MEDIRAD

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Comprehensive Reporting Templates and Pilot system for SR-Reporting

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Abbreviations

ACR	American College of Radiology
ESR	European Society of Radiology
IHE	Integrating the Healthcare Enterprise
MRRE	Mainz Radiology Reporting Engine
MRRT	Management of Radiology Reporting Templates
PACS	Picture Archiving and Communicating System

RadLex	Radiology Lexicon
RIS	Radiology Information System
RSNA	Radiological Society of North America
TI-RADS	Thyroid Imaging Reporting and Data System
TLAP	Template Library Advisory Board

1. Introduction

"MEDIRAD aims to enhance the scientific bases and clinical practice of radiation protection (RP) in the medical field and thereby addresses the need to understand and evaluate the health effects of low dose ionising radiation exposure from diagnostic and therapeutic imaging and from off-target effects in radiotherapy (RT)." (1)

The aim of MEDIRAD is to "develop and implement for the first time a European repository of patient dose and imaging data" (Item 6 according to the MEDIRAD Proposal, page 3, respective Task 2.4). To attain this goal, several scientific subprojects have been designed and will be carried out simultaneously.

"This task (2.4) will develop, deploy and operate an integrated imaging and dose biobank, in order to address the needs of the researchers in MEDIRAD (WPs 2-5) and, more generally, in clinical practice, as well as to develop harmonized coding and a structured reporting tool relevant for the procedures dealt with in MEDIRAD research." (MEDIRAD Proposal, page 35)

This report provides a description of the Task 2.4.3 on "Comprehensive Reporting Templates and Pilot system for SR-Reporting (SR)".

Reporting of imaging studies is a key task in clinical and scientific work. There is an ongoing trend to have more precise and reliable reporting practices to enhance readability, avoid mistakes and improve research opportunities. To fulfil such expectations, there is the so-called "Structured Reporting"-approach, which can provide specific templates for different clinical scenarios. Including coding, enables machine-based evaluation and analysis of reports, as well as the ability for integration with other clinical data. ESR has recently published a position paper on this topic (2). Furthermore, ESR and RSNA have established a joint committee to promote structured reporting (TLAP- Template Library Advisory Panel).

2. Comprehensive Reporting Templates and Pilot system for SR-Reporting (SR)

Subtask 2.4.3 relates to the development of templates and of the pilot system for SR Reporting. The following aspects are part pilot SR Reporting system:

- Web-based reporting system (MRRE)
- Interfacing with RIS and/or PACS
- Templates for reporting
- User-interface for management of users, requests, reports etc.
- Analytics capabilities

2.1 Web-based reporting system

As part of Subtask 2.4.3, an open-source tool for using reporting templates is provided for MEDIRAD partners. This SR-reporting tool can be implemented locally or used as a web-based service. Depending on the local IT infrastructure, several interfaces can be used (e.g. URL-based program-launch and single-sign-on for workflow integration with RIS and/or PACS). Communication of reports to RIS or other IT-systems, can be provided in HTML5, XML, DICOM-SR, DICOM-PDF, or HL7-CDA formats. Additionally, this reporting tool is able to receive and manage DICOM SR objects, e.g. measurements from ultrasound devices or DOSE SR objects. Such evidence information can be presented in the reporting template automatically. Also, another add-on is the option to have a local database, which allows for reporting management, but also evaluation and analysis of the reports stored in the pilot SR Reporting system.

The pilot SR Reporting system is compliant with the IHE Profile MRRT (Management of Radiology Reporting Templates) and supports the roles “report creator” and “template manager” (3).

Technical setup

- To operate the MRRE, a running web server with PHP and database connection must be installed.
- For sending DICOM files, querying archive or worklist servers, and for the import/export of DICOM SR and Encapsulated PDF objects, the command line programs of the dcmtk from Offis are required.
- To create/import XML and CDA documents, and to import DICOM SR objects, the program tidy is required.

- To create PDF objects (Plain or DICOM) the program wkhtmltopdf is required.
- MariaDB is operated with the DB mrre_db.
- web server: Apache 2 with the modules Rewrite and Alias.
- MRRE requires the modules intl and mbstring. For MySQL or MariaDB the module pdo_mysql is required.
- For HL7 support, the Pear module NET/HL7 has to be installed.
- For the MRRE, a database with UTF-8 character set must be created. Then a user with full rights (GRANT is not required) must be created on the new DB.
- For MySQL or MariaDB, the PHP module pdo_mysql is required.

2.2 Interfacing with RIS and/or PACS

Usually, the SR reporting system should be interfaced with a RIS or PACS to receive requests with additional information relevant for reporting, e.g. accession number. MRRE can be launched directly from RIS or PACS with a URL-request. Based on this information a new request for reporting can be initiated and an identification of the appropriate template can be done based on e.g. the study description. Export of reports is supported via XML, HL7 CDA, DICOM SR, DICOM PDF and other formats. DICOM SR Objects can be received and the content can be fed into templates automatically. Additionally, support for speech-recognition is provided. This enables the use of templates with coded and structured fields, with a combination of additional free-text fields that may be necessary for specific additional notes or e.g. conclusions.

2.3 Templates for reporting

Typically, templates provide different aspects for reporting. There should be categorized information, which will consist of quantitative data (e.g. measurement like distance, thickness, enhancement, velocity) or qualitative categories (e.g. none/mild/severe, or based on classification systems like Bosniak for renal cysts, TNM-Staging, AAST trauma categories etc.). Templates can offer additional information, for example tables of classification systems or illustrations that provide guidance for correct classification („help"-functionality). Usually, not all findings can be categorized distinctly, for such cases – as for conclusions – free text might still be obligatory. Furthermore and whenever possible, information captured in SR-templates should be linked with a coding system. This task requires clear definition of terms and some understanding/knowledge of coding systems, e.g. ICD 10 for general information. For reporting in radiology, the RadLex-system – developed by RSNA – is the most accepted ontology today.

As part of the WP 2.4 services, University Medical Center Mainz will develop and prepare templates based on requirements defined by the clinical study leads. Such templates can have a lot of different "flavours", e.g. low number of generic fields (clinical history & question, findings, conclusions) or very detailed structure, including requests for clinical information and separated items for anatomical locations.

For the MEDIRAD project, it is intended to have reports in DICOM-SR format, which will automatically be forwarded to the general data repository (managed by WP2.4.1) with no further user input needed. The joint availability of images, exposure data and medical information/interpretations has the potential to enable better and novel methods for data evaluation.

Handling of templates inside MRRE

- Templates are available to the user for reporting. These can be managed in various ways.

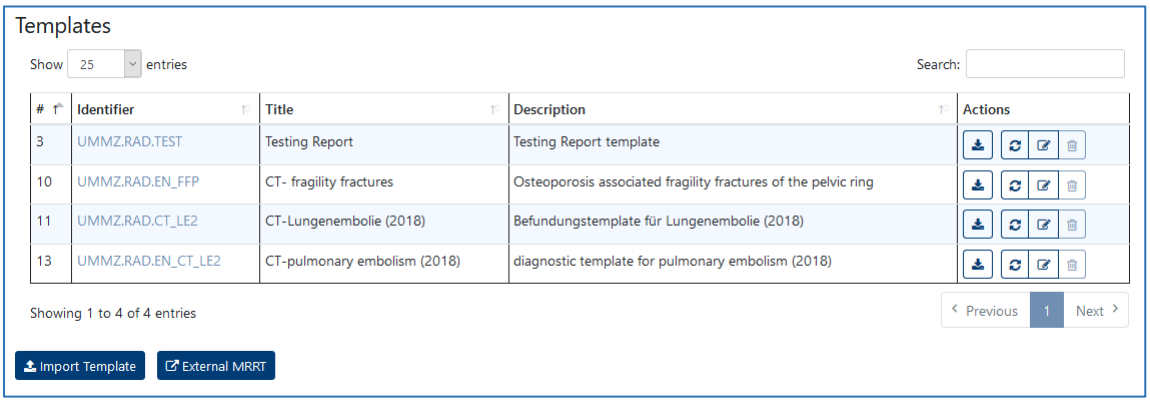

Figure 1: Listing of templates (note: these are examples, as the MEDIRAD specific templates are under development according to outstanding definitions of requirements)

- Import: With the button [Import Template] below the list, a template can be uploaded from the local file system.
- Reload: With the button [Reload] in the line of a template, a template can be uploaded from the local file system.
- Editing: With the button [Edit] in the line of a template, a template can be edited.
- Delete: With the button [Delete] in the line of a template, a template can be deleted from the local file system.
- External MRRT: By clicking the button [External MRRT] below the list, an external template manager (e.g. radreport.org) can be queried.

- The presentation of the templates depends on the workflow-integration and style sheet used by the leading system, e.g. RIS / PACS. Using MRRE as an independent solution provides a standard rendering for the templates, so that they are displayed as shown below:

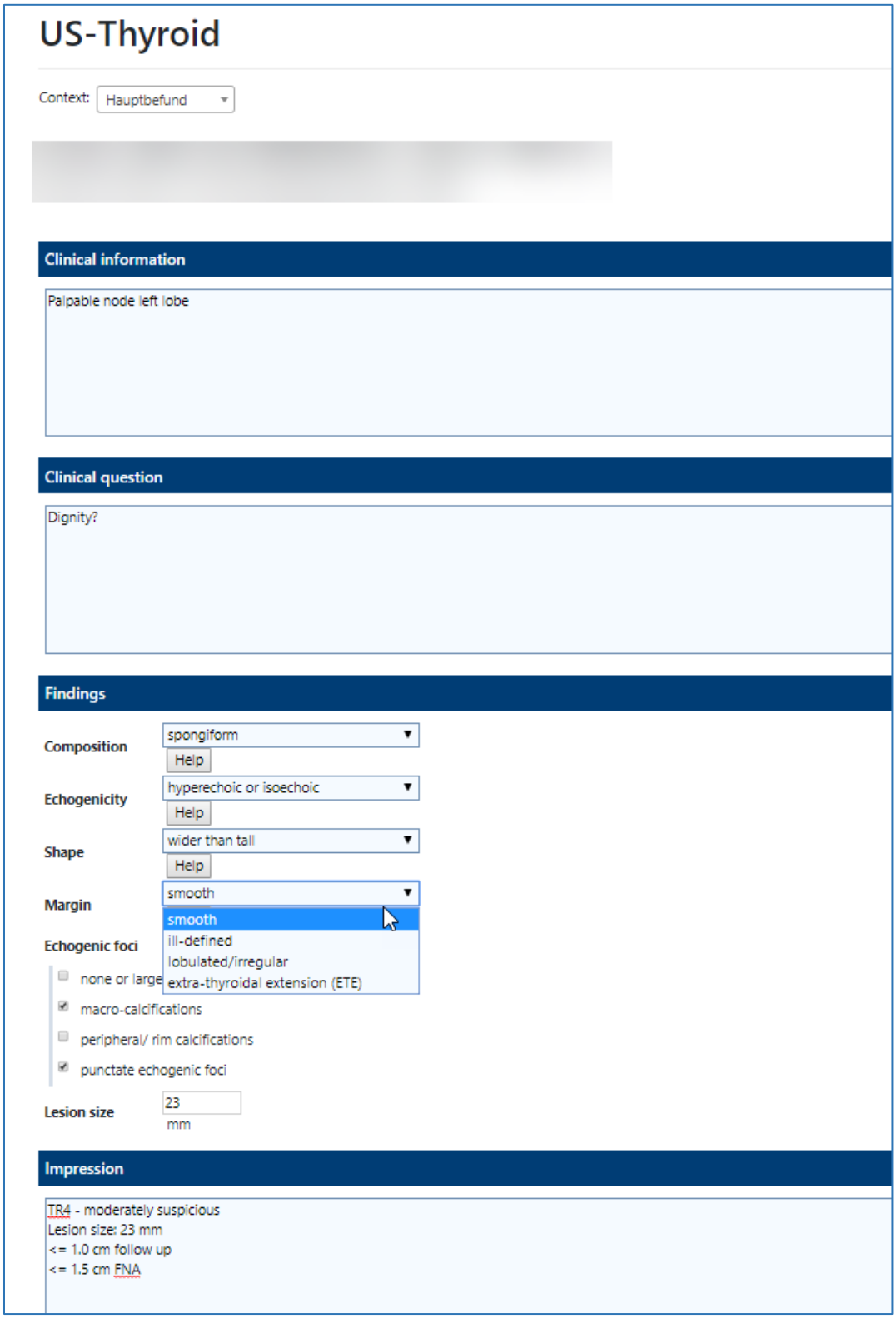

Figure 2: Example for presentation of a reporting template

The example is based on ACR´s TI-RADS concept. There are defined information to fill in, e.g. echogenicity and others. Based on these findings, a recommendation can be calculated according to the ACR guidelines and will be shown under “Impression”. This proposal can be accepted or modified by the reader. As part of the templates, there is an option to have encoded information. Usually, this will be RadLex-based coding.

```
<entry ORIGTXT="T116_18">
          <term>
            <code meaning="pulmonary
embolism" value="RID4834"
scheme="RadLex">
          </term>
        </entry>
        <entry ORIGTXT="T116_21">
          <term>
            <code meaning="lung"
value="RID1301" scheme="RadLex">
          </term>
          <term>
            <code
meaning="parenchyma"
value="RID5978" scheme="RadLex">
          </term>
```

Figure 3: Example for coded information as part of a reporting template

2.4 User-interface for management of users, requests, reports etc.

As part of the MRRE, there is a full management solution to handle users with role-based privileges, requests and reports. MRRE supports a role-based access authorization (RBAC). A user has one or more roles. A role has one or more permissions and one or more child roles that inherit the permissions of the parent role. LDAP-connection is supported.

Using an integrated workflow with RIS- or PACS-Interfacing, new request for reporting will be generated automatically. Additionally, there is an option to do this manually.

With an integrated workflow, an automatic selection of the appropriate template for the specific study can be supported, e.g. based on the study description. Therefore the system will directly launch the relevant template and the user can start reporting. Different kinds of fields are available, e.g. check-boxes, drop-down-selection, numeric fields. It is possible to display additional information, e.g. schemes for graduation, guidelines etc. Reports can have different status levels like draft, finalised, verified, which supports differentiated review processes. Also, it is possible to handle several reports for the same study, if relevant (e.g. in the context of clinical studies with several readers).

2.5 Analytics capabilities

As part of the handling of templates, an automatic adaptation of the database by generating the relevant fields is part of the pilot SR reporting system. Therefore, the database provides an independent analytics tool as part of the MRRE. Dynamic visualization of diagnostic data is achieved using the dc.js library. The data can be filtered by clicking on the bar charts, by selecting a specific age group, or by choosing the sex of any selection.

3. Conclusion

According to Subtask 2.4.3, a full pilot SR reporting system supporting an IHE MRRT compliant workflow has been developed. This tool can be used in different settings, e.g. as local application or cloud-based. A full integration with the *Imaging and Radiation Dose Repository* (Subtask 2.4.1) is in progress.

Sample templates according to the IHE MRRT requirements are part of the existing pilot-system. Specific templates for clinical studies in the MEDIRAD project will be developed based on given requirements and examples.

The developed solution is flexible in its application. In particular, the design of templates allows the realization of various differing requirements. Among these are the inclusion of clinical data, the integration of evidence-based information from examination devices (e.g. DICOM SR objects), as well as the collection of categorized values and free-text notes. Thus, for the first time a synoptic reporting format is possible with an IHE MRRT-compatible system, which supports a diverse scientific evaluation of the collected data.

4. References

1. MEDIRAD_Proposal. Implications of Medical Low Dose Radiation Exposure - MEDIRAD. Call: NRFP-2016-2017, Proposal Number 755523. 2016.

2. ESR. ESR paper on structured reporting in radiology. Insights into imaging. 2018;9(1):1-7.

3. IHE_Radiology. IHE MRRT https://www.ihe.net/uploadedFiles/Documents/Radiology/IHE_RAD_Suppl_MRRT.pdf2017