# Standardized Reporting of HCC with LI-RADS and mRECIST: Update on the Situation in Germany

## Standardisierte Diagnostik des HCC mit LI-RADS und mRECIST: ein Update zur Situation in Deutschland

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Keywords

staging, Liver Imaging Reporting and Data System (LI-RADS), hepatocellular carcinoma (HCC), modified RECIST (mRECIST)

received 6.5.2024
accepted after revision 28.9.2024

Bibliography

Rofo
DOI 10.1055/a-2438-1670
ISSN 1438-9029

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Deutsche Version unter: https://doi.org/10.1055/a-2438-1670.

ABSTRACT

**Background** Online survey about the current status of CT protocols in hepatocellular carcinoma (HCC) in the year 2023/2024. Moreover, the usage of structured reporting using LI-RADS and mRECIST was surveyed and the results were compared with a survey from 2020.

**Method** Radiologists working in outpatient or inpatient care in Germany were invited. The survey was conducted between 10/2022 and 06/2023 and between 06/2024 and 08/2024. HCC-related questions were asked regarding the commonly used imaging modalities, body coverage, and contrast phases in CT, as well as the usage of structured assessment and treatment response using mRECIST and LI-RADS.

**Results** More than half of the participants stated that they "frequently" perform imaging of HCC. In the CT protocol, acquisition of a pre-contrast phase was widespread. While a late arterial and a portal venous contrast phase was acquired in most cases, a delayed phase was used much less frequently (at small and medium-sized hospitals only in 26.5 %). For staging, LI-RADS was used in structured reports in only 13 %; for response monitoring mRECIST was used at university hospitals in only 26.5 % and LI-RADS in 14.7 %, whereas these have been almost never used in routine practice at all other sites. The main rea-

sons given for the lack of application were the expenditure of time, the lack of reporting templates, problems with integration into the IT infrastructure and a lack of reimbursement.
**Conclusion** The recommendation of a three phase CT examination in late arterial, portal venous, and delayed phase for HCC diagnostics according to LI-RADS is only partially implemented in Germany. Structured reporting for staging and response monitoring using LI-RADS and mRECIST was at a similarly low level in Germany in 2023 compared to 2020. Possible solutions include the development and distribution of online educational resources, structured reporting templates, and inexpensive IT solutions.

**Key Points**

- The CT protocols in HCC diagnostics in Germany differ considerably with regard to the contrast phases acquired.
- Definition of a late arterial (approx. 15–20 s p. i.; 5–15 s after aortic peak), portal venous (approx. 60–80 s p. i.) and delayed phase (2–5 min p. i.) as well as a pre-contrast phase only after TACE may improve quality of CT diagnostics of HCC.
- The use of structured reporting using LI-RADS, LR-TR and mRECIST in HCC remained low in 2023/2024, similar to 2020.
- The use of LI-RADS and mRECIST could be improved by providing online educational resources, structured reporting templates, and inexpensive IT solutions.

**Citation Format**

- Nelles C, Ristow I, Juchems MS et al. Standardized Reporting of HCC with LI-RADS and mRECIST: Update on the Situation in Germany. Rofo 2025; DOI 10.1055/a-2438-1670

## ZUSAMMENFASSUNG

**Ziel** Online-Umfrage zur aktuellen Statuserhebung von CT-Protokollen zur Diagnostik des hepatozellulären Karzinoms (HCC) im Jahr 2023/2024. Darüber hinaus wurde das Nutzungsverhalten strukturierter Befundung mittels LI-RADS und mRECIST erfragt und wurden die Ergebnisse mit einer Umfrage aus 2020 verglichen.
**Material und Methoden** Die Zielgruppe der Umfrage waren alle in der ambulanten oder stationären Versorgung tätigen Radiologinnen und Radiologen in Deutschland. Die Umfrage erfolgte im Zeitraum 10/2022 bis 06/2023 und 06/2024 bis 08/2024. Hierbei wurden HCC-bezogene Fragen gestellt hinsichtlich der üblich eingesetzten Bildgebungsmodalitäten, zur Körperabdeckung und zu den Kontrastmittelphasen in der CT sowie zum Nutzungsverhalten von strukturierter Beurteilung und des Therapieansprechens mittels mRECIST und LI-RADS.
**Ergebnisse** Mehr als die Hälfte der Teilnehmer gab an, eine Ausbreitungsdiagnostik des HCC „häufig“ durchzuführen. Im CT-Protokoll war die Akquisition einer nativen Phase weit verbreitet. Während die spätarterielle und portalvenöse Kontrastmittelphase in den meisten Fällen akquiriert wird, wird eine Spätphase deutlich seltener genutzt; an kleinen und mittelgroßen Krankenhäusern nur in 26,5 %. Beim Staging wurde nur in 13 % der Fälle immer strukturiert LI-RADS angewandt; für die Beurteilung des Therapieansprechens wurde an Universitätskliniken nur in 26,5 % mRECIST und in 14,7 % LI-RADS verwendet, während diese in allen anderen Tätigkeitsstätten nahezu nicht in der Routine angewandt werden. Als Gründe für die fehlende Anwendung wurden vorwiegend der Zeitaufwand, fehlende Befundvorlagen, Probleme bei der Integration in die IT-Infrastruktur und eine fehlende Vergütung genannt.
**Schlussfolgerung** Die Empfehlung einer dreiphasigen CT-Untersuchung in spätarterieller, portalvenöser und Spätphase zur HCC-Diagnostik gemäß LI-RADS wird in Deutschland nur teilweise umgesetzt. Die strukturierte Befundung beim Staging und Responsemonitoring mittels LI-RADS und mRECIST lag 2023/2024 im Vergleich zu 2020 auf einem ähnlich niedrigen Niveau. Mögliche Verbesserungsansätze sind die Entwicklung und Verbreitung digitaler Weiterbildungsinhalte, deutschsprachiger Befundungsvorlagen und preiswerter IT-Lösungen.

**Kernaussagen**

- Die CT-Protokolle in der HCC-Diagnostik unterschieden sich hinsichtlich der akquirierten Kontrastmittelphasen in Deutschland mitunter erheblich.
- Für die CT-Diagnostik des HCC erscheint eine Definition der Kontrastmittelphasen mit spätarterieller (ca. 15–20 s p. i.; 5–15 s nach Aorten-Peak), portalvenöser (ca. 60–80 s p. i.) und Spätphase (2–5 min p. i.) sowie eine native Phase nur nach lokalablativer Therapie mittels TACE empfehlenswert.
- Die Verwendung von LI-RADS, LR-TR und mRECIST war im Jahr 2023/2024 ähnlich zu 2020 weiterhin nur gering verbreitet.
- Die Anwendung von LI-RADS und mRECIST könnte durch die Bereitstellung digitaler Weiterbildungsinhalte, deutschsprachiger Befundungsvorlagen und preiswerter IT-Lösungen verbessert werden.

## List of Abbreviations

| | |
|---|---|
| AASLD | American Association for the Study of Liver Diseases |
| CEUS | contrast-enhanced ultrasound |
| DRG | Deutsche Röntgengesellschaft [German Radiological Society] |
| (q)EASL | (quantitative) European Association for the Study of the Liver |
| HCC | hepatocellular carcinoma |
| iRECIST | immune Response Evaluation Criteria in Solid Tumors |
| LI-RADS (TR) | Liver Imaging Reporting and Data System (treatment response) |
| MASH | metabolic dysfunction-associated steatohepatitis |

| | |
|---|---|
| MVZ | medical care center |
| mRECIST | modified Response Evaluation Criteria in Solid Tumors |
| RECIST 1.1 | Response Evaluation Criteria in Solid Tumors 1.1 |
| TACE | transarterial chemoembolization |

## Introduction

Hepatocellular carcinoma (HCC) is the most common primary malignant tumor disease of the liver and is the third most common tumor-associated cause of death worldwide [1, 2]. Although the majority of cases occur in Southeast Asia and Africa, the incidence is also steadily increasing in Western countries [3, 4, 5]. HCC usually manifests in the context of liver cirrhosis. Hepatitis B or C infection, steatosis hepatis (metabolic dysfunction-associated steatohepatitis, MASH), and alcohol consumption are the most important causal risk factors [6]. Diagnosis at an early stage of the disease is essential to enable patients to receive potentially curative therapies, such as surgical resection or liver transplantation [7]. In contrast to many other malignancies, the diagnosis of HCC in high-risk patients can often be made based on specific imaging characteristics alone, without the need for a biopsy [8, 9, 10]. Radiological imaging therefore plays a central role in the diagnosis, spread diagnostics, and follow-up exams for HCC under systemic and/or local therapy. For the diagnosis and treatment monitoring of HCC, both international and the German S3 guidelines recommend cross-sectional imaging with multiple contrast phases, preferably using MRI [11, 12]. However, the information in the guidelines on the exact imaging protocol is sometimes imprecise. For example, the guideline neither defines the exact times for the corresponding contrast agent phases nor does it specify which contrast agent phases should be considered for the initial diagnosis or after local or systemic therapy.

The Liver Imaging Reporting and Data System (LI-RADS) was developed by the American College of Radiology (ACR) and aims to optimize standardization of data acquisition, nomenclature, and interpretation of findings in liver imaging using MRI, CT, and CEUS (contrast-enhanced ultrasound) [11]. Its aim is to reduce variability in the assessment of liver lesions, standardize the monitoring of the success of therapeutic measures, and improve interdisciplinary communication. However, LI-RADS is only designed for use in patients who are at increased risk for developing HCC (patients >18 years old with liver cirrhosis or chronic hepatitis B infection or patients who have already been diagnosed with HCC). LI-RADS includes imaging recommendations with dedicated CT and MRI protocols. In CT, a pre-contrast phase should only be acquired after local therapy using TACE, with otherwise typical late arterial, portal venous, and late contrast phases. In LI-RADS, liver lesions are classified in categories from LR-1 to 5 with increasing probability of HCC based on a scoring algorithm (LR-1: definitely benign; LR-3: unclear; LR-5: definitely HCC) [11]. LI-RADS can also be used qualitatively to assess treatment response as LI-RADS "after treatment" (LR-TR). In this case, a lesion with post-therapeutic intralesional persistent arterial hyperenhancement as an indication of vital tumor components is classified as "LR-TR viable," in the absence of enhancement as "LR-TR non-viable" and in ambiguous cases as "LR-TR equivocal" [11].

Several studies have shown that structured diagnostic reports are better than free-text reports in terms of completeness, clarity, comprehensibility, and quality. For example, the LI-RADS category was reported in only 18.4% of HCCs when free-text reports were used but in 98.3% when structured templates were used [13]. It was also shown that the main features for the HCC diagnosis were reported significantly more frequently in the structured report compared to the usual free-text report (arterial hyper-enhancement 80.8% vs. 97.8% and washout 74.4% vs. 98.3%).

The Response Evaluation Criteria In Solid Tumors (RECIST 1.1) are widely established in the clinical trial sector and support quantitative assessment of the treatment response based on the sum of the lesion measurements (progressive disease (PD ≥ 20%), partial response (PR ≤ 30%), stable disease (neither PD, PR) or complete response (CR)), using standardized measurement and evaluation criteria for defined tumor lesions [14, 15]. However, only measuring size in line with RECIST 1.1. cannot adequately describe the treatment response of HCC lesions due to possible therapy-related reduced perfusion and devascularization or necrosis areas only [16]. For this reason, modified RECIST criteria (mRECIST) for treatment monitoring of HCC were developed in 2010; these criteria focus on measuring the vital, arterially hypervascularized tumor element [16, 17]. Numerous clinical studies have demonstrated the benefit of mRECIST for the standardized assessment of radiological treatment response in early and intermediate stages of HCC, including higher objective response rates in patients treated with molecular and/or immunomodulatory therapies [18, 19, 20].

For example, mRECIST has been included in the German S3 guideline for treatment monitoring, as well as in other European, American, and Asian guidelines. LI-RADS was already included in the clinical guideline on HCC of the American Association for the Study of Liver Diseases (AASLD) in 2018 [2], but up until 2023 it had not yet been integrated in the recommendations of the German S3 guideline. An interdisciplinary survey conducted in 2020 by the Gastrointestinal and Abdominal Diagnostics Working Group of the German Radiological Society (DRG) on the level of awareness and usage behavior of LI-RADS [21] found that although LI-RADS was already relatively well known outside the S3 guideline (among 73% of participants), but it was only rarely used clinically (26%). Overall, this is in contrast to the general desire to increase standardized reporting in radiology [22, 23].

This article is based on a nationwide survey conducted by the DRG's Oncology Imaging Working Group in 2023 about CT protocols in the context of spread diagnostics for various tumor diseases. With regard to HCC, the additional aim of the survey was to record the current status of imaging in Germany, particularly with regard to complying with the protocol recommendations of the S3 guideline in version 4.0 (as of August 2023), as well as to query the usage behavior of mRECIST and LI-RADS and to compare this with the results of the 2020 survey. A supplementary online survey conducted in 2024 investigated the reasons for the lack of use of structured reporting via mRECIST and LI-RADS, as well as possible solutions for better integrating it in everyday clinical practice.

## Materials & Methods

### Developing, validating, and implementing the questionnaire

After preparatory discussions among all participating members of the Oncology Imaging Working Group, the tumor entities whose staging routines were to be collected as part of the survey were first defined. For the purposes of this article, only the HCC is considered. Other tumor entities not discussed in detail below were: 1) colorectal carcinoma, 2) esophageal and gastric carcinoma, 3) pancreatic carcinoma, 4) breast carcinoma, 5) ovarian carcinoma, 6) bronchial carcinoma, 7) renal cell carcinoma, 8) urothelial carcinoma, 9) malignant melanoma and 10) head and neck tumors.

The questionnaire was entered in a web tool provided by the DRG on Surveymonkey (Surveymonkey Inc., San Mateo, California, USA, www.surveymonkey.de) and initially validated internally with regard to comprehensibility and technical reliability in practice by 15 testing persons. The supplementary survey was created in Google Forms (Google LLC, Mountain View, California, USA).

### Design of the questionnaire

The order of questions per tumor entity was based on a fixed and repeating pattern for each entity. At the start, we asked how often initial staging for the corresponding tumor entity was carried out in one's own institution. This was followed by a total of six questions on the use of different imaging modalities, the use of oral, rectal, and intravenous (i. v.) contrast agent, body coverage in CT diagnostics, and the dedicated CT protocol of the abdomen, including naming the different contrast agent phases in advanced local staging and indicated spread diagnostics followed by two final HCC-specific additional questions on the usage behavior of LI-RADS and/or structured assessment of the treatment response.

The eight individual questions on hepatocellular carcinoma were as follows:

1. Frequency of carrying out initial staging (spread diagnostics/not local staging) for hepatocellular carcinoma at your place of work:
   1: never
   2: rare
   3: occasional
   4: frequent
   5: very frequent
2. The imaging method regularly used for advanced local staging and indicated spread diagnostics is: *(Note: multiple answers possible)*
   1: CT
   2: cMRI
   3: MRI (thorax + abdomen)
   4: Ultrasound
   5: X-ray
   6: Hybrid (PET/CT or PET/MR)
3. The CT protocol is performed with/without contrast agent:
   1: exclusively native
   2: with i. v. contrast agent
   3: native + with i. v. contrast agent
4. Is an oral contrast agent used?
   1: yes, a negative (water)
   2: yes, a positive (iodine-containing)
   3: no
5. The CT protocol covers the following body regions: *(Note: multiple answers possible)*
   1: Skull
   2: Neck
   3: Thorax
   4: Abdomen
   5: Pelvis
6. The CT protocol of the abdomen includes the following contrast phases: *(Note: multiple answers possible)*
   1: Non-contrast
   2: Virtual non-contrast
   3: Arterial (approx. 15–20 s)
   4: Portal venous (approx. 60 s)
   5: Venous (80–120 s)
   6: Urographic
   7: Late venous (3–4 min)
7. Is a diagnosis and classification of liver lesions based on LI-RADS carried out in preventive care or staging?
   1: No
   2: Partially (optional)
   3: Always (routine)
8. Is there a structured assessment of the treatment response in cases of known HCC? *(Note: multiple answers possible)*
   1: No
   2: RECIST partially (optional)
   3: RECIST always (routine)
   4: mRECIST partially (optional)
   5: mRECIST always (routine)
   6: iRECIST partially (optional)
   7: iRECIST always (routine)
   8: LI-RADS partially (optional)
   9: LI-RADS always (routine)
   10: EASL partially (optional)
   11: EASL always (routine)
   12: qEASL partially (optional)
   13: qEASL always (routine)

After answering questions regarding all tumor entities, the following demographic information was collected voluntarily from the participants: sex, age, professional experience, position (resident, specialist, or chief physician), work location (university hospital, maximum care hospital, small/mid-sized hospital, practice/medical care center, other) and whether at the work location there is a focus on oncology imaging.

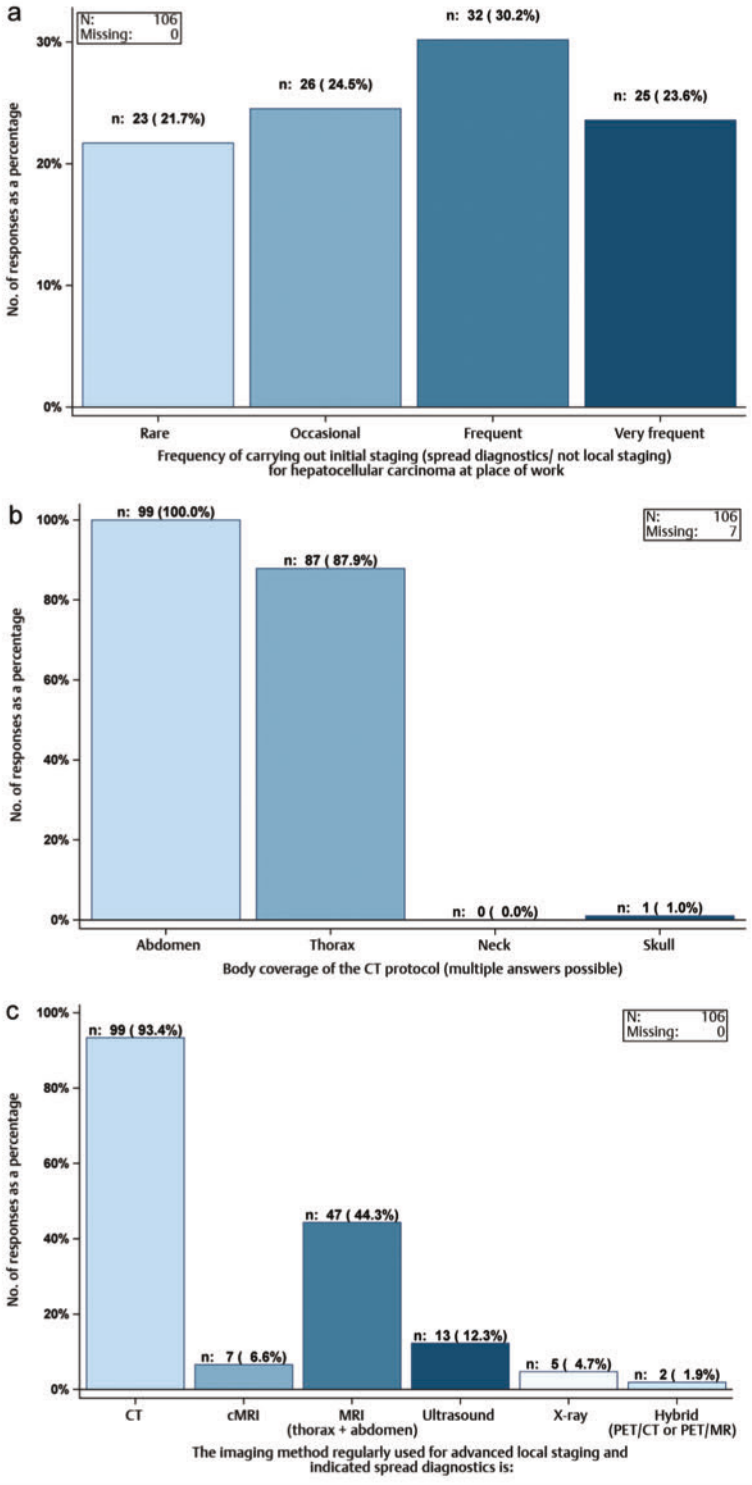
In the supplementary survey, demographic information was again requested (age, professional position, type of workplace). In addition, the following questions were asked verbatim regarding the usage behavior of structured reporting systems:

1. I am familiar with the following (not/somewhat/well/no response):
   1: RECIST 1.1
   2: mRECIST
   3: LI-RADS

2. I find that using the criteria in everyday routine is (not feasible/impractical/feasible in principle/I don't know):
   1: RECIST 1.1
   2: mRECIST
   3: LI-RADS preventive care
   4: LI-RADS treatment response
3. I use LI-RADS in prevention/screening in CT and/or MRI:
   1: No, I describe the findings in free-text format
   2: Partially (optional)
   3: Always (routine)
   4: No response
4. To assess the response to therapy for known HCC, I use the following (never/partially/always/not specified):
   1: RECIST 1.1
   2: mRECIST
   3: LI-RADS
5. The introduction of mRECIST, RECIST 1.1, and/or LI-RADS in everyday reporting is problematic because the following statements (very true/true/may sometimes be true/rather unproblematic/unproblematic/no response):
   1: mRECIST is only specified for studies and has a lack of definition for use in clinical routine.
   2: RECIST 1.1 is only specified for studies and has a lack of definition for use in clinical routine.
   3: LI-RADS v2018 has a lack of definition for use in clinical routine.
   4: The German version of LI-RADS v2018 is incomprehensible.
   5: The English version of LI-RADS v2018 is incomprehensible.
   6: A German-language reporting template is unavailable.
   7: In patients at risk for liver cirrhosis, use of structured reporting is not clearly required by the S3 guideline (not defined as a "must-do").
   8: In treatment monitoring, the use of mRECIST, RECIST 1.1 and/or LI-RADS is not clearly required by the S3 guideline (not defined as "must-do").
   9: Integration of structured reporting based on mRECIST, RECIST 1.1 and/or LI-RADS is difficult in my local IT infrastructure.
   10: Integration of structured reporting based on mRECIST, RECIST 1.1 and/or LI-RADS is too expensive.
   11: The use of mRECIST, RECIST 1.1 and/or LI-RADS in everyday routine takes too long; free-text reports are faster.
   12: The use of mRECIST, RECIST 1.1 and/or LI-RADS in everyday routine is not reimbursed (no additional code).
   13: I haven't had time to look into the criteria or coordinate with my colleagues.
   14: I see no benefit in using structured reporting based on mRECIST, RECIST 1.1, and/or LI-RADS.
6. I would like to use mRECIST, RECIST 1.1, and/or LI-RADS in my everyday routine in the future and would like to have the following (very preferable/preferable/may be helpful/not especially important/unimportant/no response):
   1: Availability of agreed and clinically relevant reporting templates.
   2: Improved information and education in German-language overview articles (medical journals).
   3: Improved training through hands-on case studies via in-person lectures (courses/conferences).
   4: Improved training through hands-on case studies via online lectures (courses/conferences).
   5: State-of-the-art training with short videos and/or interactive online case studies for self-study
   6: Mandatory recommendation in the S3 guideline ("must-do" recommendation).
   7: Easy to integrate IT solutions.
   8: Inexpensive IT solutions.
7. Would you like to use mRECIST, RECIST 1.1, and/or LI-RADS (more) in your everyday routine?
   1: Yes
   2: No
   3: Still undecided

| | Total | Oncological focus at place of work | Female | Age (years) | Experience (years) |
|---|---|---|---|---|---|
| | n(%) | n(%) | n(%) | Mean (SD) | Mean (SD) |
| **Professional position (N=96, Missing: 10)** | | | | | |
| Resident physician | 52 (54.2) | 39 (75.0) | 31 (59.6) | 31.4 (3.7) | 3.4 (1.6) |
| Specialist physician | 29 (30.2) | 23 (79.3) | 14 (48.3) | 36.8 (4.1) | 8.7 (3.3) |
| Management | 15 (15.6) | 15 (100.0) | 4 (26.7) | 51.1 (9.7) | 23.4 (9.5) |
| **Workplaces (N=96, Missing: 10)** | | | | | |
| Practice/Medical care center (MVZ) | 13 (13.5) | 7 (53.8) | 7 (53.8) | 39.5 (7.0) | 9.2 (7.3) |
| Small/mid-sized hospital | 35 (36.5) | 24 (68.6) | 14 (40.0) | 36.8 (9.9) | 8.5 (9.4) |
| University hospital | 34 (35.4) | 33 (97.1) | 21 (61.8) | 33.0 (5.2) | 6.2 (5.2) |
| Max. care provider | 14 (14.6) | 13 (92.9) | 7 (50.0) | 38.9 (11.3) | 11.1 (10.9) |

▶ **Fig. 1** Respondent demographics. Only respondents who reported initial staging as at least "rare" were considered. N: not missing answers; n: number of responses; mean: mean value; SD: standard deviation; (%): percentage based on N for the "total" category and on n (total) for all other categories.




▶ **Fig. 2** Overview of frequency performed, examination region, and imaging modalities for hepatocellular carcinoma (HCC). **a** Frequency of initial stagings performed. N: number of responses, at least "rare"; n: number of responses provided depending on category; percentages based on N. **b** body coverage of the CT protocol for initial staging. N: number surveyed; n: number of responses; percentages based on respondents who gave a corresponding response. Multiple answers possible. **c** Imaging modalities regularly used for initial staging. N: number surveyed; n: number of responses; percentages based on N. Multiple answers possible.

## Distribution of the questionnaire

The target group was defined as all radiologists working in outpatient or inpatient care. Invitations to participate in the anonymous survey were sent via the following mailing lists: newsletter of the DRG, newsletter of the DRG's Oncology Imaging Working Group, newsletter of the DRG's Young Radiology Forum. Other marketing channels included an advertisement in the magazine RöFo and publicizing the survey via the digital career platform LinkedIn (LinkedIn Corporation, Dublin, Ireland). The survey was open between October 2022 and June 2023. The supplementary survey was publicized in the DRG newsletter and the DRG's Oncology Imaging Working Group newsletter, and could be completed between June 2024 and August 2024.

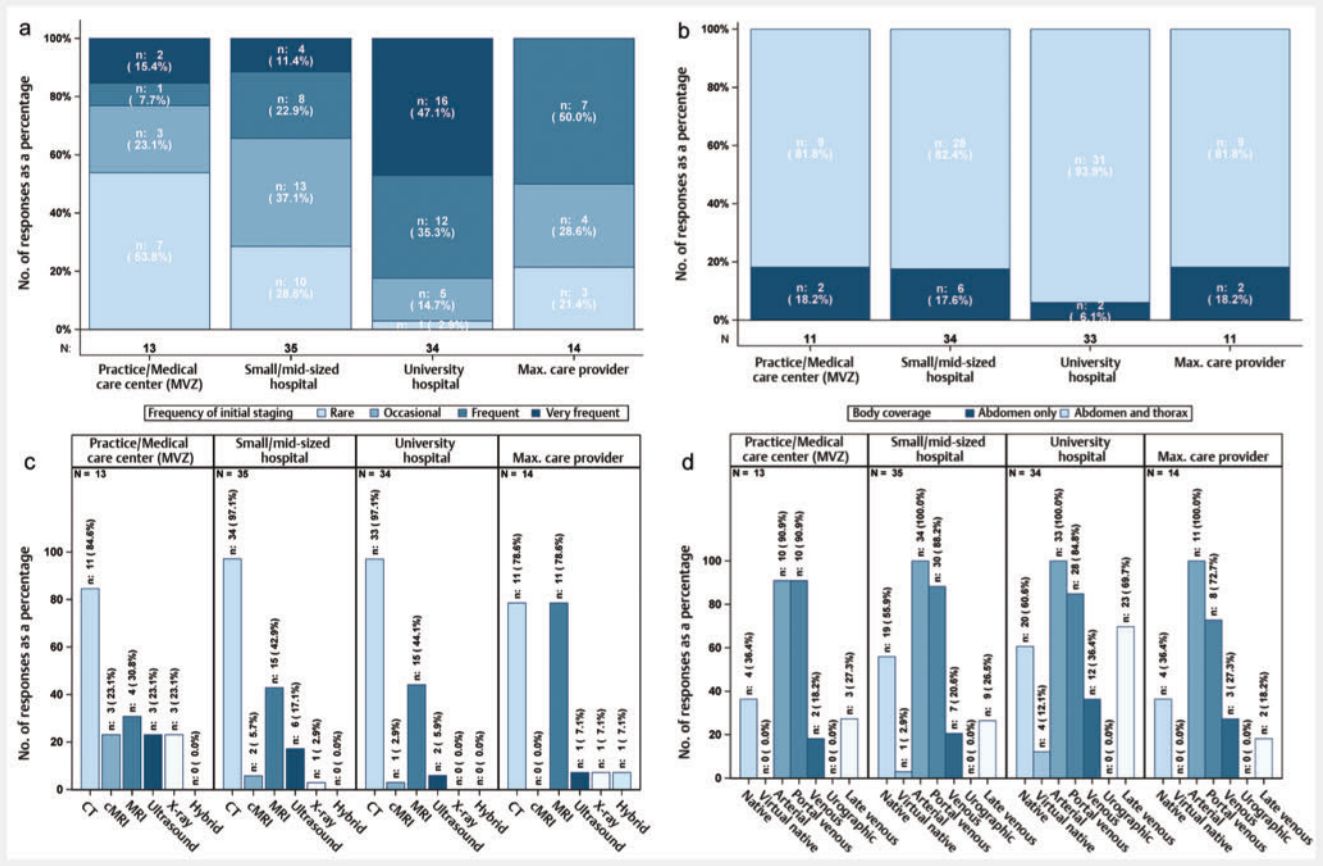
## Statistical analysis

Statistical analysis was performed using SAS, version 9.4 (SAS Institute, Cary, NC). Continuous variables are given as mean and standard deviation. Boxplots visualize the observed distributions. Categorical variables are expressed as absolute and relative frequencies. Clustered or stacked bar charts are used to display relative frequencies. The results are presented on a purely descriptive basis.

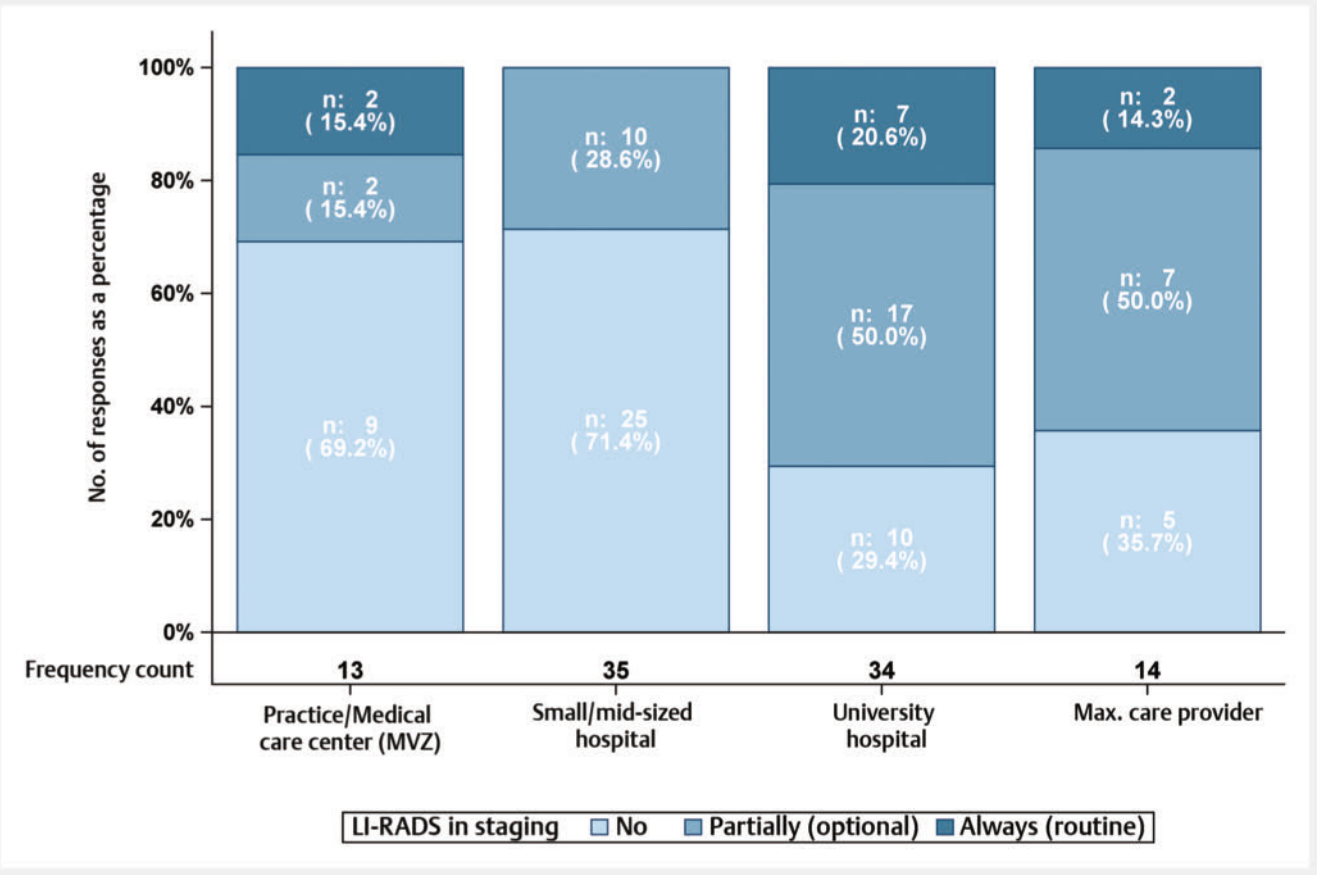
# Results

A total of 106 people participated in the survey, including 10 participants who did not fully complete the questionnaire. Of the active participants in the survey, 54.2 % were resident physicians (n = 52), 30.2 % were attendings (n = 29), and 15.6 % were physicians in leading management positions (n = 15), with an average professional experience of 3.4 years, 8.7 years, and 23.4 years, respectively (▶ **Fig. 1**). Of the participants, 35.4 % worked at a university hospital (n = 34), 14.6 % at a maximum care hospital (n = 14), 36.5 % at small and medium-sized hospitals (n = 35), and 13.5 % in practices or medical care centers (MVZ) (n = 13). The majority of participants confirmed that their workplace had an oncology focus, with the largest proportion university hospitals at 97.1 % (n = 33) and maximum care hospitals at 92.2 % (n = 13), while the lowest proportion was found in practices/medical care centers at 53.8 % (n = 7).

The answers to the question about the frequency of performing initial staging of HCC were relatively uniform (▶ **Fig. 2a** and ▶ **Fig. 3a**): 23.6 % (n = 25) of the participants stated that they performed initial staging "very frequently," 30.2 % (n = 32) "frequently," 24.5 % (n = 26) "occasionally," and 21.7 % (n = 23) "rarely". In line with the details of an oncology focus at the workplace, initial




▶ **Fig. 3** Details of frequency, examination region, imaging modality, and contrast agent phases for staging of HCC. **a** frequency of initial staging by work location. Number of responses depending on category; percentages based on responses provided by work location. **b** body coverage of the CT protocol by work location. n: number of responses; percentages based on responses by work location. **c** Imaging modalities used based on work location. n: number of responses provided; percentages based on responses by work location. Multiple answers possible. Hybrid includes PET/CT or PET/MRI. **d** Contrast agent phases in CT initial staging by work location. n: number of responses; percentages based on responses by work location.




▶ **Fig. 4** Diagnosis and classification according to LI-RADS in preventive care or staging based on work location. n: number of responses; percentages based on responses by work location.

staging is most frequently performed in university hospitals (47.1 % "very frequently" and 35.3 % "frequently", only 2.9 % "rarely"), while it is least frequently performed in practices/medical care centers (only combined 23.1 % "very frequently" and "frequently," whereas 53.8 % "rarely").

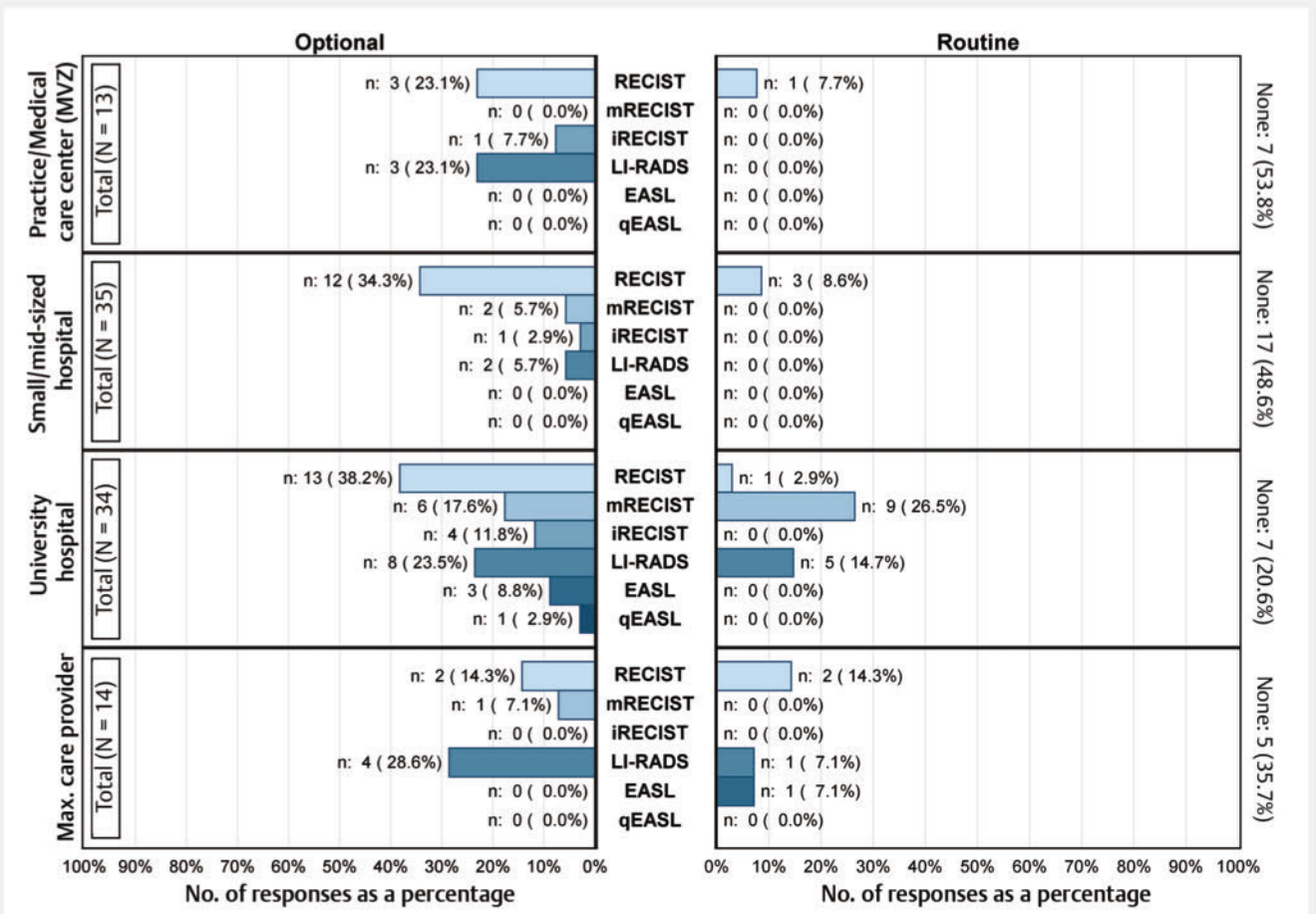
When asked about the body coverage of the CT protocol for staging HCC (▶ **Fig. 2b**), all participants stated that the abdomen is covered, while the majority of participants (87.9 %) also included the thorax in the CT protocol. When examined separately according to workplace, results showed that, regardless of the place of work, in more than 80 % of cases both the abdomen and the thorax are covered in the imaging protocol (▶ **Fig. 3b**).

In the total population of respondents, CT is by far the most frequently used imaging modality for initial staging (93.4 %), although MRI of the trunk is also frequently used (44.3 %), while other imaging modalities are used to a lesser extent (▶ **Fig. 2c**). When considering workplaces separately (▶ **Fig. 3c**), this result corresponds to the information provided by respondents from university hospitals and small and medium-sized hospitals. In maximum care hospitals, MRI is used comparatively more frequently, even as frequently as CT (78.6 %). In practices/medical care centers, however, the proportion of CT (84.6 %) and MRI of the trunk (30.8 %) is somewhat lower, while other procedures such as ultrasound or X-rays are used more frequently (23.1 % each).

Regardless of the workplace, the CT protocol for staging HCC includes an arterial contrast phase in almost all cases (▶ **Fig. 3d**), while the portal venous phase is used somewhat less frequently, but also by the majority of respondents; for example, the proportion of the portal venous phase in university hospitals is 84.8 %. In contrast, the frequency of using a "venous" or "late venous" phase is overall significantly lower and varies between the places of work. For example, in university hospitals the rate for the venous phase is 36.4 % and the late venous phase is 69.7 %, whereas in small and medium-sized hospitals it is only 20.6 % and 26.5 %, respectively. Regardless of the workplace, a native phase is often used in the CT protocol; in university hospitals, this proportion is highest at 60.6 % of respondents.

Structured reporting based on LI-RADS classification system is rarely used in the prevention or staging of HCC among the respondents, regardless of the place of work (▶ **Fig. 4**). Even in university hospitals and maximum care hospitals, only 20.6 % and 14.3 %, respectively, reported always using LI-RADS, while the proportion of those not using LI-RADS was 29.4 % and 35.7 %, respectively. In practices/medical care centers and small and medium-sized hospitals, 69.2 % and 71.4 % of respondents, respectively, stated that they did not use LI-RADS at all.

When asked about structured assessment of a treatment response for HCC, a similar picture emerges (▶ **Fig. 5**). For example, at university hospitals, only 26.5 % of respondents use mRECIST




▶ **Fig. 5** Structured reporting of treatment response based on work location. N: number surveyed by work location; n: number of responses; percentages based on N. Multiple answers possible.

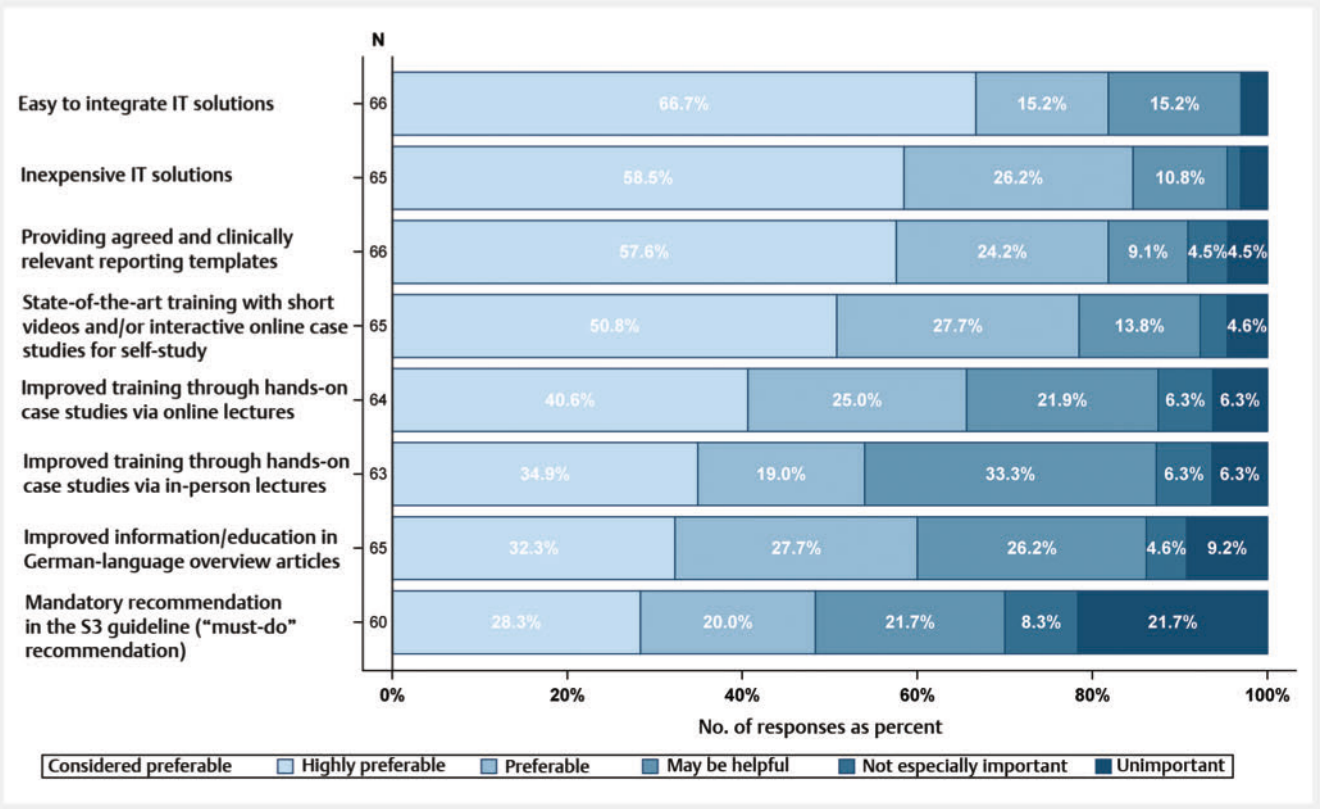
and 14.7 % of respondents use LI-RADS in routine response assessment, while in smaller facilities, it is not used at all in routine practice. There are significant differences between workplaces regarding the optional use of mRECIST and LI-RADS; larger workplaces use a structured response assessment more frequently than smaller ones. In practices/medical care centers, mRECIST is not used at all, while LI-RADS is used at least optionally by 23.1 % of respondents. RECIST 1.1 shows the greatest prevalence across all workplaces and is used optionally by 38.2 % of respondents in university hospitals, for example.

A total of 70 people participated in the supplementary survey, including 27.1 % resident physicians (n = 19), 37.1 % attendings (n = 26) and 30 % physicians in leading management positions (n = 21). At 64.3 % (n = 45), the largest proportion of participants worked at a university hospital, 17.1 % (n = 12) worked in a practice or a medical care center, and 10 % (n = 7) worked at a small or medium-sized hospital.

The majority of respondents stated that they are "well" acquainted with RECIST 1.1, mRECIST, and LI-RADS; the proportion was highest for RECIST 1.1 (65.7 % for RECIST 1.1, 51.4 % for mRECIST, and 62.8 % for LI-RADS). With regard to the various systems of structured reporting, the majority of participants also reported that their use in clinical routine was "feasible," with this proportion being highest for the use of LI-RADS in preventive care (61.4 %).

Similar to the main survey, only a small proportion of respondents (31.4 %) stated that they "always" use LI-RADS in preventive care. Regarding the assessment of a treatment response, only a minority of respondents stated that they "always" use all structured reporting systems (30 % for LI-RADS, 20 % for mRECIST, and 10 % for RECIST 1.1). By contrast, the largest proportion of participants (58.6 %) would like to see mRECIST, RECIST 1.1, and/or LI-RADS used more widely at their place of work.

When asked why the introduction of mRECIST, RECIST 1.1, and/or LI-RADS in routine practice is problematic, the main answers given ("very true") were that structured reporting takes too long and free-text reports can be prepared more quickly (31.9 %), that structured reporting is not additionally reimbursed (30.4 %), that integration in the local IT infrastructure is difficult and too expensive (24.6 % and 14.5 % respectively), that mRECIST and RECIST 1.1 were only defined for studies and there are uncertainties regarding clinical application (15.9 % and 14.5 % respectively) and that the application is not clearly required as a "must-do" and that corresponding German reporting templates are also unavailable (13.0 % and 11.6 %). The other possible problems were rated significantly lower (less than 10 % "very true"), such as the




▶ **Fig. 6** Responses to the statement "I would like to use mRECIST, RECIST 1.1, and/or LI-RADS in my everyday routine in the future." N: number of votes provided depending on response category; percentages based on N.

fact that the German-language LI-RADS v2018 description was incomprehensible (2.9%).

In order to increasingly use structured reporting in a clinical routine in the future, a large proportion of respondents ("very preferable") wanted inexpensive or easily integrated IT solutions (58.5% and 66.7%, respectively), the availability of agreed and clinically relevant reporting templates (57.6%), and better continuing education, primarily through self-study using videos or interactive online case studies (50.8% and 40.6%, respectively) (▶ **Fig. 6**).

## Discussion

The majority of survey participants stated that they work at a facility with an oncology focus, with the largest proportion, as expected, being university hospitals at 97.1%. This explains the frequency of performing initial staging of HCC, which was stated as "very frequent" and "frequent" by more than half of the respondents (53.8%) in the total population. Here too, the rate in university hospitals was, as expected, even higher than in the total population at 82.4%. In line with German guidelines, as well as international guidelines, almost all respondents use CT of the thorax and abdomen to perform diagnostics of HCC spread. Both the large proportion of 44.3% of respondents who stated that they use MRI of the trunk to diagnose the spread of HCC and the minority of 12.1% of respondents who only perform CT of the abdomen and not of the thorax for staging may be due to a blurred distinction between local staging and spread diagnostics among the respondents.

Despite the frequent use of HCC spread diagnostics among respondents, discrepancies with national and international guidelines are evident. What is remarkable is the widespread use of acquisition of a pre-contrast phase in the CT protocol in addition to the contrast-enhanced phases. The proportion of respondents who stated that they used a pre-contrast phase was even highest in university hospitals at 60.6%. This is in contrast to international and German recommendations on the CT protocol for HCC diagnostics. Both the current LI-RADS guideline [11] and the current German S3 guideline for the diagnosis and treatment of HCC [12] recommend a three-phase contrast-enhanced CT examination. The pre-contrast phase should not be used in CT spread diagnostics of HCC. In the German guideline, the only indication for the use of a non-contrast is mentioned in the accompanying text that after conventional transarterial chemoembolization (TACE) using Lipiodol, a non-contrast CT should be performed 1–3 days after treatment in order to monitor the deposition of the embolic agent in the target region and to exclude possible undesirable embolic agent transport. If TACE is established as a locally ablative therapy procedure in most clinics, this can at least partially explain the frequent use of the pre-contrast phase. The results of our survey therefore indicate a potential for reducing radiation exposure in the population of HCC patients without TACE; especially against the background of the clinical establishment of "dual energy" CT

systems with the option of virtual non-contrast image reconstructions, acquired non-contrast CT scans appear increasingly obsolete. In particular, the university hospitals showed an initial use of virtual non-contrast reconstructions (12.1 %), deploying new CT scanners with the option of material decomposition (such as dual-energy CT and photon-counting technology). This trend can partly be explained by newer and more expensive CT scanners in clinical care at university hospitals.

Almost all respondents stated that they use an arterial contrast phase in their CT protocol, thus following the recommendations of international and national guidelines. In contrast, the portal venous phase, which is also uniformly prescribed, is used in the vast majority of workplaces surveyed, but not in all. In university hospitals, for example, the proportion was 84.4 %. The inconsistencies are even more pronounced with regard to the third prescribed contrast phase: at university hospitals, 69.7 % stated that a late phase (3–4 minutes after contrast injection) was acquired and 36.4 % stated that a "venous" phase (80–120 seconds after contrast injection) was acquired, while the rate in smaller facilities was even lower, for example, for small and medium-sized hospitals with 26.5 % and 20.6 %, respectively. The German translation of the current LI-RADS guideline [11] calls for a three-phase examination with "late arterial, portal venous and late phase," whereas the German guideline version 4.0 [12] has so far recommended cross-sectional imaging in "arterial, portal venous, and venous phase." While the recommendations regarding the arterial and portal venous phases are therefore identical, an inconsistency regarding the nomenclature of the required third contrast agent phase is already apparent. In the LI-RADS guideline, the late phase is defined in terms of time (2–5 minutes after contrast injection), but the other phases are defined only based on the contrast pattern. In the German guideline, however, the contrast agent phases have not yet been defined in more detail by either acquisition times or contrast behavior. It is therefore conceivable that the inconsistencies regarding the use of the venous/late contrast phase in our survey could be at least partly due to inconsistent nomenclature in the international and national guidelines or to a lack of a concrete definition of the contrast phase in the German guideline and that the participants' answers were inconsistently divided between the two answer options. A concrete definition of the acquisition time of the venous/late phase in the German guideline could play a role in standardizing CT protocols and improving examination quality. As a result of this survey, this was also included in the guideline update to version 5.0.

In 2020, the DRG's Gastrointestinal and Abdominal Diagnostics Working Group conducted a nationwide survey among physicians from radiology, gastroenterology, and surgery on the awareness and dissemination of the LI-RADS classification system [21]. This showed that LI-RADS was relatively well known in Germany but was rarely used, which stands in contrast to the desire for a more widespread use of standardized reporting in liver imaging. The majority of participants in this survey (73.2 %) stated that they knew about LI-RADS or had heard of it, while only a minority stated that they used it themselves (26 %) or in tumor conferences (19.2 %). In contrast, however, the narrow majority of respondents (52.1 %) expressed a desire for more structured reporting in radiology. Our current survey shows similar results: only 13 % of respondents in the total population stated that they always use LI-RADS in HCC staging. So the proportion is even slightly lower compared to 2020. Even in university hospitals and maximum care hospitals, the proportion was very low at 20.6 % and 14.3 %, respectively. Just over half of the respondents in the total population (51 %) stated that they never use LI-RADS; in particular, in practices/medical care centers and small and medium-sized hospitals, 69.2 % and 71.4 % of respondents, respectively, stated that they do not use LI-RADS at all. The supplementary survey on the usage behavior of structured reporting also revealed a similar picture compared to 2020, with just over half of the participants (58.6 %) expressing a desire for increased use of structured reporting in their own place of work.

Our results show that the LI-RADS classification system continues to be used only to a limited extent in Germany and that even over the course of three years there has been no positive trend compared to the 2020 survey. While the LI-RADS classification system was already integrated in the clinical guideline on HCC from the American Association for the Study of Liver Diseases (AASLD) in 2018 [2], it has not yet been included among the recommendations from the German S3 guideline. Only the accompanying text mentions that the system has unfortunately not yet been adopted widely in Germany, although the standardized use of LI-RADS can play a role in improving patient management. A study from the US showed that the use of structured LI-RADS reporting templates leads to more comprehensive and consistent reporting of key HCC features compared to free-text reports [13]. As already recommended by the authors of the 2020 survey [21], the inclusion of the LI-RADS classification system for staging among the recommendations from the German guidelines, similar to the US guidelines, could help to improve its dissemination and use in Germany.

The standardized assessment of a response by HCC manifestations to local or systemic therapy is of great importance for the decision for or against continuation of therapy. Nevertheless, 35 % of respondents in the total population stated that they did not conduct a standardized response assessment. At university hospitals, 38.2 % of respondents reported using RECIST 1.1 at least partially for response assessment. However, generally established criteria, such as RECIST 1.1 [15] or iRECIST [24], which are based on size measurements of a lesion in its entirety, are not suitable for response assessment of HCC due to possible intratumoral necrosis areas [25]. In addition to the modified RECIST (mRECIST) for HCC, other response criteria are available, such as LI-RADS Treatment (LR-TR) or EASL, which are based on the measurement of the vital, arterially hypervascularized part of the tumor [25]. The S3 guideline for the diagnosis and treatment of HCC (version 4, as of August 2023) recommended the use of mRECIST or EASL to assess remission after local therapy [12]. This recommendation was adopted in the questionnaire of the German Cancer Society for Liver Centers [26] and a response assessment using mRECIST or EASL is required. Despite the previous recommendation, mRECIST has found little use in Germany. Only 26.5 % of respondents at university hospitals reported that they always use mRECIST, while mRECIST is almost never used in all other settings. The EASL criteria are also practically not used in Germany. The use of LR-TR for response assessment is, as already mentioned above for the pri-

mary diagnosis of HCC, also only rarely done and use remains at a low level similar to mRECIST. Only 14.7% of respondents at university hospitals stated that they always use LR-TR for response assessment, while in all other settings, similar to mRECIST, LR-TR is practically not used in routine practice. However, compared to mRECIST, LR-TR appears to be more widely used for response assessment at smaller sites. For example, 23.1% of respondents in practices/medical care centers stated that they use LR-TR at least partially. This may be due to the easier use of LR-TR compared to the last examination, which does not require dedicated oncology software, whereas correct use of mRECIST without the support of such software with longitudinal comparison of all prior images in the treatment cycle is more complicated. In addition, the purchase of this software is associated with costs that cannot currently be billed additionally using special codes. However, LR-TR only allows an approximately binary treatment monitoring of the liver, whereas mRECIST allows comprehensive monitoring of all tumor manifestations, including possible lymph node and distant metastases with assessment of the quantitative treatment response (in percent). As a result, mRECIST appears to hold a clear benefit for monitoring systemic therapies. Compared with an international study [23] with participants from Asia, Australia, South America, North America, and Europe, usage of mRECIST in Germany appears to be low. Internationally, RECIST and mRECIST were the most frequently used metrics used to assess response to HCC treatment (48.3%). As in Germany, most respondents (68.9%) agreed that a standardized classification system was necessary for the diagnosis of HCC and that an atlas and a lexicon, such as LI-RADS, would help to improve consensus between evaluators (71.5%).

In the supplementary survey on the usage behavior of structured reporting, similar to the main survey and also to the survey of the Gastrointestinal and Abdominal Diagnostics Working Group from 2020, it was shown that most participants are well acquainted with LI-RADS and mRECIST, but that the systems are used comparatively little in clinical routine. This stands in contrast to the preference for increased use of structured reporting at their own workplace, a preference that was expressed by the majority of participants.

The following main reasons were given for a lack of integration of structured reporting into everyday clinical practice: first, structured reporting is too time-consuming and free-text reports can be prepared more quickly ("very true" in 31.9%). This could be due, on the one hand, to a lack of routine in dealing with structured reporting and, on the other hand, to the lack of standardized reporting templates. In fact, 11.6% of the participants fully agreed with the statement that corresponding German reporting templates were unavailable and more than half (57.6%) would find the availability of such templates "very preferable". This suggests that the development of interdisciplinary agreed, standardized German-language reporting templates and their dissemination could improve the widespread use of structured reporting by simplifying it and saving time. Many participants also expressed a desire for better training on LI-RADS and mRECIST, mainly through self-study using videos or interactive online case studies. Providing such training formats on an increased basis could improve routine use of structured reporting and thus support practical applications in everyday routine. In addition, many participants reported difficulties in integrating the system in the local IT infrastructure and expressed a preference for inexpensive or easier-to-integrate IT solutions, so that the development and dissemination of such solutions also has great potential for improving the use of structured reporting. Finally, many participants cited the lack of additional reimbursement for using structured reporting as a higher-level obstacle.

## Conclusions

For the CT diagnostics of HCC, a contrast-enhanced examination in the late arterial (approx. 15–20 s p. i.; 5–15 s after aortic peak), portal venous (approx. 60–80 s p. i.) and late phase (2–5 min p. i.) appears to be recommended, similar to the LI-RADS criteria. An exact definition of the contrast agent phases in the German guideline can play a role in standardizing the protocols and improving the examination quality, and this information was incorporated in the S3 guideline update to version 5.0 based on the results of this survey. A pre-contrast phase is not indicated for the primary diagnosis of HCC, but only after local therapy with Lipiodol-TACE; yet it is still widely used. As a result, there is potential for dose reduction when studying patients with HCC.

Compared to the survey conducted by the DRG's Gastrointestinal and Abdominal Diagnostics Working Group in 2020, the usage behavior of the mRECIST and LI-RADS response criteria is at a similarly low level; EASL is practically not used in Germany. The international literature shows the superiority of standardized reporting using mRECIST and LI-RADS classifications in HCC diagnostics and objective response monitoring. So widespread use seems preferable.

Possible solutions to improve the situation and to speed up diagnosis would be to develop inexpensive and easy-to-implement IT solutions, providing German-language reporting templates, modern digital training opportunities, and possible additional reimbursement for carrying out structured reporting.

## Clinical relevance of study

- The international recommendation of a three-phase CT examination for HCC diagnostics in late arterial, portal venous, and late phases is being implemented only partially and on an inconsistent basis in Germany.
- Structured reporting and assessment of treatment response using LI-RADS and mRECIST is still rarely used in Germany.
- Increasing the use of LI-RADS and mRECIST could play a role in improving the quality of CT diagnostics of HCC.

### Conflict of Interest

Simon Lennartz: Authorship and speaker fees, Amboss GmbH.
Thorsten Persigehl: travel expenses and speaker fees, MINT Medical.

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