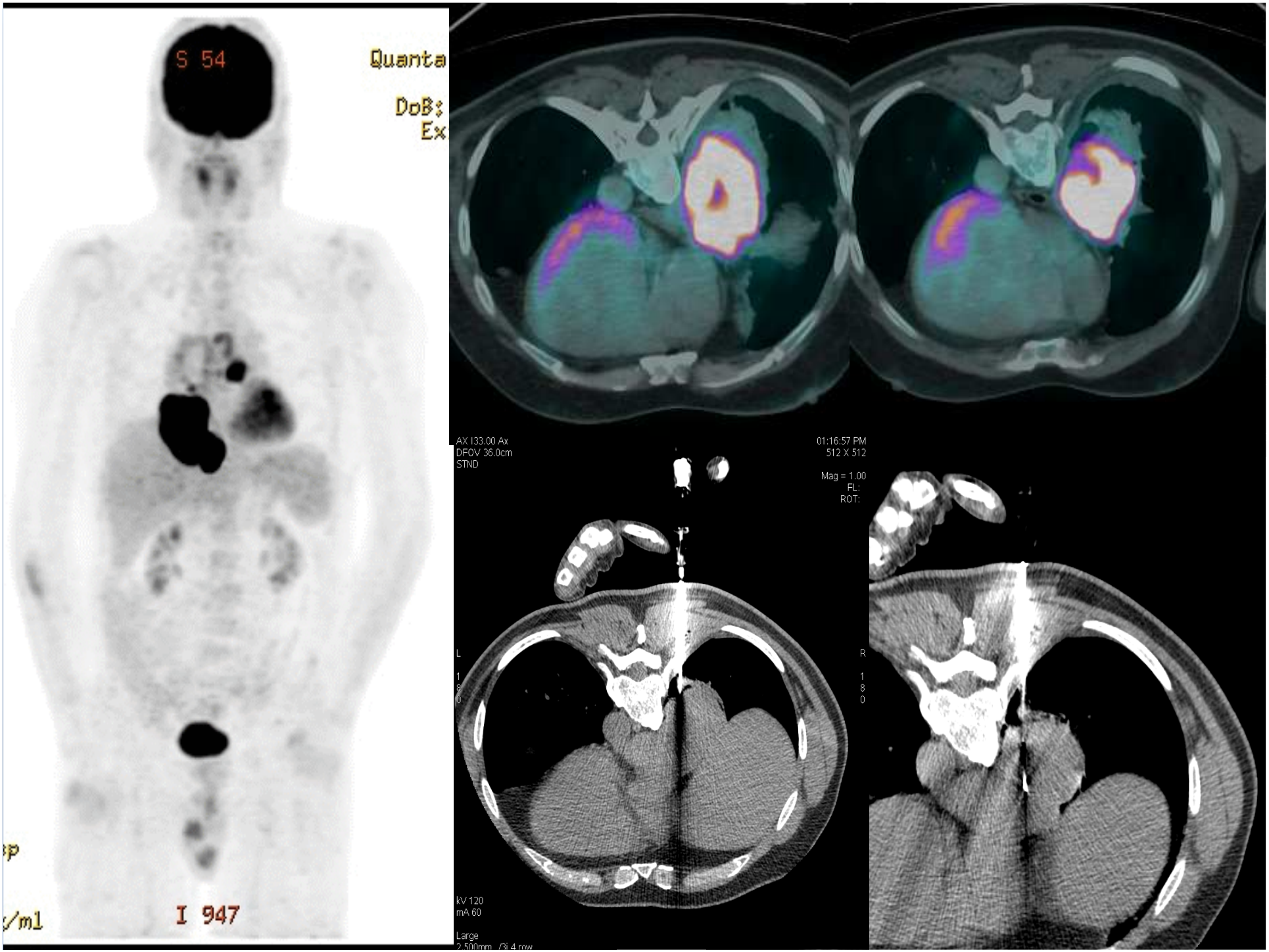
CONCLUSION: FDG-PET demonstrated 95.9% accuracy in restaging for patients with HL with CRu/PR after first-line therapy. Given the observed probabilities, FDG-PET is highly cost effective and would reduce costs for the public health care program in Brazil.

JOURNAL OF CLINICAL ONCOLOGY ORIGINAL REPORT

Cost Effectiveness of Positron Emission Tomography in Patients With Hodgkin's Lymphoma in Unconfirmed Complete Remission or Partial Remission After First-Line Therapy

Juliano J. Cerci, Evelinda Trindade, Luís F. Pracchia, Felipe A. Pitella, Camila C.G. Linardi, José Soares Jr, Dominique Delbeke, Leigh-Ann Topfer, Valeria Buccheri, and José C. Meneghetti

- 127 patients
  - 74 in CR
  - 3 Progresssion
  - 50 in PR e Cru → FDG-PET
  - 3 exclusion → 23 PET – clinical FU
    → 27 PET + biopsy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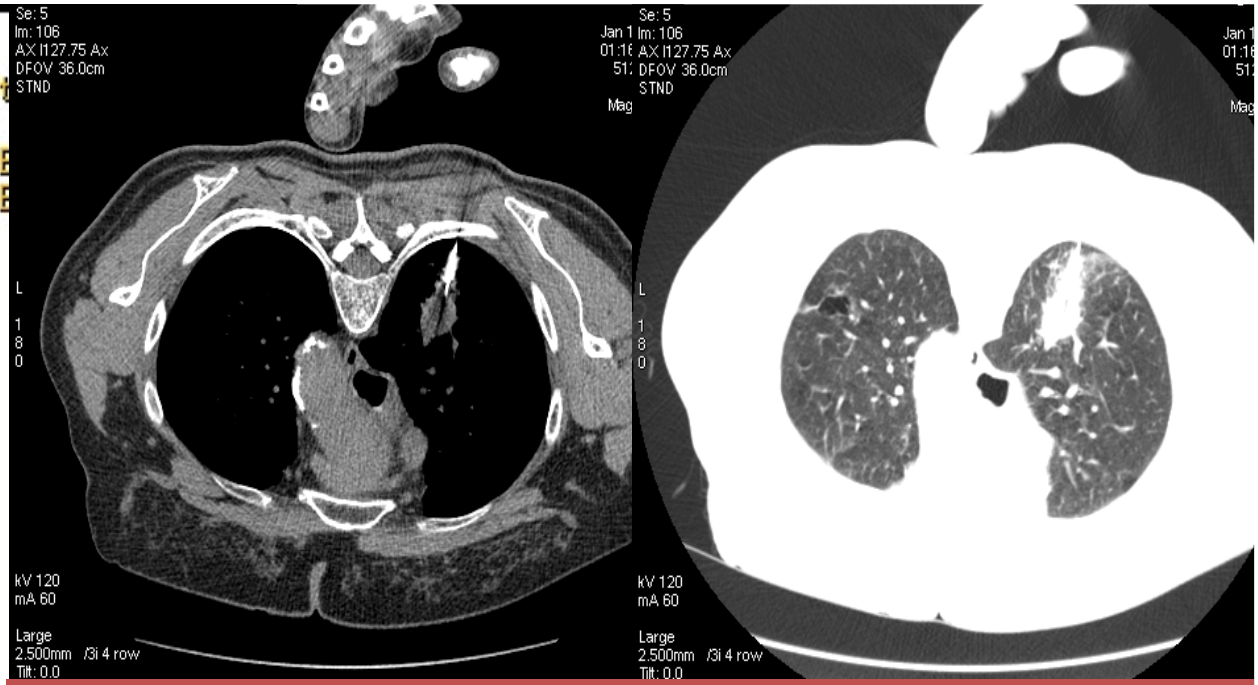

Tuberculosis

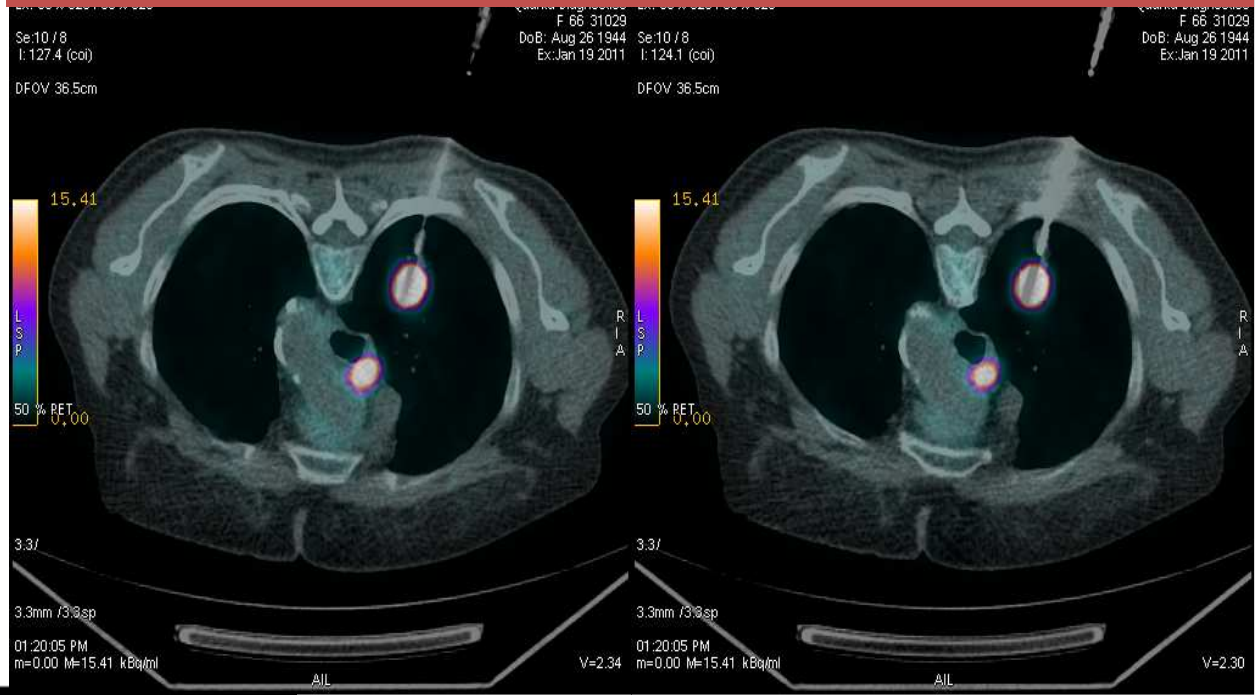

Table 3: Summary of restaging program costs for CRu/PR patients, with or without PET.

Cost center	Average Cost	Restaging with PET CRu/PR		Restaging without PET CRu/PR
		PET -	PET +	
Number of Patients		23	27	50
Restaging CT	$1,200	$ 27,600	$ 32,400	$ 60,000
Restaging PET	$1,330	$ 30,590	$ 35,910	-
Byopsis	$1,479	-	$ 39,933	$ 73,950
Hospital & Procedures	$4,326	-	$ 116,802	$ 216,300
		$ 30,590	$ 192,645	
Cumulative costs		$ 283,235		$ 350,250

Cost savings: 19%

FDG-PET costs represents: 1% in first line treatment

Radiotherapy planing

Cancer Radiother. 2009 Jul;13(4):313-7. Epub 2009 Jun 2.

[Impact of FDG-PET on radiation therapy: economic results of a STIC study].

[Article in French]

Remonnay R, Morelle M, Giammarile F, Pommier P, Carrère MO.

Université de Lyon, and Centre Léon-Bérard, 28 rue Laennec, Lyon, France. remonnay@lyon.fnclcc.fr

Abstract

The aim of this study is to assess the effects of Positron Emission Tomography (PET) associated with computed tomography (CT) on resource allocation (costs and savings) of the following treatment in radiotherapy for non small cell lung cancers (NSCLC) and Hodgkin's diseases. A national prospective study was conducted in nine hospitals. Two treatment decisions made on the basis of CT only or on PET associated with, were compared in a before-after design. The direct medical cost of using PET was assessed by micro-costing. The costs of new exams and the costs and savings associated with changes in the chosen treatment were calculated on the basis of reimbursement rates. The economic study was conducted over 2 years and included 209 patients (97 patients with Hodgkin's disease and 112 with NSCLC). The mean cost of using PET, corresponding to an extra cost, was approximately 800 euro (50% for the radionuclide FDG). Radiotherapy treatments were modified for only 10% of patients with Hodgkin's disease with a minor impact on treatment costs versus 40% of patients with lung cancer with a reduction in mean treatment cost of more than 500 euro.

Clinical and cost effects of PET on the choice of following RT treatment in 97 stage I and II HL patients.

Two treatment decisions made on the basis of only CT or CT associated with PET.

Treatment changes were defined as modification of the target volume and the dose to be delivered, or even RT cancelation.

With a PET cost of approximately E$ 800 per patient, RT treatments were modified in 10% of HL patients. Overall, the use of PET induced increase of E$ 931 in the mean cost per stage I and II HL patients.

- Economic evaluation of PET in assessment of residual mass in previous studies evaluating HL patients.

- The Scottish model predicted that with only CT 36% of patients would receive unnecessary consolidation radiotherapy (RT). If CT-positive patients were then imaged by PET, only 6% of patients would receive consolidation therapy, and if CT was not used at all just 4% would have unnecessary RT.

- This model showed that PET without CT, or in CT-positive patients was highly cost-effective. Probabilistic sensitivity analysis showed that across a range of input values, the willingness to pay needed only to be L$ 5000 per life-year.

– Bradbury I, et al. Health Technology Assessment Report 2: Positron emission tomography (PET) imaging in cancer management. Glasgow: Health Technology Board for Scotland; 2002. No. 1903961319.

4.1.5 Lymphoma

were limited, and the authors of the HTA were unable to draw conclusions from the data. The authors of the NIHR HTA suggested that it was unlikely PET would be

Obrigado!

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