ORIGINAL ARTICLE

Imaging modalities for the staging of patients with colorectal cancer

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ABSTRACT

Dutch guidelines made the following recommendations for staging colorectal cancer (CRC). For liver metastases, computed tomography (CT) or magnetic resonance imaging (MRI) could be used. For lung metastases, imaging could be limited to chest X-ray. The primary aim of this survey was to summarise the use of imaging modalities and the variation in techniques.

Three surveys were created and sent to three groups of medical specialists, namely surgeons, radiologists and nuclear medicine physicians. The management survey included questions on the role of different modalities for evaluation of synchronous liver, lung and extrahepatic metastases. The radiological survey included questions concerning the technical aspects of ultrasound (US), CT and MRI. The nuclear medicine survey included questions concerning the technical aspects of FDG-PET and FDG-PET/CT. The management and radiological surveys were sent to abdominal surgeons and abdominal radiologists within 88 hospitals and the nuclear medicine survey to specialists within 34 hospitals.

Response rates were 75.0% (n=66/88), 77.3% (n=68/88) and 64.7% (n=22/34) for the management, radiological and nuclear medicine surveys, respectively. For liver metastases, the first modality of choice was CT in 52 (78.8%) and US in 12 hospitals (18.2%). Lung metastases were evaluated by either chest X-ray or chest CT and extrahepatic metastases mainly by CT (n=55). In the radiological and nuclear medicine surveys, some variations in techniques of US, CT, MRI, FDG-PET and FDG-PET/CT were seen.

CT is primarily used for liver and extrahepatic metastases and both chest CT and chest X-ray for lung metastases. There are discrepancies between the survey of daily practice and the present guidelines. Comparative studies on different staging strategies for colon and rectal cancer, including comparing a strategy of CT liver/abdomen versus MRI liver/abdomen for the evaluation of liver and extrahepatic disease and chest X-ray or chest CT for lung metastases would be important for well-founded adjustments of the present guidelines.

KEYWORDS

Colorectal neoplasms, diagnostic imaging, metastasis, staging

INTRODUCTION

Colorectal cancer (CRC) is diagnosed in the Netherlands in over 10,000 new patients per year, making colorectal cancer the third most diagnosed cancer in men, next to prostate and lung cancer. In women it is the second most diagnosed cancer, next to breast cancer. It is expected that in 2015 the incidence of colorectal cancer will have increased to approximately 14,000 new patients per year.[1]

A Dutch national evidence-based guideline on the diagnosis and treatment of patients with colorectal liver metastases was published in 2006.[2,3] The guidelines were developed by a working group mandated by the disciplines involved in this field, including surgeons, medical oncologists, gastroenterologists, radiologists and nuclear medicine physicians. The recommendations for detection of synchronous metastases by diagnostic imaging were as follows. For synchronous liver metastases, spiral computed tomography (CT) with an intravenous contrast agent (more than 45 gram iodine), or magnetic resonance imaging (MRI) with a contrast agent were indicated as imaging modality. For the evaluation of lung metastases, imaging could be limited to conventional chest X-ray, based on the low prevalence of lung metastases and the occurrence of false-positives at CT. No recommendations were made for the use of ^{18}F fluorodeoxyglucose positron emission tomography (FDG-PET) and FDG-PET/CT for this patient group, since data and the use of these modalities were limited at that time.

Since the introduction of this evidence-based guideline, several improvements have been made in imaging such as the extensive use of multispiral CT, new available MRI-contrast liver agents and the more widespread use of FDG-PET and the introduction of FDG-PET/CT. [4-9] In addition, many new studies have evaluated the role of the different modalities or techniques for this patient population.[10-15]

At this time point it is unclear if and to what extent these improvements have led to variations in the management. To gain information on the use of imaging modalities and the variation in techniques, we performed a digital survey in all hospitals in the Netherlands. The aim of this survey was to summarise the use of imaging modalities in staging of patients with CRC and the extent of variation in techniques used by radiologists and nuclear medicine specialists.

METHODS

Survey

Three different surveys were sent to three groups of medical specialists who are mainly involved in the staging of patients with colorectal cancer, by using imaging modalities.

1) The management survey. This survey included general questions, such as information on the hospital, specialist and years of experience, and specific questions on the role of the different imaging modalities in the staging of CRC, for the evaluation of liver, lung and extrahepatic disease. The specific questions are described in *table 1*.

2) The radiological survey. This survey also included general questions, such as information on the hospital, specialist and years of experience, and the specific questions concerning the technical aspects of ultrasonography (US), CT and MRI. The specific questions are described in *table 2*.

3) The nuclear medicine survey. This survey also included general questions, such as information on the hospital, specialist and years of experience, and the specific questions concerning FDG-PET and FDG-PET/CT. The specific questions are described in the *table 3*.

Table 1. *The management survey to define the role of imaging modalities*

Questions	Answers
Is an imaging modality used for the detection of synchronous liver metastases?	Always (100%), Often (50-90%) Sometimes (<50%) Never
Which imaging modality is used for the detection of synchronous liver metastases? Indicate which modality is the first, second, third choice, etc.	US CT MRI FDG-PET FDG-PET/CT
Is imaging performed for the detection of synchronous lung metastases?	Always (100%) Often (50-90%) Sometimes (<50%) Never
Which imaging modality is used for the detection of synchronous lung metastases? Indicate which modality is the first, second, third choice, etc.	Chest X-ray Chest CT Other
Is imaging used for the detection of synchronous extrahepatic abdominal metastases?	Always (100%) Often (50-90%) Sometimes (<50%) Never
Which imaging modality is used for the detection of synchronous extra-hepatic abdominal metastases? Indicate which modality is the first, second, third choice, etc.	US CT MRI FDG-PET FDG-PET/CT
What is the frequency of multi-disciplinary meetings for colorectal cancer patients held in your institution? Are these meetings held with consultants from the Comprehensive Cancer Centres (CCC) or with specialists from other hospitals?	Times per week CCC Other hospitals
To what extent are surgeons, oncologists, gastroenterologists, radiologists, nuclear medicine physicians or internists involved in the care of these patients?	4-point scale varying from no role to major role
To what extent do findings in the literature, availability of techniques, available expertise, associated costs, available personnel and waiting lists affect the choice for a diagnostic modality?	4-point scale varying from no role to major role

Participants

Since surgeons are mainly involved in the management of these patients, the management survey was sent to abdominal surgeons in all 88 Dutch hospitals with the help of the 'Dutch Surgical Society' (NVvH) in November 2010. The radiological survey was sent to abdominal radiologists in all 88 Dutch hospitals with the help of the 'Radiological Society of the Netherlands' (NVvR) in November 2010. The nuclear medicine survey was sent to nuclear medicine physicians within 34 hospitals in January 2011: only hospitals with the availability and use of FDG-PET or FDG-PET/CT (based on the results of the management survey) were contacted.

Table 2. *The radiological survey to summarise the technical aspect of US, CT and MRI*

Modality	Questions	Answer
US	What part of the abdomen is imaged using US for the detection of synchronous metastases?	Solely the liver Upper abdomen Lower abdomen
	What type of transducer is used?	Convex Convex+Linear
	What is the frequency of the transducer?	Mhz
	Which US technique is used?	Grayscale imaging Tissue-harmonic imaging
	Is a contrast agent used for US?	Yes (type, dose) No
CT	What part of the body is imaged using CT for the detection of synchronous metastases?	Solely the liver Upper abdomen Lower abdomen Thorax
	What type of CT scanner is used?	Single-slice or multi-slice Number of detectors
	Is intravenous contrast agent used?	Yes (type, dose) No
	Which phases are used and what is the timing of the phases?	Arterial, portal or late (timing)
MRI	What part of the body is imaged using MRI for the detection of synchronous metastases?	Liver/Upper abdomen Lower abdomen
	Which MRI scanner is used?	Strength and type of coil
	Is an intravenous contrast agent used for MRI in the detection of synchronous metastases?	Yes (type, dose, timing) No
	What sequences are used in MRI for the detection of synchronous metastases?	T1W-SE, T1W-GRE, T1W-FSE, T1W-FATSAT, T2W-SE, T2W-FSE T2W-FATSAT, Dynamic T1W with contrast agent, HASTE, Diffusion weighted sequence with ADC-mapping

Table 3. *The nuclear medicine survey to summarise the technical aspects of PET and PET/CT*

Modality	Questions	Answers
FDG-PET or FDG-PETCT	Is NEDPAS used*	Yes No
FDG-PET	What is the PET acquisition time?	Minutes per bed position
	What amount of FDG is used for the detection of synchronous metastases?	MBq/kg bodyweight
	What are the specifications for the patient preparation?	Fasting time Time interval between FDG injection and scanning
	How are the images evaluated	Quantitatively Qualitatively
	What modality is used for visually comparison?	CT MRI Other
FDG-PET/CT	What is the PET acquisition time?	Minutes per bed position
	What amount of FDG is used for the detection of synchronous metastases?	MBq/kg bodyweight
	What are the specifications for the patient preparation?	Fasting time and time interval between FDG-injection and scanning
	How is the evaluation of the images read?	Quantitatively Qualitatively
	Is a low dose or a high dose used for CT imaging?	Low dose (mAs, kV) High dose (mAs, kV)
	Is an intravenous contrast agent used for CT with FDG-PET/CT?	Yes (type, dose, phases, timing) No
	Is an oral contrast agent used for CT with FDG-PET/CT?	Yes (type, dose)
	Who evaluates the images from the FDG-PET/CT?	Nuclear medicine physician Radiologist

*** Boellaard R, Oyen W, Hoekstra C et al. The Netherlands protocol for standardisation of FDG whole body PET studies in multi-center trials (NEDPAS). Nucl Med. 2008;49 (Supplement 1):106P**

Response

After two months, all non-responders were contacted, initially via email, subsequently via telephone call. We aimed to reach a response rate of at least 70%.

Data presentation

We used a descriptive statistical analysis to summarise the results. Continuous, normally distributed data were expressed as means, with corresponding standard deviations. Continuous, not normally distributed data, were expressed as median with ranges or as modus with ranges, depending on the type of data. Categorical data were expressed as number and percentage.

RESULTS

Response rate

The response rates were 75.0% (n=66/88), 77.3% (n=68/88) and 64.7% (n=22/34) for the management, radiological and nuclear medicine surveys, respectively. All eight academic hospitals participated in the management and radiological surveys. Based on the results of the management surveys, concerning the use of FDG-PET or FDG-PET/CT for staging of CRC, specialists within 34 hospitals were invited to complete the nuclear medicine survey. For the nuclear medicine survey five out of six (83.3%) academic medical hospitals using either FDG-PET or FDG-PET/CT participated in this survey.

Management survey

This survey was completed by surgeons (n=62), oncologists (n=1), internists (n=1) or this was not described (n=2). The experience of the responders ranged from one year to 29 years, with a mean of 11.3±6.7 years. The availability of US, CT, MRI, FDG-PET or FDG-PET/CT was 100% (66), 100% (66), 100% (66), 56.1% (37) and 62.1% (41) hospitals, respectively.

Liver metastases: In 64 of the 66 hospitals (97.0%) imaging was always performed for the assessment of synchronous liver metastases, while in two hospitals (3.0%) imaging was often used, but not in all patients. The first modality of choice was CT in 52 hospitals (78.8%) and US in 12 hospitals (18.2%). The second choice was US in 34 hospitals (51.5%) and CT in 11 hospitals (16.7%). MRI, FDG-PET and FDG-PET/CT were not frequently used as first or second choice modality (*figure 1*).

Lung metastases: 53 of 68 hospitals (80.3%) always used an imaging modality for the assessment of lung metastases, in ten hospitals (15.2%) an imaging modality was often used and sometimes in three hospitals (4.5%). No imaging for lung metastases was performed in one hospital (1.5%). In all hospitals, assessment of synchronous lung metastases was done by either conventional chest X-ray or chest CT; FDG-PET or FDG-PET/CT was only used as third choice modality *(figure 2)*.

Extrahepatic abdominal metastases: For the detection of extrahepatic abdominal metastases, imaging was used in all patients in 40 of the 66 hospitals (60.6%). Twelve hospitals (18.2%) often used an imaging modality and in 13 hospitals this was sometimes used (19.7%). One hospital (1.5%) never used an imaging modality for the assessment of extrahepatic abdominal metastases. In most hospitals evaluating extrahepatic abdominal metastases was mainly done by CT (n=55) and to a lesser extent by US, MRI, PET and/or PET/CT *(figure 3)*.

In summary, CT is primarily used for the evaluation for liver and extrahepatic colorectal metastases. For evaluation of lung metastases, chest CT and conventional chest X-ray are used to a comparable extent.

Decision making

Specialists involved: Specialists primarily involved in decision making were predominantly surgeons in 51 and

Figure 2. *Choices of modalities used for the detection of synchronous lung metastases*

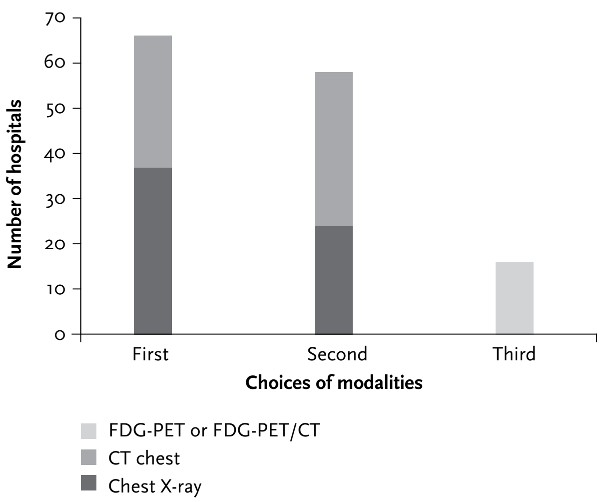


Figure 1. *Choices of modalities used for the detection of synchronous liver metastases*

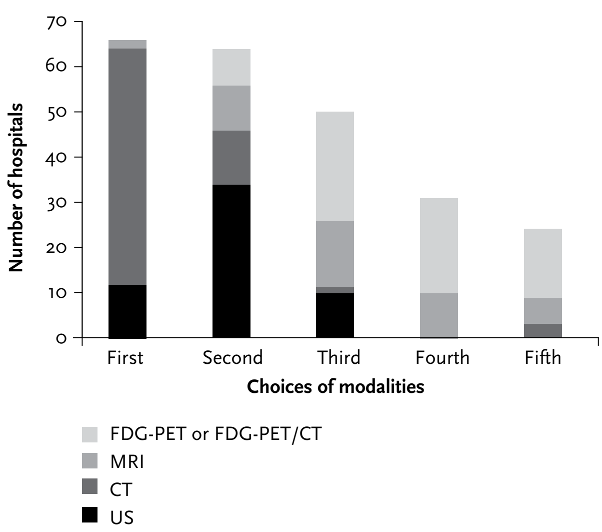
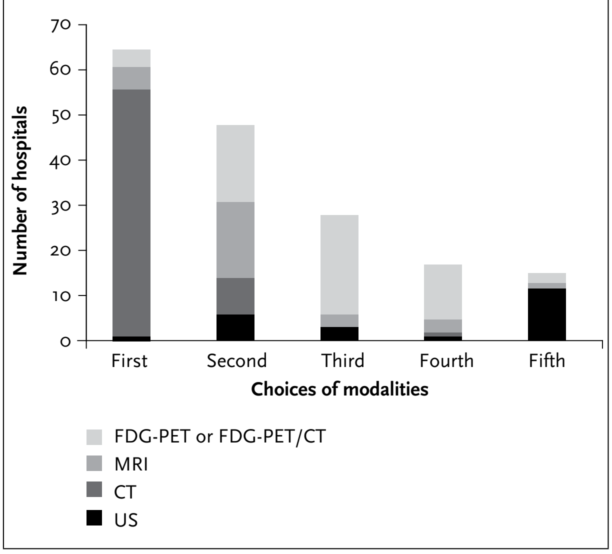


Figure 3. *Choices of modalities used for the detection of synchronous extrahepatic abdominal metastases*



medical oncologists in 22 hospitals. Gastroenterologist, radiologists, nuclear medicine physicians and internists were less involved in decision making.

Multidisciplinary meeting: Multidisciplinary meetings to discuss treatment options for colorectal cancer patients were routinely held in 65 hospitals (twice a week in six hospitals, weekly in 55 hospitals and every other week in four hospitals). Meetings with other hospitals were held in 19 hospitals and consultations from the Comprehensive Cancer Centres were requested in 47 hospitals. In seven hospitals, both other hospitals as well as specialists from Comprehensive Cancer Centres were involved. Seven hospitals did not have meetings with either the Comprehensive Cancer Centres or other hospitals.

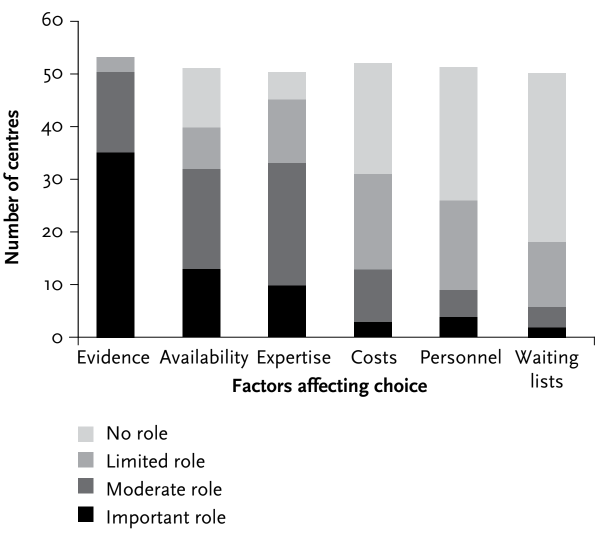
Factors affecting choices: The choice of imaging modality was mostly determined by evidence in the literature, followed by availability and expertise and occasionally by costs, personnel and waiting lists *(figure 4)*.

Radiological survey

The radiological survey was only completed by radiologists (n=68), with experience ranging from two to 32 years, with a mean experience of 12.2±7.2 years. The radiological surveys were not completed in exactly the same 66 hospitals as the management surveys; in 50 hospitals both surveys were completed.

Ultrasonography was performed in 31 (45.6%), CT in 67 (98.5%) and MRI in 20 (22.7%) hospitals for the detection of synchronous colorectal metastases.

Figure 4. *Factors such as literature, availability, expertise, costs, personnel and waiting lists affecting the choice for a diagnostic modality*



Ultrasonography: US was used for visualisation of the liver in all 31 hospitals (100%) where it was performed and for the evaluation of extrahepatic abdominal disease in 13 of these hospitals (41.9%). In all 31 hospitals (100%) a convex transducer was used and an additional linear transducer for detailed visualisation of the liver surface was used in three hospitals (9.7%). The frequency of the transducer ranges from 3 MHz to 8.5 MHz. US with harmonic imaging in combination with conventional US was performed in 22 hospitals (71.0%). One hospital (3.2%) occasionally used a contrast agent during ultrasound.

Computed tomography: CT was used for evaluation of liver metastases in all 67 hospitals (100%) were it was applied, for extrahepatic abdominal metastases in 63 hospitals (94.0%) and for lung metastases in 32 hospitals (47.8%). In 66 hospitals (98.5%), a multislice CT scanner was available, with the number of detectors ranging from 2 to 320 (modus 64 detectors), while one hospital (1.5%) had a single-slice CT scanner. CT was always performed with an intravenous contrast agent (100%) and the number of phases varied between hospitals. The portal phase was always used (100%), either as a single phase (52.2%) or in combination with arterial and late phases (*table 4*).

Forty-two hospitals (62.7%) used fixed timing for contrast; the arterial phase ranged from 20 to 40 seconds (modus 25 seconds), the portal phase ranged from 55 to 90 seconds (modus 70 seconds) and the late phase ranged from 120 to 360 seconds (modus 300 seconds). Twenty-three hospitals (34.3%) used bolus tracking and two hospitals (3.0%) did not report the type of timing.

The amount of iodine administrated ranged from 21 to 53 gram (mean 35.6±7.2 g). Ten hospitals (14.9%) used at least 45 gram iodine.

Magnetic resonance imaging: MRI was used for the evaluation of the liver disease in 12 of the 20 hospitals (60%) were it was used and for the evaluation of extrahepatic disease evaluation in nine hospitals (45.0%). The magnetic field strength of the available MRI scanners were predominantly 1.5 T (n=17), and further 3.0 T (n=2) and 1.0 T (n=2). In 15 hospitals (75.0%), an additional coil was used (14 phased array and 1 wrap around coil). Contrast agents were used in 15 hospitals (75.0%);

Table 4. *Phases used for the evaluation of synchronous liver lesions*

Phases used	Number of hospitals	Percentage
Portal phase	35	52.2%
Arterial + portal phases	11	16.4%
Arterial + portal +late phases	18	26.9%
Portal + late phases	3	4.5%

Gadolinium or a comparable contrast agent was used in ten hospitals and a liver specific contrast agent (Gadoxetic acid, Primovist, Bayer Schering, Berlin, Germany) was used in five hospitals. The sequences used for MRI were predominantly T2W-FSE (n=12), dynamic contrast-enhanced T1W (n=12) and diffusion weighted images (n=11).

Nuclear medicine survey

The nuclear medicine survey was completed by nuclear medicine physicians (n=21) and by one radiologist, with years of experience ranging from three to 28 years (mean 11.2±7.3 years). In 18 hospitals (81.8%), the Dutch protocol for standardisation of FDG (NEDPAS) was used. For evaluation of synchronous liver, lung and extrahepatic abdominal disease, FDG-PET was solely performed in two hospitals and FDG-PET/CT with either low-dose or high-dose CT in 14 hospitals.

FDG-PET (n=2): Patients fasted for six hours in both hospitals and were scanned 60 minutes after the injection of FDG (3 and 4.6 MBq/kg, respectively). The acquisition times were three and five minutes per bed position, respectively. Assessment was done qualitatively in both hospitals and visually compared with either CT or MRI.

FDG-PET/CT (n=14): In all hospitals, a multi-slice PET/CT scanner was available, with the number of detectors ranging from two to 64 (modus 16 detectors). Patients fasted for either four or six hours prior to the investigation. Administration of on average 2.99 Mbq/kg FDG (min: 1.7, max: 4.6) was predominantly 60 minutes prior to the investigation. Acquisition time ranges from 1.45 to 5 minutes per bed position. A low-dose CT image was performed in 13 hospitals (92.9%) and in eight of these hospitals (61.5%) an additional high-dose CT (diagnostic CT) was performed. Only one hospital (7.1%) performed a diagnostic CT solely. For the diagnostic CT, intravenous contrast agent administration with fixed timing and portal phase CT was always performed.

Data on radiation intensity, tube voltage, amount of contrast agent and phases are presented in *table 5*. The use of oral contrast agent was limited. Evaluation of the images was done by both the radiologist and nuclear medicine physician in 12 hospitals (85.7%). In two hospitals (14.2%) only the nuclear medicine physician evaluated the PET/CT images as only low-dose CT was used.

DISCUSSION

This study shows that a majority of hospitals use a comparable staging strategy, with CT as the first choice for staging of liver and extrahepatic disease and either chest CT or chest X-ray for evaluation of lung metastases. The role of US, MRI, FDG-PET and FDG-PET/CT as first choice techniques was limited.

In the radiological and nuclear medicine surveys, some variations in US, CT, MRI, PET and PET/CT techniques were seen. The majority of variation was within the accepted variation reported in the literature. In the Dutch guideline on colorectal liver metastases, recommendations were made concerning the use of a contrast agent for MRI and at least 45 grams of iodine for CT. Only a minority used at least 45 gram iodine for CT. However, this 45 gram iodine cut-off was chosen arbitrarily based on the results of a meta-analysis.[16] Not all hospitals used an MRI contrast agent, which could be explained by the use of recently introduced advanced MRI techniques (e.g. diffusion weighted imaging), which makes the use of contrast agent less critical.[17,18]

The strengths of this survey are the relatively high response rate and the participation of all types of hospitals (e.g. academic, tertiary). Therefore we believe that this survey does reflect the status of the use of imaging for the detection of synchronous colorectal metastases in the Netherlands.

This study has several limitations. First, the survey was relatively detailed and not all information requested was readily available, especially for the nuclear medicine physician dealing with the FDG-PET/CT technical features. This might explain the lower response rate for this part of the survey. Another limitation is that we did not separate the survey for colon and rectal tumours. As MRI is used for local staging of rectal cancer, there might be a difference in the utilisation of MRI for evaluation of the liver, lung and extrahepatic disease between patients with colon cancer or rectal cancer.[19] We chose not to perform a different survey for colon tumour and rectum tumour to enhance participation. Finally, not all management and radiology surveys were obtained from the same hospitals. However, the majority of these surveys were obtained from the same hospitals (n=50).

The Dutch guideline indicates either computed tomography (CT) or magnetic resonance imaging (MRI) as the first choice for liver staging.[1,20,21] This survey demonstrated that the role of MRI for staging is less prominent in daily practice as could have been expected based on the literature, where MRI has shown to have higher sensitivity rates for the detection of liver metastases than CT.[17,18,22,23] As the liver is the primary organ for metastatic spread (15%) of colorectal cancer, the use of the technique with the highest sensitivity seems obvious. Further, in patients with rectal cancer MRI is already part in the work-up for local staging. Presumably, lack of expertise, more limited availability and higher costs are important reasons for this rather limited use of MRI.

Table 5. *PET and PET/CT features in the hospitals using these modalities for evaluation of synchronous liver, lung and extrahepatic metastases*

PET features					**CT features**						**PET/CT image analyses**
Fasting (hours)	Amount FDG	Scan time	Time after FDG injection (min)	PET analyses	Slice CT	Low dose (mAs/kV)	High dose (mAs/kV)	IV contrast and amount Iodine	Phases (sec)	Oral contrast	Image analysis by
6	3 MBq/kg	3 min/bp	60	Qualitative[*,†]							
6	4.6 MBq/kg	5 min/bp	60	Qualitative[*]							
6	NA	NA	60	Qualitative Quantitative	16	YES (50/120)	NO	NO		NO	Nuclear medicine physicians[‡]
6	3.45 MBq/kg	4 min/bp	55-65	Qualitative	16	YES (NA/NA)	NO	NO		NO	Nuclear medicine physicians
6	2.0 - 2.2 MBq/kg	3 min/bp Total 7 positions	60	Qualitative	40	YES (40/120)	NO	NO		NO	Radiologists and nuclear medicine physicians
6	3.0 MBq/kg	3 min/pb Total 7 positions	60	Qualitative	40	YES (20/130)	NO	NO		100 ml Telebrix 350	Radiologists and nuclear medicine physicians
4	3.2 MBq/kg	Total 24-32 min	50	Quantitative	16	NO	YES (150-250/120)	YES (36 gr)	Portal (70s)	NO	Radiologists and nuclear medicine physicians
4	Based on BMI	3 min/bp Total 7 positions	60	Qualitative Quantitative	16	YES (60/120)	YES 150/120	YES (30 gr)	Portal (60s)	25 ml Telebrix	Radiologists and nuclear medicine physicians
6	3.125 MBq/kg	1.45 min/bp	60	Qualitative Quantitative	10	YES (62/120)	YES (100/120)	YES (30-36 gr)		NA	Radiologists and nuclear medicine physicians
6	Based on BMI	3-5 min/pb Total 24-40 min	60	Quantitative	6	YES (40/130)	YES (90/130)	YES (36 gr)	Portal (70s)	NO	Radiologists and nuclear medicine physicians
6	3.0 MBq/kg	Total 25 min	60	Qualitative	16	YES (25/120)	YES (350/120)	YES (31.5 gr)	Arterial (NA) Portal (70s) Late (300s)	10 ml Omnipaque 350	Radiologists and nuclear medicine physicians
6	1.7 MBq/kg	3 min/bp	60-90	Qualitative Quantitative	6	YES (NA/NA)	YES (95/110)	YES (36 gr)	Portal (45-50s)	NA	Radiologists and nuclear medicine physicians
6	Based on BMI	Total 20-22 min	60	Qualitative	16	YES (30/140)	YES (250/120)	YES (NA)	Arterial (30s) Portal (90s)	100 ml Omnipaque	Radiologists and nuclear medicine physicians
4	2.7 MBq/kg	2.30 min/bp	45	Qualitative Quantitative	64	YES 20/120	YES[§] (175/120)	YES[‖] (39.6 gr)	Arterial (25s) Portal (70s) Late (360s)	50 ml Telebrix 350	Low dose: nuclear medicine physicians High dose: Radiologists and nuclear medicine physicians
4	3.0 MBq/kg	4 min/bp	60	Qualitative	64	YES (NA/NA)	YES[§] (NA/NA)	YES[‖] (NA)	Portal (NA)	NO	Radiologists and nuclear medicine physicians
4	Based on BMI	4 min/bp Total 5 -6 positions	60	Qualitative Quantitative	40	YES (30/120)	NO	NO		NO	Radiologists and nuclear medicine physicians

bp = bed position; [*] FDG-PET data were visually compared with either CT or MRI; mAs = radiation intensity; NA = not available; [†] FDG-PET data were used for fusion with CT using software; [‡] 80% is always performed with low-dose CT and therefore read by nuclear medicine physicians; [§] high-dose CT is not always performed; [‖] contrast agent is only administrated for high-dose CT scans.

For evaluating lung metastases, the Dutch guidelines recommend the use of conventional chest X-ray[1,20,21] as different studies, including a recent Dutch study, have shown the limited role of chest CT (chest CT has many false-positives).[12] However the UK guideline prefers chest CT[24] and USA guidelines recommend conventional chest X-ray for colon cancer,[25] and in case of resectable rectal cancer an additional chest CT.[26] From a practical point of view, a chest CT is a simple addition to the – widespread utilised – CT for detection of liver and extrahepatic diseases and this presumably explains this inconsistency between evidence and daily practice/guidelines. This difference in viewpoints is reflected in the results of this survey where both chest CT as well as conventional chest X-ray are used to a comparable extent. In addition, some responders noted that chest CT was predominantly used for staging of rectal cancer which is in line with the USA guideline. As the prevalence of lung metastases is higher in rectal cancer compared with colon cancer,[27] the role of chest CT should be more clearly defined in the Dutch guidelines and differentiating between patients with colon cancer and rectal cancer might be a sensible approach.

For the evaluation of extrahepatic abdominal disease, no recommendations were made in the Dutch guidelines.[1,20,21] In international guidelines CT is preferred as is also seen in our survey. This may be different between patients with rectal and colon cancer, where in the former MRI is used for local staging and might be extended as an abdominal MRI.[24-26]
The Dutch guidelines lag behind in following current insights into the role of FDG-PET and FDG-PET/CT.[28,29] In USA guidelines these modalities are already playing a major role[24] and this is also seen in clinical practice to some extent. However, the role of FDG-PET and FDG-PET/CT as routine investigation in staging CRC is not well established and is primarily used in specific groups of patients.[30]

In summary, the present Dutch guidelines on staging of patients with colorectal cancer are only partly in line with recent international guidelines and on some aspects there is considerable discrepancy between the guideline and the findings of the survey. A potentially important reason for this discrepancy between guideline and daily practice – as well as between guidelines – is the lack of cost-effectiveness studies comparing different strategies. Hospitals will therefore either use a commonly used established strategy or develop a different strategy based on variable weighting of different issues, including evidence, availability and costs. This leads to variation in work-up with either over- or under-utilisation of imaging techniques. Research into the optimal strategy of staging of patients with CRC is therefore mandatory.

There is only one German study comparing the costs of whole body MRI with the costs of a conventional diagnostic algorithm for the staging of rectal cancer, consisting of abdominal ultrasound and chest X-ray (chest/abdominal CT in the case of positive findings at abdominal ultrasound or chest X-ray).[19] They reported substantial savings when whole-body MRI was used for the preoperative TNM staging of patients with rectal cancer; however, no data on the effectiveness in terms of diagnostic accuracy have been reported.
We therefore propose to perform cost-effectiveness studies for the comparisons of different staging strategies for colon and rectal cancer separately, including comparing a strategy of CT liver/abdomen versus MRI liver/abdomen for the evaluation of liver and extrahepatic disease and chest X-ray or chest CT for lung metastases and studying the additional role of FDG-PET and FDG-PET/CT. Based on these data well-founded adjustments can be made to the present guidelines

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