USE OF A DECISION ANALYSIS MODEL TO ASSESS THE COST-EFFECTIVENESS OF FDG PET IMAGING IN THE MANAGEMENT OF METACHRONOUS LIVER METASTASES OF COLORECTAL CANCER

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Abbreviations: CT = Computed Tomography, MRI = Magnetic Resonance Imaging, PET = [18 F] 2-Fluoro-2-Deoxy-D-Glucose Positron Emission Tomography, ICER = incremental cost-effectiveness ratio

ABSTRACT

Few data exist on the medico-economic usefulness of Positron Emission Tomography (PET) in the management of metachronous liver metastases from colorectal cancer. The study was designed to assess the cost-effectiveness of PET in the diagnosis and staging of patients with metachronous liver metastases of colorectal cancer using a decision analysis model. **Methods:** Two alternatives were compared: computed tomography (CT), and computed tomography associated with PET (CT + PET). Transition probabilities were estimated from published data and consultations with experts. Survival data were provided by the Burgundy digestive cancer registry (France). Costs of imaging techniques and treatments were assessed using reimbursements from the French health care insurance for the year 2004. Evaluation criteria included incremental cost-effectiveness ratios (ICERs) and the proportion of unnecessary operations avoided in patients without metachronous liver metastases. **Results:** CT associated with PET was the most cost-effective strategy, presenting an expected incremental cost saving of 2,671 € per patient, for the same level of expected effectiveness as CT alone (1.88 years life expectancy per patient). Sensitivity analyses performed on epidemiological and economic parameters showed that this model was robust. The model also suggested that CT + PET could avoid exploratory surgery for 6.1% of patients, i.e. 88.4% risk reduction compared to CT alone. **Conclusion:** PET for diagnosis and staging does not generate additional survival effectiveness compared to CT alone. However cost savings associated with its use and the improvement of therapeutic management justify therefore its generalization in clinical practice.

Key-words; Positron-Emission Tomography, metachromous metastases, decision modeling, cost-effectiveness, program evaluation.

INTRODUCTION

Colorectal cancer (CRC) is one of the most frequent cancers in France with more than 36,000 new cases every year [1]. About 80% of patients undergo primary tumour resection for cure [2]. After curative resection, recurrence develops in approximately 30% to 40% of patients [3]. The liver is the most common site of recurrence, metachronous liver metastases, affecting 15% to 25% of patients during the first five years following curative resection [4]. Liver resection is potentially curative for patients with metachronous liver metastases. However this concerns about 30% of patients [4]. Best candidates for resection are patients with less than 4 metastases, under 5 cm in size, and without extra-hepatic dissemination [5, 6]. Therefore, accurate assessment of patients with metachronous liver metastases is essential in defining the appropriate treatment and in avoiding inappropriate surgery. Computed Tomography (CT) is one of the preoperative investigation techniques. However it may fail in detecting small lesions and extra-hepatic dissemination and can be inaccurate in differentiating benign from malignant lesions [7, 8]. [18 F] 2-fluoro-2-deoxy-D-glucose (FDG) Positron Emission Tomography (PET), a scintigraphic imaging technique, relies on increased rates of glucose metabolism in malignant cells. Available data suggest that this can be a valuable tool for the detection and staging of recurrent CRC [9, 10]. At present, 60 PETs have received authorization for implementation in France. To be generalized on a national scale, any new technique must prove to be more effective and cost-effective compared to previous strategies. However, the costs and health outcomes associated with the use of PET in addition to CT in clinical practice for colorectal cancer have not been assessed in the French clinical and economic context. Two cost-effectiveness analyses based on decision analysis models suggested that CT + PET was cost-effective and a suitable strategy [11, 12]. However these findings cannot necessarily be extrapolated to the French context because of possible variations in clinical practice and approaches to pricing and reimbursement.

The purpose of this paper was to compare the cost-effectiveness of standard imaging techniques with and without PET in the management of metachronous liver metastases from the French health care system insurance perspective using a decision analysis model.

MATERIALS AND METHODS

Base Case

Using data issued from the Burgundy digestive cancer registry, the base case was considered to be a 68-year-old individual previously resected for colorectal cancer, with suspected metachronous liver metastases. Metachronous metastases were defined as lesions diagnosed during the follow-up after the resection of the primary tumour by abdominal ultrasonography.

General Description of the Model

A decision analysis tree representing the management of metachronous liver metastases was built. In this decision tree, strategies to be compared originated from a decision node. Strategies comprised sequences of clinical events with associated estimated transitional probabilities. These sequences were constructed from data issued from published literature, and then validated by a committee of multidisciplinary experts composed of surgeons, oncologists and gastroenterologists. At the end of each alternative arm of the tree, payoffs were assigned corresponding to the total cost of care (diagnosis + staging + treatment) and life expectancy in years. The expected life expectancy and the expected cost of care associated with each strategy were estimated by weighting life expectancies and costs of each arm of the decision tree by the probability that a patient experiences a clinical event. Data 3.5 software (TreeAge, Inc Williamston, MA) was used to construct and analyze the decision tree.

Strategies

To decide on the treatment strategy, lesions characteristics must be accurately assessed. In this context, two alternative strategies were modeled. The first one consisted in a CT of thorax, abdomen and pelvis (CT) (Fig. 1), and the second one in an initial CT of thorax, abdomen and pelvis followed by a PET (CT + PET) (Fig. 2).

CT STRATEGY. In the CT strategy, a transparietal liver biopsy was performed in the case of positive CT findings (indicating a high presumption of metachronous liver metastases). If the biopsy confirmed the diagnosis (positive biopsy), the patient was oriented either to exploratory surgery if the disease appeared resectable, or to palliative treatment if the patient presented an *a priori* extensive disease. The “exploratory surgery” event was then weighted by the proportion of patients presenting in fact a non-resectable lesion. In this case, palliative treatment was proposed. Similarly, the “palliative treatment” event was weighted by the

proportion of patients presenting a localized lesion. In this case, patients were assumed to be reoriented to surgery for cure after 2 cycles of chemotherapy [13]. Liver biopsy could also be negative. Since the imperfect sensitivity of the biopsy is well established [14], the probability of false negative results was taken into account and a second biopsy was performed. In the case of positive findings at the second biopsy, the same management as described above was applied. In the case of a new negative biopsy, exploratory surgery was performed. If evidence of metachronous liver metastases was found, the patient underwent either surgery for cure or palliative treatment according to the staging of the lesion. If no evidence of the disease was found, the work-up was stopped.

When CT findings were negative (indicating a high presumption of absence of metachronous liver metastases), magnetic resonance imaging (MRI) was performed. In the case of negative MRI, the work-up was stopped. Diagnostic errors associated with MRI due to its imperfect sensitivity were taken into account [7, 15]. Indeed, a small proportion of patients was assumed to present a malignant lesion despite negative MRI and was oriented towards surgery or palliative treatment according to the extent of the disease. If MRI findings were positive, the patient was directed towards exploratory surgery if the disease appeared localized on MRI or towards palliative treatment in the case of suspected extensive disease. Similarly, imperfect MRI specificity allowed us to model the case of patients oriented to treatment, even though presenting a benign lesion.

CT+PET STRATEGY. In the case of positive CT findings a biopsy was performed, followed by a second one in the case of negative results. In the case of positive findings at the first or second biopsy and if the lesion was considered to be resectable by CT, it was assumed that the patient would be systematically re-evaluated with PET and then oriented to the most suitable treatment. If the patient was considered to have non-resectable hepatic disease by CT, experts considered that re-assessment using PET would be performed in 10% of cases due to clinical uncertainty. Otherwise (in the remaining 90% of cases), the patient was oriented directly to a palliative treatment. In the case of negative biopsy, the same management as described in the CT-alone strategy was applied.

If CT findings were negative, a PET was immediately performed to confirm the CT results. If PET was negative, the work-up was stopped. Possible diagnostic errors due to its imperfect sensitivity [16, 17] were modeled. If PET was positive, the same scenario as described with MRI was modeled.

Epidemiological parameters

TRANSITION PROBABILITIES. Epidemiological data are reported in Table 1. The probability of having metachronous liver metastases after abnormal abdominal ultrasound was estimated to be 0.85 [4, 18]. The probability that the diagnosis of liver metastases would be confirmed by imaging techniques was estimated using the sensitivity and specificity of CT [7, 16, 19], MRI [7, 15] and PET [16, 17]. The probability that liver metastases would be found resectable by imaging techniques was estimated along with the proportion of resectable metachronous liver metastases [4] and the sensitivity and specificity of CT, MRI and PET in predicting resectability [20-22]. Sensitivity in predicting resectability was defined as the number of individuals with no evidence of extensive disease (liver invasion or extra-hepatic metastases) depicted on imaging tests divided by the number of individuals with no evidence of extensive disease at surgical examination. False positive patients were those thought to be resectable by imaging test criteria, but who were not found to be resectable at exploratory surgery. Specificity in predicting resectability was defined as the number of individuals with evidence of extensive disease depicted on imaging tests over the number of individuals with extensive disease at surgical examination. False negative patients were subjects thought not to be resectable by imaging test criteria but finally directed towards surgery for cure because of the presence of a localized lesion. Data about morbidity and mortality related to surgical resection were also taken into consideration [23, 24]. Mortality associated with biopsy was not introduced into the model given the small number of such events [14]. Experts were consulted on the following points: sensitivity of the second liver biopsy, frequency of PET use after the patient has been considered non-resectable by CT, proportion of patients directed to chemotherapy or symptomatic treatment in the case of a priori non-resectable disease.

LIFE EXPECTANCIES. Life expectancies were calculated using the DEALE method [25, 26] (Table 1). Survival rates according to surgery for cure, chemotherapy, and symptomatic treatment were extracted from the Burgundy digestive cancer registry database over the period 1976-1995 (non-published data). After one year, mean observed survival rates were 62%, 43% and 20% respectively, allowing life expectancies to be estimated at 1.86, 1.11 and 0.60 years. Patients reoriented towards surgery for cure after 2 cycles of chemotherapy were assumed to have the life expectancy of a patient initially directed to justified resection. Patients with benign lesions, but falsely considered as presenting a malignant disease were assumed to have the life expectancy of patients resected for cure of a primary colorectal tumour and presenting no recurrence over the whole period of their follow-up. Based on the

data of the Burgundy digestive cancer registry, the mean one-year observed survival rate was 89% for these patients, leading to an estimated life expectancy of 5.62 years.

Economic Parameters

The economic analysis was performed from the national health insurance perspective. Costs were expressed in Euros (€) for the year 2004.

COST OF DIAGNOSTIC TESTS. CT, MRI and PET did not require hospitalization. Their costs were obtained from the "Nomenclature Générale des Actes Professionnels" (NGAP), a fixed costs scale of medical procedures based on practitioners' fees, fixed costs for the medical procedures themselves, and fixed costs for operating the equipment (Table 2). Liver biopsy required a 12-hour stay in hospital. Therefore its cost included the cost of an ambulatory hospitalisation stay (less than 24 hours) in the medical department of our Dijon university hospital, reimbursed by the French health care insurance (Table 3).

COST OF TREATMENT PROCEDURES. Treatment costs were calculated in a similar way to liver biopsy cost. These costs varied according to the type of hospitalization: complete (more than 24 hours), ambulatory (less than 24 hours) and the type of department (surgical, medical, drug-specialized). Surgeons from our Dijon university hospital estimated that surgery for cure without complications required 10 days of hospitalization, 12 days if complications occurred, and 7 days for exploratory laparotomy. Palliative treatment consisted of chemotherapy and symptomatic treatment. The association of Folinic Acide and Fluoro-Uracile® (LV5 FU2) was used as standard protocol for chemotherapy. It required 2 days of ambulatory hospitalization every two weeks for an optimal period of 6 months (12 cycles). Its cost was estimated by multiplying the total number of hospitalization days (*i.e.* 24) by the cost of ambulatory hospitalization in a drug-specialized department. If chemotherapy was stopped after 2 cycles, only 4 days were considered [13].The hospitalization duration for symptomatic treatment was issued from the national hospital database on diagnosis related groups (DRGs) in the public health care sector for 2003. This database allowed us to determine which of the existing DRGs covered each of the specific medical procedures modeled in the study. The DRG including the "symptomatic treatment" procedure presented an average hospitalization length of 5 days in a medical department. This duration was also multiplied by the cost for complete hospitalization.

Outcomes

EFFECTIVENESS, COSTS AND COST-EFFECTIVENESS. A cost-effectiveness analysis was performed using CT alone as reference strategy. Incremental effectiveness was measured in terms of the difference in expected average life expectancy between the CT + PET strategy and the reference strategy. Incremental costs were evaluated in a similar fashion. The cost-effectiveness analysis was based on an incremental cost-effectiveness ratio (ICER), calculated by dividing the incremental costs by the incremental effects of two alternatives according to the following formula: ICER = (Cost $_{CT + PET}$ - Cost $_{CT}$)/ (Life expectancy $_{CT + PET}$ - Life expectancy $_{CT}$). The most cost-effective strategy was defined as that with the lowest ICER. Incremental costs were not discounted given the time period elapsed between the diagnosis of recurrence and the first treatment (less than one year). In the case of incremental gains in effectiveness (Life expectancy $_{CT + PET}$ - Life expectancy $_{CT}$) , these were discounted back at the annual discount rate of 5% [27].

CLINICAL RESULTS. The number of true diagnoses of recurrence, the number of unseen recurrences, as well as the number of well-suited treatments (curative resection, palliative treatment) and the number of not well-suited treatments (unnecessary exploratory surgery, palliative treatment), among patients with suspected liver metastases were estimated. Therefore, for each of the two modeled strategies, transition probabilities associated with the arms of the decision tree were applied to a fictitious population of 1,000 individuals. It was also possible to estimate the number of patients reaching the ends of the arms of the decision tree, to add together all those having the same diagnostic status (false or true) or the same type of treatment (well-suited or not well-suited) and then to calculate the proportion of patients according to their diagnostic or therapeutic management.

Sensitivity Analysis

One-way sensitivity analyses were performed on epidemiological and economic parameters. Threshold values were determined and used as cut-off points beyond which the hierarchy between strategies could be modified, therefore changing the conclusions of the study.

RESULTS

Cost-effectiveness modeling baseline value

Table 4 shows the cost-effectiveness results of CT and CT + PET in the management of an average 68-year-old individual previously resected for a CRC and with suspected

metachronous liver metastases after an abnormal abdominal ultrasound. CT was a dominated strategy, presenting an extra-cost of 2,671€ and a similar expected effectiveness-per-patient compared to CT + PET (1.88 years life expectancy per patient).

Sensitivity analyses

SENSITIVITY ANALYSIS PERFORMED ON THE NATURAL HISTORY OF THE DISEASE. The probability of having liver metastases after a suspicious abdominal ultrasound was tested first over the [0.80-0.95] interval. No thresholds were found and CT remained dominated by CT + PET. The increase in the proportion of non-resectable metastases (baseline value of 0.80, varying between 0.60 and 0.90) led to the same conclusion.

SENSITIVITY ANALYSIS PERFORMED ON THE PARAMETERS CHARACTERISING PET STRATEGY. The following parameters characterizing PET were changed: sensitivity and specificity for detecting liver lesion, sensitivity and specificity for assessing resectability and frequency of PET use among patients considered as non resectable by CT. The model was not sensitive to any of these parameters.

SENSITIVITY ANALYSIS PERFORMED ON THE EPIDEMIOLOGICAL PARAMETERS CHARACTERISING CT STRATEGY. Similarly, no thresholds were found for diagnostic performances associated with biopsy, CT or MRI, as well as for CT and MRI performances in assessing resectability.

SENSITIVITY ANALYSIS PERFORMED ON ECONOMIC PARAMETERS. Costs of CT, MRI, biopsy and treatment procedures were separately increased and decreased by 20%. The conclusion of the cost-effectiveness analysis remained unchanged. The only threshold found concerned the cost of PET. The baseline cost used was 1,034 €. Sensitivity analysis showed that above 8,992 €, CT + PET became dominated by CT alone. However, this cost was not a reasonable range cost for PET.

Outcomes concerning diagnostic and therapeutic management of patients

The introduction of PET did not greatly modify the diagnostic management of patients with suspected metachronous liver metastases (Table 5). The main difference between the two strategies concerned the therapeutic management of patients. Compared to CT + PET, CT alone was associated with a relative risk reduction of 9.5% in correctly assessing patients with non-resectable disease. The relative risk that patients undergo inappropriate surgery was estimated to be reduced by 88.4% when PET was associated with CT compared to CT alone.

DISCUSSION

To our knowledge, this study is the first attempt to estimate the clinical and medico-economic implications of PET in France among patients with metachronous metastases. Results indicated that CT + PET was a more cost-effective strategy than CT alone with an incremental cost saving of 2,671 € per patient, and the same level of life expectancy. Only two other studies have been published regarding the use of PET to detect and stage patients with suspected metachronous liver metastases [11, 12]. Gambhir, et al demonstrated that CT + PET was associated with a 2-day increase in life expectancy and savings of $220 per patient compared to CT [11]. In Park's study, CT + PET generated a gain in life expectancy of 9.5 days and an ICER of $16,437 per life-year gained compared to CT [12]. Though these published models and the present study differ in the sequence of clinical events modeled, as well as epidemiological and economic assumptions, close results were found conducting to similar conclusions. For instance in both published analyses, CEA testing was used previously to CT, which was not the case in the present study where patients were selected following a suspicious abdominal ultrasound, as recommended by French clinical guidelines [28]. Another difference of our model was the introduction of MRI when the absence of metachronous liver metastases using CT was suspected. This point also reflects French guidelines which recommend using MRI when CT fails in characterizing detected lesions [29]. The introduction of liver biopsy into the present decision tree could be argued. Its use depends mainly on the degree of uncertainty associated with radiological findings and the treatment to be considered [29]. In this work, liver biopsy was modeled because of the imperfect diagnostic performances of CT for recurrence detection. The place of PET in the present decision tree can finally be discussed. Recent French guidelines issued from the National Agency for Accreditation and Evaluation in Health Care (ANAES) recommend that PET could be considered when CT was not sufficient in determining the most appropriate treatment for the patient and when a resection is considered [30]. Therefore, PET was systematically modelled in this study prior to any therapeutic decision when the liver lesion was *a priori* considered as localized using CT and after negative CT findings. However, in order to take into account possible different clinical practices, PET was also assumed to be performed in 10% of the cases when CT suggested the presence of non-resectable hepatic disease. The sensitivity analysis performed on this parameter did not modify the conclusion of the analysis.

All studies demonstrated that CT + PET generated cost savings per patient, but no added gain in effectiveness compared to CT alone. This result is as a poor argument to justify

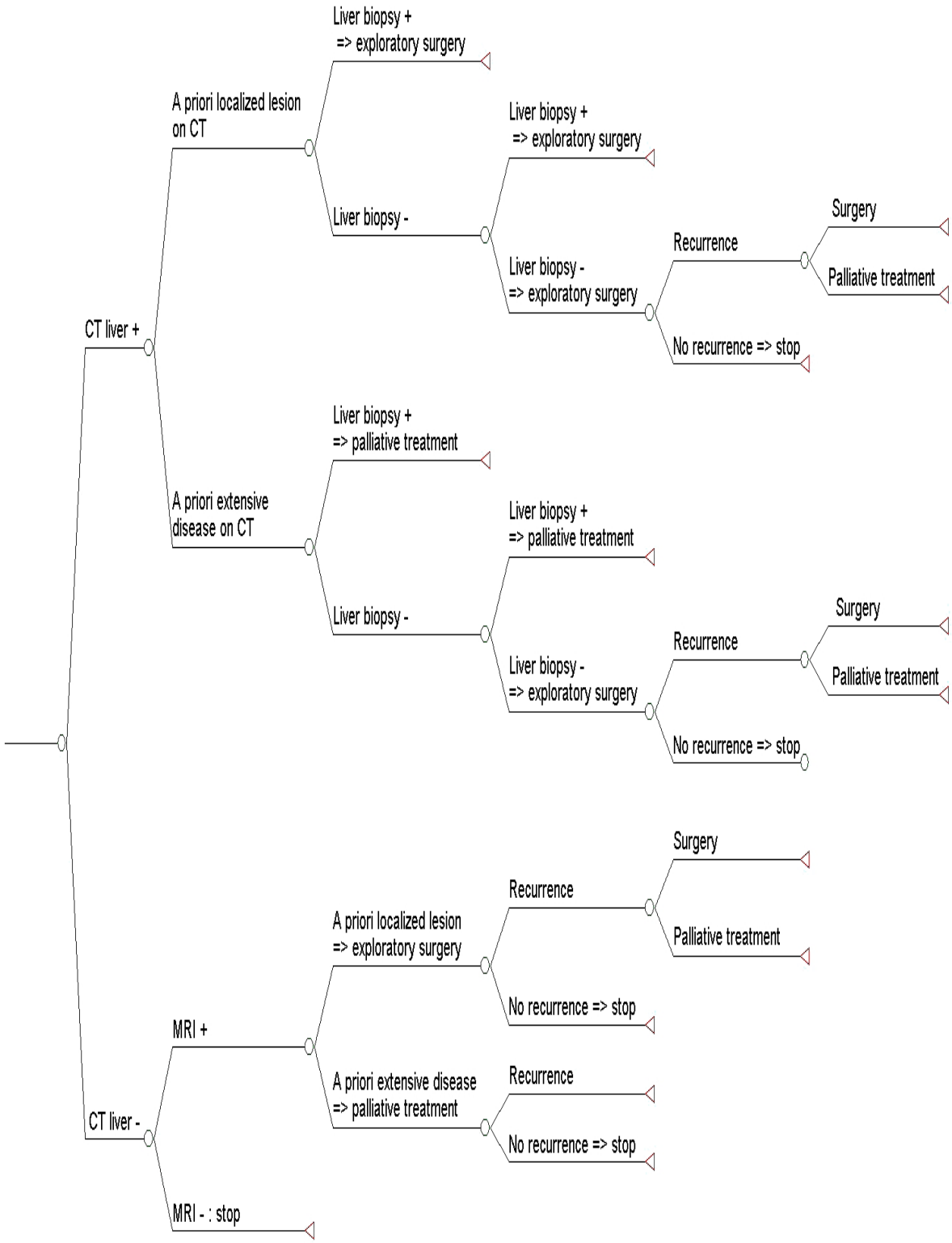
the implementation of PET in France for diagnosing and staging metachronous metastases. This is a limit of cost-effectiveness analyses which are based on a single effectiveness criterion. That is the reason why the proportion of patients who had undertaken unnecessary treatment has been taken into account in this work to help in decision. Our study suggests a positive influence of PET on the management of metachronous liver metastases of colorectal cancer. A total of 6.1% of patients could avoid inappropriate exploratory surgery thanks to its introduction, whereas Park found a smaller figure (2.8%) in his cost-effectiveness analysis [12]. In another study reporting the first five-year overall survival in patients considered to have resectable liver disease after conventional imaging, PET was estimated to reduce the number of futile laparotomy by 25% [31]. The difference between the results issued from the two modelisations and this population-based study can be explained to great extent by the fact that models are affected by the choice of sequences of clinical events and diagnostic performances of tests. Other criteria could have been introduced in this work. Especially quality of life could have been considered. Given the important estimated proportion of patients who received chemotherapy as treatment, it could have been relevant to perform a cost-utility analysis. Similarly, evaluation of adverse effects associated to futile laparotomy and useless chemotherapy for patients could have been of interest. Such evaluations requires however *adhoc* studies.

The perspective of the present work can be opened to question. The cost-effectiveness analysis was performed from the point of view of the national health insurance. Only reimbursed costs were assumed to be taken into account. Therefore the choice of different sources of costs used in the analysis can be discussed. Indeed, the cost of diagnostic tests was estimated using the NGAP, a fixed cost scale used by the French insurance for reimbursements. Treatment and biopsy costs were evaluated using prices for ambulatory and complete hospitalization in medical, surgical and drug-specialized departments. However these prices respond to accounting rules and do not represent the amount of money spent by the French health care insurance to balance the costs of health care provided by hospitals. Another solution could have been to use a case-mix derived from the national hospital database on GHMs “Groupe Homogène de Malades”. GHMs have been adapted from diagnosis related groups (DRGs). This database can be used to determine which of the existing GHMs covered each of the specific medical procedures modelled in the study. Once the GHM was defined, it could have been possible to determine the cost of hospital stays using a French national public cost scale compiled by the Ministry of Health from data collected from a representative sample of public hospitals. The cost scale includes budget

headings such as costs for labour, technical procedure, supplies, maintenance, provision for depreciation, laundering, catering and general logistics. However, using GHMs would have also been tricky because this database is not used at the moment for reimbursing hospital costs, but to evaluate hospital activity, and help with the budget allocation between hospitals.

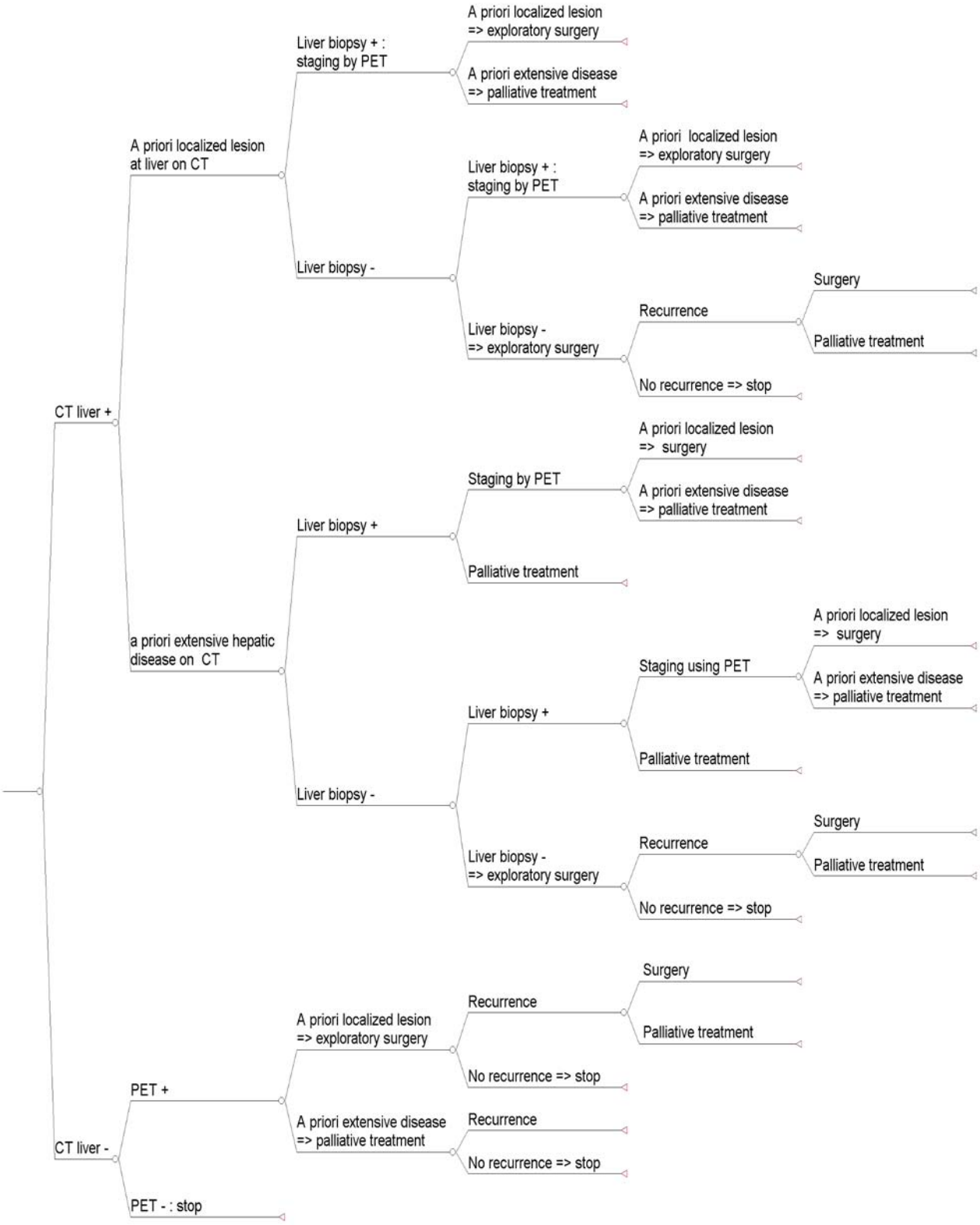
At present, PET units are planned to be installed throughout France, even though the medico-economic consequences of PET use have been poorly analyzed. Decision analysis models are a useful tool for estimating cost and effectiveness of health care programs and new technologies when results from controlled studies are not available. In spite of its limitations, this work demonstrated the value of the association of CT + PET from an economic point of view, but also the non-relevance of this association if only survival effectiveness was taken into consideration. The main advantage of the introduction of PET consists in decreasing the number of inappropriate exploratory surgical acts. Clinical trials are necessary to back up these results and to determine over a long period the effectiveness and costs incurred by introducing PET into the management of patients with suspected metachronous liver metastases.

FIGURE 1. CT strategy decision analysis tree



Legend. Outline of decision tree showing the diagnosis and staging of metachronous liver metastases with CT. Circles represent chance nodes, and triangles termination nodes.

FIGURE 2. CT + PET strategy decision analysis tree



Legend. Outline of decision tree showing the diagnosis and staging of metachronous liver metastases with CT + PET. Circles represent chance nodes, and triangles termination nodes.

TABLE 1. Epidemiological parameters (baseline value and range) used in the model

Variables	Value	Range	References
Probability of metachronous liver metastases	0.85	[0.80-0.95]	[4, 18]
Diagnostic imaging test performances for detection :			
CT sensitivity for metastases detection	0.98	[0.90-0.99]	[7, 16, 19]
CT specificity	0.85	[0.80-0.95]	[7, 16, 19]
PET sensitivity	0.90	[0.85-0.99]	[16, 17]
PET specificity	0.98	[0.80-0.99]	[16, 17]
MRI sensitivity	0.98	[0.90-0.99]	[7, 15]
MRI specificity	0.95	[0.80-0.98]	[7, 15]
1^{st} liver biopsy sensitivity	0.85	[0.70-0.95]	[14]
2^{nd} liver biopsy sensitivity	0.99	-	Experts
1^{st} and 2^{nd} liver biopsy specificity	1.00	-	[14]
Diagnostic test performances for assessing resectability:			
CT sensitivity	0.80	[0.80-0.99]	[21, 22]
CT specificity	0.90	[0.60-0.95]	[21, 22]
PET sensitivity	0.95	[0.80-0.99]	[20]
PET specificity	0.95	[0.85-0.99]	[20]
MRI sensitivity	0.85	[0.80-0.99]	[21]
MRI specificity	0.95	[0.80-0.95]	[21]
Proportion of resectable metastases	0.20	[0.10-0.40]	[4]
Clinical Practices :			
Frequency of use of PET after a patient is considered as non resectable after CT	0.10	[0.00-0.80]	Experts
Proportion of patients directed to chemotherapy	0.90	-	Experts
Risks associated with surgery for cure :			
Morbidity rate	0.10	-	[23, 24]
Mortality rate	0.03	-	[23, 24]
Life expectancy in years :			
Absence of recurrence (68-year-old individual)	5.62	-	Burgundy
Surgery for cure	1.86	-	Digestive
Chemotherapy	1.11	-	Cancer
Symptomatic treatment	0.60		Registry

TABLE 2. Baseline values of the cost of diagnostic tests used in the decision tree and performed on ambulatory patients (€ in year 2004)

Diagnostic tests	Resources utilization	Cost (€)	Total cost (€)
CT	Equipment	213	313
	Medical procedure	62	
	Contrast product	28	
	Contrast product injection	10	
MRI	Equipment	282	365
	Medical procedure	69	
	Contrast product	5	
	Contrast product injection	10	
PET	Equipment	950	1,034
	Medical procedure	84	

TABLE 3. Baseline values of the cost of transparietal liver biopsy and treatments used in the decision tree and requiring hospitalization (€ in year 2004)

Diagnostic test and treatment	Hospitalization length (days)	Hospital cost* (€)	Total cost (€)
Transparietal liver biopsy	1	567.26	567
Surgery for cure without complications	10	669.24	6,692
Surgery for cure with complications	12	669.24	8,031
Exploratory laparotomy	7	669.24	4,685
Complete chemotherapy	24†	961.37	23,073
Incomplete chemotherapy	4†	961.37	3,845
Symptomatic treatment	5	550.26	2,751

*567.26 € is the cost for ambulatory hospitalization in a medical department, 669.24 € is the cost for complete hospitalization in a surgical department, 961.37 € is the cost for ambulatory hospitalization in a drug-specialized department, 550.26 € is the cost for complete hospitalization in a medical department at the Dijon university hospital.

†The chemotherapy protocol consists in 2 days of ambulatory hospitalization every 2 weeks over a 6-month period (12 cycles). In the case of incomplete protocol, the patient was assumed to receive 2 cures over the period of one month (2 cycles)

TABLE 4. Cost-effectiveness results of CT and CT + PET in the management of metachronous liver metastases

	Cost (€)	**Life expectancy (years)** *	**Incremental cost-effectiveness ratio**
CT + PET	17,064	1.88	-
CT	19,735	1.88	dominated

*All life expectancies have been rounded up to two decimal places

TABLE 5. Modification of the diagnosis and therapeutic orientation of patients with metachronous liver metastases induced by CT and CT + PET (%)

	CT	**CT + PET**
Absence of recurrence	14.4	14.7
Unseen recurrence	0.0	0.3
Curative resection	13.6	13.2
Palliative treatment *	61.3	67.1
Unnecessary exploratory surgery †	6.9	0.8
Unnecessary palliative treatment‡	3.9	3.9

* Palliative treatment includes chemotherapy and symptomatic treatment

† Exploratory surgery performed although the tumour was non resectable

‡ Palliative treatment adopted whereas the malignant tumour could be resected for cure in first intention

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