Editorial

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Research Highlight: How to Use Technical and Oncologic Outcomes of Image-Guided Tumor Ablation According to Guidelines by Society of Interventional Oncology and DATECAN?

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Take-home points

- We highlight key points from recent consensus guidelines by Society of Interventional Oncology (SIO) and Definition for the Assessment of Time-to-event Endpoints in CANcer trials (DETACAN) to facilitate effective communication in the field of image-guided tumor ablation.
- The guidelines include recommendations for defining and analyzing various oncologic endpoints at per-patient, per-procedure, or per-tumor levels and terminologies commonly used in image-guided tumor ablation.
- Precise definitions of various oncologic endpoints and terminologies will lead to an objective and reliable interpretation of results and accurate comparison of oncologic outcomes of image-guided tumor ablation, ultimately providing scientific reproducibility among researchers.

To ensure a standardized interpretation and reporting of results and allow for accurate comparison of image-guided tumor ablation outcomes, the SIO and DATECAN group recently published consensus guidelines [1]. We want to highlight some key points, to facilitate their use in reporting and reviewing research studies.

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Background of Guideline Development

In 2014, Ahmed et al. [2] published a paper regarding the updated standardized terminology and reporting criteria for image-guided tumor ablation, which has been cited by over 500 studies on tumor ablation over the past eight years. The document has contributed to interventional oncology by providing a common language to describe the treatments and their outcomes and has facilitated effective communication throughout the field. However, there is still variability in interpreting and using time-to-event endpoint terms, and definitions of starting and ending times, throughout the interventional oncology literature. Because of this unmet need, the SIO and the DATECAN group worked on a project with an international panel of 62 experts, and a consensus was reached on the use of the validated three-step modified Delphi consensus method.

How Can We Analyze Various Outcomes at Per-Patient, Per-Procedure, or Per-Tumor Levels and How Can We Define Them?

Outcome parameters should be analyzed appropriately at different levels, including per-patient, per-procedure,

Table 1. Summary of the Use of Per-Patient, Per-Procedure, or Per-Tumor Analyses for Different Outcomes

Parameter	Accepted Acronyms	Per-Patient	Per-Procedure	Per-Tumor
Overall survival	OS	Yes		
Disease-specific overall survival		Yes		
Disease-free survival	DFS	Yes		
Recurrence-free survival	RFS	Yes		
Progression-free survival	PFS	Yes		
Distant progression-free survival	DPFS	Yes		
Procedure-related side effects			Yes	
Direct costs			Yes	
Short-term complications			Yes	
Anesthesia technique			Yes	
Hospital-stay characteristics			Yes	
Laboratory tests			Yes	
Technical success			Yes	Yes
Local tumor progression-free survival	LTPFS	Yes		Yes
Time-to-local (tumor) progression		Yes		Yes
Freedom from local or organ-specific recurrence		Yes		Yes
Primary technique efficacy		Yes		Yes
Secondary or assisted technique efficacy		Yes		Yes
Residual disease		Yes		Yes
Local (tumor) progression		Yes		Yes
Recurrence rates		Yes		Yes
Local control		Yes		Yes

Adapted from Puijk et al. Radiology 2021;301:533-540 [1].

and per-tumor, when performing studies on image-guided tumor ablation, as summarized in Table 1. Of note, survival outcomes should be interpreted per-patient and not per-tumor or per-procedure. However, as an exception, local tumor progression-free survival (LTPFS) can be assessed on a per-patient or per-tumor basis. The local (tumor) progression rate can also be used, instead of LTPFS, when analyzing on a per-tumor basis as the term has been widely used in previous studies [3-5]. Parameters closely related to the treatment session should be analyzed per-procedure, as a synonym for the session. Such items include procedure-related side effects, direct costs, short-term complications, anesthesia technique, hospital-stay characteristics, laboratory tests, and technical success. However, technical success can also be interpreted on a per-tumor basis. The parameters related to the local efficacy that are assessed on a per-patient and per-tumor basis are as follows: LTPFS, time-to-local (tumor) progression, freedom from local or organ-specific recurrence, primary and secondary or assisted technique efficacy, residual disease, local (tumor) progression, recurrence rates, and local control. In patients with multiple index tumors (e.g., multiple colorectal metastases), standard survival estimates (Kaplan-Meier or cumulative incidence functions) may not consider the dependency of partially correlated or clustered data. Therefore, this potential limitation must be considered.

The definitions of the various oncologic endpoints are summarized in Table 2. Overall survival, defined as death from all causes, is widely used to describe survival outcomes in oncologic studies [6]. However, if the occurrence of death from causes other than the disease being studied is substantial, both overall survival and disease-specific survival should be documented. Death from causes other than the disease being explored is considered a competing risk for disease-specific survival analysis. When tumor ablation is performed for early stage disease, recurrence-free survival should be used if the intervention is likely curative (i.e., ablation of small renal tumors). When the intervention is considered potentially curative for intermediate-stage disease (i.e., ablation of colorectal liver metastases), disease-free survival should be used.

Unlike the diagnosis/prediction of static binary outcomes, the follow-up time should be considered for survival analysis and should be defined accurately [7,8]. The commonly used time-to-event endpoints are presented in Table 3. The definition of the starting time should differ according

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Table 2. Definitions of Various Oncologic Endpoints

Observation	DFS	RFS	TTR	DSS*	OS
Locoregional recurrence	Event	Event	Event	Ignored	Ignored
Distant metastases	Event	Event	Event	Ignored	Ignored
Second primary, the same cancer	Event	Ignored	Ignored	Ignored	Ignored
Second primary, other cancer	Event	Ignored	Ignored	Ignored	Ignored
Death from the same cancer	Event	Event	Event	Event	Event
Death from other cancer	Event	Event	Censoring	Censoring	Event
Non-cancer-related death	Event	Event	Censoring	Censoring	Event
Treatment-related death	Event	Event	Censoring	Censoring	Event
Loss to follow-up	Censoring	Censoring	Censoring	Censoring	Censoring

Modified from Punt et al. J Natl Cancer Inst 2007;99:998-1003 [6]. *Synonyms for cancer-specific survival. DFS = disease-free survival, DSS = disease-specific survival, OS = overall survival, RFS = recurrence-free survival, TTR = time to recurrence

Table 3. Definitions of Time-to-Event Endpoints Commonly Used in Image-Guided Tumor Ablation

Time-to-Event Endpoints	Starting Point*	Ending Point
Time to progression	Starting time	Any disease recurrence (local, regional, or distant)
Distant progression-free survival	Starting time	Distant tumor progression, but not local or regional progression
LTPFS	Starting time	Local tumor progression per tumor treated (per-tumor analysis) or per patient treated (per-patient analysis)
Time-to-local (tumor) progression, horizontally flipped LTPFS	Starting time	Local tumor progression per tumor treated
Disease-specific survival	Starting time	Death from the same cancer
Overall survival	Starting time	Death from all causes

*Definition of starting time differs according to the study design. LTPFS = local tumor progression-free survival

to the study design. For randomized controlled trials, the starting time should be the randomization date, and it is recommended that the time taken from the interventional procedure be added to the data. For single-arm prospective studies and retrospective comparative and non-comparative studies, the starting time should be the date of the first intervention.

Other Terminologies Commonly Used in Image-Guided Tumor Ablation

Ablation confirmation: This refers to postprocedural imaging or any alternative technique that is implemented to allow for additional overlapping (completion) procedures, either within the same session or in a complementary completion session, in the days or weeks hereafter.

Technical success: This addresses whether the tumor was treated according to a predefined protocol and covered completely by the ablation zone using ablation confirmation techniques. Technical success rates should be documented in a research paper.

Technique efficacy: This refers to the achievement of complete tumor ablation at a prospectively defined time point, as evidenced by imaging follow-up or any alternative technique (i.e., biopsy or serologic criteria). If a patient died due to any cause before that time point, then the event should be analyzed and reported as a competing risk.

Primary efficacy rate and secondary or assisted technique efficacy rate: The former refers to the percentage of target tumors that were successfully eradicated following initial ablation. In contrast, the latter addresses the percentage of target tumors that were eventually removed with repeat ablations using ablation therapy.

Local control: This is equivalent to assisted technique efficacy, except that repeat treatments using alternative methods (other ablation therapy, radiation therapy, or surgical excision) are allowed.

Residual unablated tumor and local tumor progression: The former refers to a residual viable tumor at the ablative margin at the initial follow-up imaging. In contrast, the latter refers to the appearance of a viable tumor, provided that a residual viable tumor was not found in at least one contrast-enhanced follow-up study at the ablative margin.

Key words
Guideline; Image-guided ablation; Tumor; Survival; Recurrence

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Availability of Data and Material

Data sharing does not apply to this article as no datasets were generated or analyzed during the current study.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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