



# Five imperatives for Dose Management Excellence

Dose management systems: essential tools for systematically monitoring and optimizing radiation dose in medical imaging

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## Why is software essential for managing dose?

Continuous monitoring of applied radiation dose is key for optimum patient care. Recent trend studies show that the implementation of patient protection programs such as the European Directive [2013/59/Euratom](#), effective since 2018, and dose reduction initiatives like [Image Wisely®](#) from the American College of Radiology (ACR), have already helped reduce patients' radiation dose exposure from medical imaging. [1]

However, in many cases, stricter dose management regulations represent a substantial operational burden for healthcare providers, since dose values must be transmitted to national authorities. Reporting of significant events according to country guidelines can consume valuable time and resources that would be better devoted to other tasks.

Here, dose management systems (DMS) provide much-needed support. Loose et al. conclude that these "very helpful software tools ... should be used wherever possible and appropriate". [2] The main goal, of course, is compliance monitoring against diagnostic reference levels (DRLs), but users can also receive performance overviews of their connected devices and institutions. Further advantages include alert generation, error identification, workflow optimization, and a more patient-centric approach thanks to personalized dosimetry. [2,3]

Choosing the right DMS, adapted to institutional needs, can be an invaluable tool in the daily practice of radiation-emitting imaging and a crucial game changer for healthcare providers. We have distilled **five imperatives for Dose Management Excellence**.

**Author:** Julia Weißberger

**Reviewers:** Stephan Achhammer,  
Dr. Maria Bertling, Florian Reinhold,  
Holger Reinsberger, Christian Sauter,  
Jörg Schmidt, Dr. Jürgen Steinheber

## Imperative 1: Data aggregation and processing

All the data required for effective dose management is already available in medical imaging departments, but often not harnessed sufficiently. To perform its intended tasks, a DMS must acquire dosimetry parameters – either from DICOM headers, from DICOM images with bitmap dose reports or secondary captures (SC), which both require Optical Character Recognition (OCR), or from DICOM RDSR reports – and store them in an easily searchable database. [2] The DMS needs to be compatible with the modalities DX/CR, MG, CT, RF, and XA. [2] But unless this data is automatically aggregated, dose management is time-consuming and tedious, including hours of searching the PACS. And manually-sampled information can only provide an incomplete picture. [4]

DMS software remedies these issues by automatically gathering and consolidating the large amounts of dose data generated by imaging modalities. [2] Instead of individual connections to modality workstations, a central connection to the PACS is preferred in terms of configuration efforts when managing a larger fleet of imaging equipment. [5]

A DMS that is able to intelligently combine multiple data sources and make the most of the data available has a strategic advantage over other dose management systems. Once the examination is completed and sent to the PACS, the DMS retrieves the dosimetry data for subsequent processing. [5] Appropriate dose metrics can then be used to facilitate and monitor dose optimization.

### Highly automated and intelligent with teamplay Dose

Via a central gateway between the PACS and the teamplay digital health platform, the teamplay Receiver software is designed to query the Service Object Pair (SOP) classes needed for dose management use cases. teamplay Dose derives the data needed for its functionalities from relevant DICOM studies, i.e., DICOM Radiation Dose Structured Reports, DICOM header, secondary capture-based protocol reports read by OCR, and localizer scans. The Siemens Healthineers DMS is vendor-agnostic and can process information from many different sources and modalities (DX/CR, MG, CT, RF, XA, and even NM including PET-CT and SPECT).

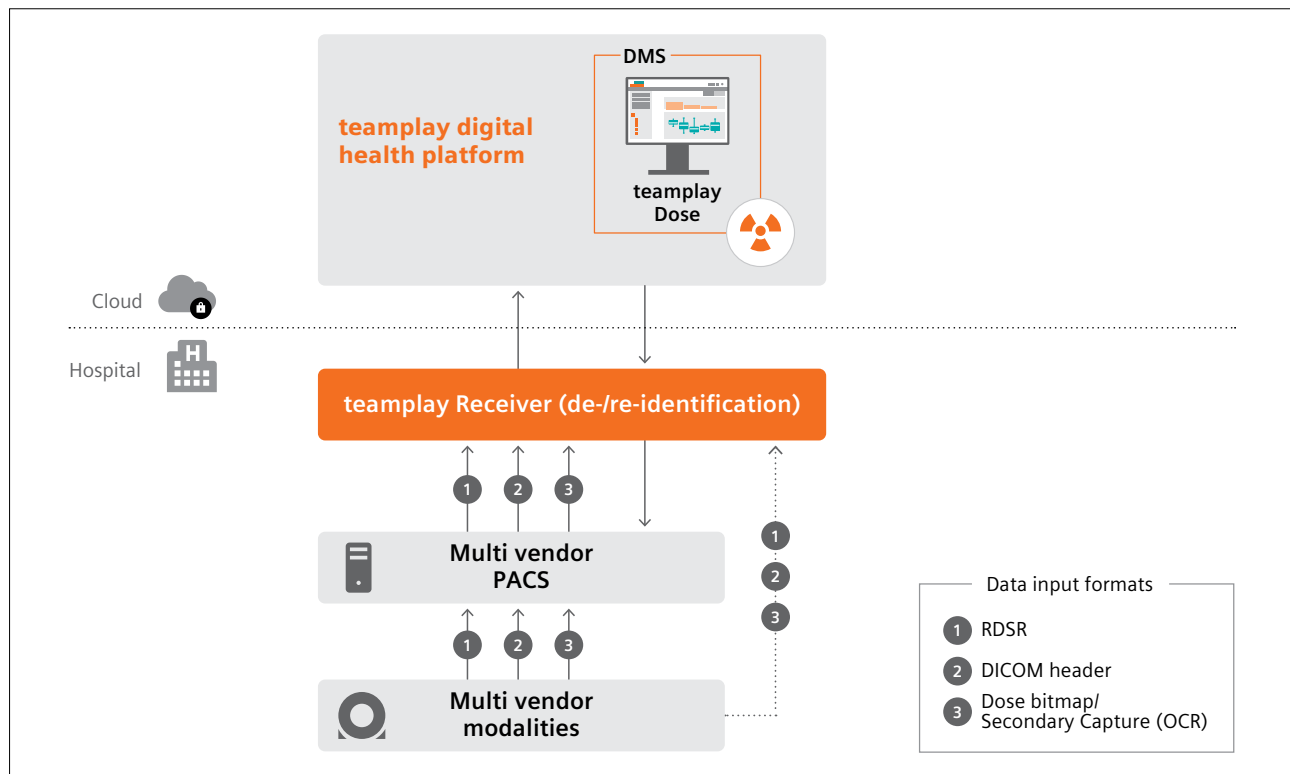


Figure 1: teamplay Dose – Vendor-agnostic data flow from multiple sources and modalities.

For every individual examination, the application collects information from multiple data sources – if available – and intelligently combines it to achieve improved data quality (see Fig. 1). teamplay Dose is even able to aggregate data from split studies. Moreover, the software is smart enough to source only the relevant data, thus preventing network overload. This way, teamplay Dose expertly handles the scope, completeness, and quality of the data provided by all the different devices.

## Imperative 2: Compliance with regulations and best practices

One of the main uses of DMS is to record the dose metrics, assign protocols to corresponding DRLs, and compare them with the respective thresholds, ensuring compliance with national and local DRLs. [5,6] As Tsala-foutas et al. state, “[f]or the DMS to be able to proceed to comparisons with reference values of dose metrics, it is required to identify the examination type and the anatomic region scanned in each individual acquisition” [5] – and then map them to a uniform, internationally-recognized nomenclature [2]. As protocol nomenclatures differ in clinical practices, a common ontology is key for enabling comparisons between centers, both nationally and internationally.

A DMS must be able to identify, analyze, and process significant dose events. It also needs to be easy to use, as this is crucial for DMS adoption in clinical routine. For example, a DMS should automatically inform radiologists, medical physics experts, and radiographers about relevant events. [2] This facilitates root-cause analysis and targeted measures to address protocol improvements, mismatch of acquisition protocol and body region, or operator-driven causes.

What’s more, a DMS should make it easy to export dose data for reporting – in the format requested by the respective authorities [2].

## Rigorous compliance with teamplay Dose

By systematically monitoring dose levels, as well as identifying variability in study descriptions, protocols, and dose delivered to patients, teamplay Dose supports the ALARA principle and the respective reference levels for applied radiation. Its intuitive interface enables users to easily implement best-practice protocols, and detect significant dose events at a glance.

To ensure that exams can be compared across institutions, and to avoid misleading results, teamplay Dose uses AI-based algorithms to standardize local nomenclature automatically. The software supports rule-based mapping, auto-mapping to standards such as RadLex® and LOINC®, as well as optional manual adjustment in complex cases. For CT and XR examinations, mapping rules can be even defined based on acquisition protocols and a single RadLex Protocol ID (RPID). This makes 100% precise mapping possible – independent of the protocol structure.

Outliers can be viewed at any time on a separate alert management page (see Fig. 2) and commented on within teamplay Dose using an individual categorization for commenting. As a result, the user is always well-prepared for audits and has the needed proof for the radiation protection authority at hand. Users can also tag specific examinations for further discussions, for example in a Dose Monitoring Board meeting or for educational purposes.

As proof for the radiation protection authority, the complete study list in teamplay Dose can be exported to a Microsoft Excel spreadsheet. This export includes the comments mentioned above. Moreover, the application provides ACR-like quarterly reports for all RadLex Protocol IDs and LOINC IDs, with worldwide, national, and regional benchmarks.

“Having previously relied on PACS and CRIS for dose audits, Siemens Healthineers teamplay has allowed us to quickly download and process a huge volume

of patient dose data so that our dose audits are much quicker and more powerful than before. Because of this, we can audit more of our protocols, and spend more time investigating outliers and unexpected results as opposed to doing data collection,” says Colin Lee, Senior Clinical Scientist at the Clatterbridge Cancer Centre, NHS Foundation Trust, UK.<sup>1</sup>

When the software identifies a case of over-radiation, it generates an alert, and emails a summary of all dose alerts to the user. Notification rules can be adapted to the user’s needs. This helps the alerted examinations receive direct attention, and allows them to be validated in the application without delay. Specifically, for Germany, a dedicated function simplifies compliance with the German Radiation Protection Ordinance, and

it is also possible to receive notifications in accordance with the requirements of appendix 14.

To further support the daily work of radiation protection officers and medical physics experts, teamplay Dose automatically highlights the DLP and CTDI<sub>vol</sub> for CT examinations if they exceed a certain threshold, and automatically calculates the rolling average, thus eliminating time-intensive manual work. Color highlighting shows at a glance where further investigation may be required.

Data visualization is one of the most powerful ways to gain insights from data, and clearly communicate them to others involved. This topic is covered in the next section.

The screenshot displays the Siemens Healthineers teamplay Dose software interface. The top navigation bar includes the Siemens Healthineers logo, the product name 'teamplay Dose', and user information for 'Chris Winter' at 'Mountain Springs Medical Center'. The main interface is divided into several sections:

- Alert management**: A sidebar on the left showing a list of exams with search functionality. The list includes exams like 'CONTRAST', 'CTAVHRT', 'PET^UMMC\_WB\_NO\_CT (Adult)', 'CT Head W/o IV Contrast', and 'PET CT SKULL TO THIGH AREA SUBSEQUENT', each with a status and an 'Open' button.
- Exam Details**: The main panel shows detailed information for the selected 'CTAVHRT' exam. This includes:
  - Patient**: Size, Weight (117.94 [kg]), BMI, Gender (M), Age.
  - Exam Details**: Study Date (2/15/2022 11:00), Body Region (Heart), Body parts (HEART;HEART;HEART;HEART), Protocol (CTA\_CARDDEMO\_STROKE), Study description (CTAVHRT), Series description (PreMonitoring 10.0 Br36;M...), Procedure description (CTA HEART (CORONARY,PUL...), Modality Type (CT), Manufacturer (SIEMENS - SOMATOM Force), Modality Name (SOMATOM Force 1), Device serial number (7492d925-e6ca-4f48-92b7...), RadLex short description (CT Heart Coronary Angio w...).
- Exam Mapping**: A section at the bottom of the main panel showing a CT scan image with dose metrics and a commenting function.
- Commenting Function**: At the bottom, there is a user profile for 'chris.winter@mountainsprings.com' (25/2/2022 12:1) with the note 'Patient has large body habitus'. There is a 'Save' button and a '0 comments' indicator.

Figure 2: teamplay Dose – Alert management page with commenting function to track dose alerts for audits.

## Imperative 3: Visualizations and insights

State-of-the-art dose management systems can analyze a complete set of dose data for a defined period of time – and automatically visualize it. Presenting data in a pictorial or graphical format enables decision makers to grasp complex data quickly, and identify patterns. [7] A DMS should be able to display dose charts as timelines, link from any dose parameter to the corresponding image, and report modality load (day, time, and procedure). [2]

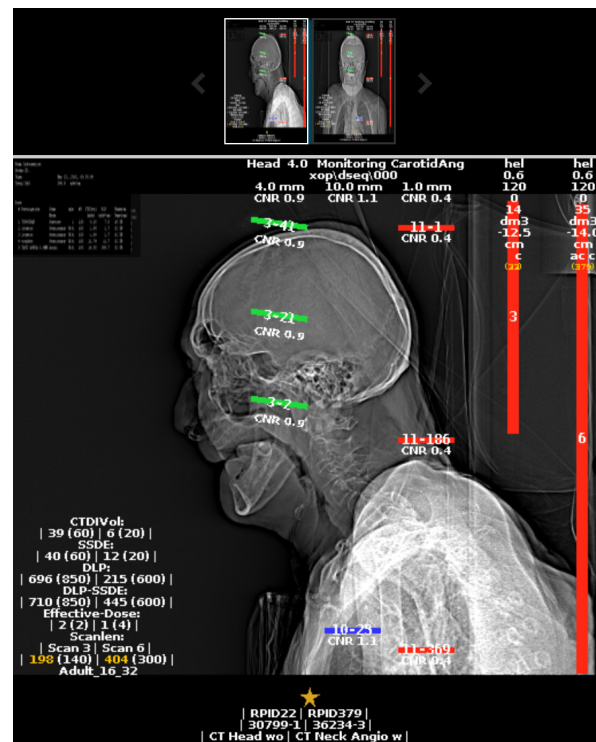
Users should be able to drill down to each individual exam and get in-depth insights from dose-related calculations like size-specific dose estimate (SSDE), effective dose, cumulative patient dose, organ dose, or skin dose. The latter plays an important role in interventional radiology (IR) examinations, where high skin doses can cause adverse tissue reactions. A DMS makes it possible to quickly and efficiently follow-up with the patient. [3] For organ dose assessments, it is important to acknowledge the variety of patient types for which multiple phantoms are recommended. [8]

High-end dose management solutions should perform the above mentioned calculations automatically. [2] By having patient-specific dosimetry at hand, and by being able to conduct more in-depth analysis of root causes, healthcare providers can identify mistakes in their technique and perform corrective actions for improved patient care. [3]

### Efficient, sensible, and to the point with teamplay Dose

teamplay Dose offers several automated mechanisms that help derive essential information and present it as clearly as possible. For example, by using a dose histogram to give an immediate and clear view of dose distribution, or using box-and-whisker plots to show dose level and distribution by modality, exam protocol, location, and operator.

For CT examinations, comprehensive visual indications of the image quality are provided within teamplay Dose. Topogram images in combination with annotations (see Fig. 3) help to validate protocol-, scan-, and mapping-related image quality evaluations. These images give medical staff all the information they require to report dose outliers and identify the concrete cause of why each outlier occurred. This contextual information helps users understand whether a dose alert may be part of a larger issue, which would prompt further action.



**Figure 3:** The image displays the scan- and protocol-related parameters automatically calculated in teamplay Dose. Color indications (green = OK, red = not OK, blue = not relevant) immediately show whether dose and image quality are within the acceptable range.

### High-end ALARA concept

teampay Dose provides very deep insights into CT exams, using DICOM-level axial images as well as topogram images to optimize both image quality and dose level. Users can:

- Check CT axial images within teampay Dose, with PACS-comparable image quality and tools. This avoids time-consuming and error-prone PACS activation.
- Show slice images within the topogram related to the scans, and load the real DICOM axial image behind it – with just one click.
- Make ALARA judgements in terms of dose level and image quality – using the 5-star ALARA quality rating implemented in teampay Dose.

Being able to assess CT axial image quality in an integrated online viewer within the teampay Dose application, rather than having to use the respective PACS, saves considerable time and effort. The viewer supports various other dose-relevant evaluations like medical gray scale levelling (windowing), zoom, pan, measurements, pixel lens, water-equivalent diameter (WED) calculation with interactive ground truth method, reading the DICOM header of the axial image, and many other functions required in dose management.

To offer more personalized dosimetry, teampay Dose provides – along with DLP, DAP,  $CTDI_{vol}$ , AGD, injected activity depending upon modality type – further important dose KPIs: SSDE, effective dose, skin dose, and organ doses.

For CT examinations, in line with the approach suggested by the American Association of Physicists in Medicine (AAPM), teampay Dose calculates SSDE based on the

### How are parameters calculated in teampay Dose?

For CT and IR examinations, **organ dose** is estimated via Monte Carlo simulation based on phantoms. The **effective dose** is estimated based on the dose value multiplied by the respective conversion (k-)factor per body region. In NM and PET-CT, effective dose is estimated based on injected activity, type of pharmaceutical, and patient weight. The **SSDE** is calculated automatically, using

$$SSDE = f(D) \cdot CTDI_{vol}$$

where  $f(D)$  is the conversion factor (published in [9] and [10]).

Pixel data of a localizer image is uploaded to the teampay digital health platform to derive the **WED**, which is needed to determine the conversion factor.

WED. To calculate this metric, the application derives the WED from the localizer or axial image of the patient. The diameter is needed to look up the conversion factor  $f(D)$ , which in turn is multiplied by the  $CTDI_{vol}$  to obtain the SSDE. Effective doses in CT are calculated based on technical doses, publicly-available conversion factors as described in [AAPM Report 96](#), and the body region examined. On mapped examinations, the body region of the underlying standard takes priority. In other cases, the body region found in the data is used. If the patient has examinations from different modality types, the accumulation is presented based on effective dose in mSv, as accumulative effective dose.

For the modality types RF, XA, and XR, teamplay Dose offers additional dose-related KPIs like skin dose at irradiation event level, as well as peak skin dose at exam level. What's more, a skin dose distribution view (see Fig. 4) is available for IR examinations.

For the modality types CT, RF, and XA, the teamplay Dose application offers a seamlessly integrated organ dose assessment by Virtual Phantoms, Inc. for scan parameters and patient specifics (including pregnancy state) on irradiation event level. On top, Monte Carlo simulation is available, displaying the estimated radiation dosage in correlation with the investigated organ, if organ dose assessment is desired for e.g., training or research purposes.



**Figure 4:** The skin dose distribution view visualizes dose at reference point based on primary and secondary angle. If orange or red pixels appear on the map, the dose is medium or high, depending on the severity of skin reactions it may potentially cause. Skin reactions typically occur after a certain radiation dose threshold.

## Imperative 4: Interoperability with existing IT infrastructure

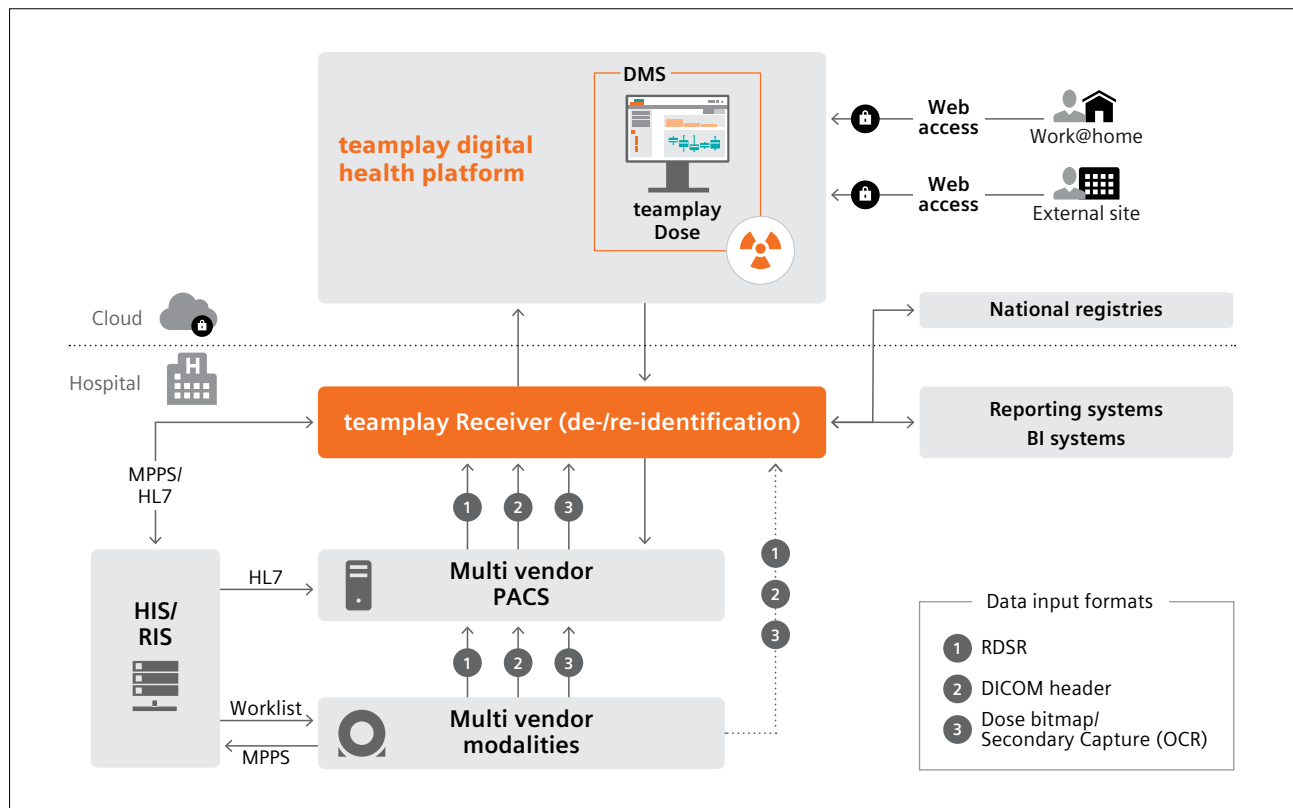
To seamlessly integrate a DMS in clinical practice, it not only requires an inbound connection to the PACS of the hospital or the modalities themselves. It also needs outbound interfaces to third parties, allowing dose information to be transmitted to other IT systems, such as the Radiology Information System (RIS) or the Hospital Information System (HIS). [3] "Older generation systems may also require data transfer procedures to be activated using Modality Performed Procedure Step (MPPS)." [2] In addition, a DMS must be able to easily export dose data for quality assurance, reporting, optimization, and post-processing. [2]

To meet these requirements, the DMS needs to be integrated in a central IT infrastructure. This integration includes different levels of administrative data structures, and must comply with national or federal data protection regulations. [2]

Some users do not exclusively focus on qualitative dose management and process standardization. If patient-centric use cases are also of interest, the dose management system needs to adapt to changes in patient information. Such changes in a leading system are broadcast as HL7 messages. A dose management system needs to be able to reconcile HL7 ADT change and merge messages to ensure data consistency. [2]

### Extremely practical, seamless, and secure with teamplay Dose

teamplay Dose supports interfaces with various information systems (visually summarized in Fig. 5). Outbound interfaces allow teamplay Dose to send data to third-party systems such as RIS or EMR, and to third-party reporting applications like PowerScribe® 360 from Nuance, in order to automatically insert exam dose summaries in diagnosis reports.



**Figure 5:** Siemens Healthineers dose management system teamplay Dose, seamlessly integrated into the IT landscape of a hospital with high practicability standards.

## Imperative 5: Enhancements and scalability

Via the teamplay digital health platform, a RIS call-up connection can be established to retrieve and visualize patient-based dose information from teamplay Dose – either as a static patient report (.pdf) or as a direct-access, interactive patient view in line with the data privacy settings made in teamplay.

Even though MPPS no longer meets today's standard for transmitting dose data, teamplay Dose has the ability to push MPPS dose sequences, i. e., if required by the RIS. Via the MPPS plugin, teamplay Dose can bridge the different communication standards of the RIS and scanners of various ages. For patient-centric use cases, teamplay Dose reconciles HL7 ADT change and merge messages, and ensures patient dose compliant to changes in HIS or RIS.

Moreover, teamplay Dose smoothly interfaces with national registries like the ACR registry. The application can be configured to automatically upload the modalities' dose data directly to the ACR Registry client. For further analysis, dose data and associated comments can be easily selected and exported to a Microsoft Excel spreadsheet.

Data security and privacy are of utmost importance, especially when it comes to data-processing applications deployed in the cloud. Therefore, teamplay Dose and the entire teamplay digital health platform meet the highest standards in terms of cybersecurity and data privacy best practices. teamplay's IT security has been developed in accordance with an ISO 27001-certified Information Security Management System and has been awarded the European Privacy Seal (EuroPriSe) for the applications "teamplay Dose", "teamplay Usage", and "teamplay Protocols". In addition, as a data-processing platform, teamplay supports compliance with U.S. standards, including HIPAA (Health Insurance Portability and Accountability Act), as well as global data protection laws and, in particular, the European GDPR (General Data Protection Regulation). The effectiveness of the implemented measures is regularly evaluated and continuously improved.

As remote work is becoming more and more prevalent, teamplay Dose ensures that data can be reliably accessed and analyzed by authorized users.

In their 2021 paper, the EuroSafe Imaging initiative identified a need for configurable dose management systems – ones that can be tailored to the respective institution's size and workload. Today, the most flexible DMS products are offered as Software as a Service (SaaS), deployed via the cloud. This model eliminates the need for local IT infrastructure and related upfront investment, reducing both effort and total cost of ownership. In addition, SaaS allows quicker scalability, continuous upgrades without additional costs, and reliable access to the most recent functionality. Within the healthcare industry, the adoption rate of the SaaS model is growing by 20% annually. [11]

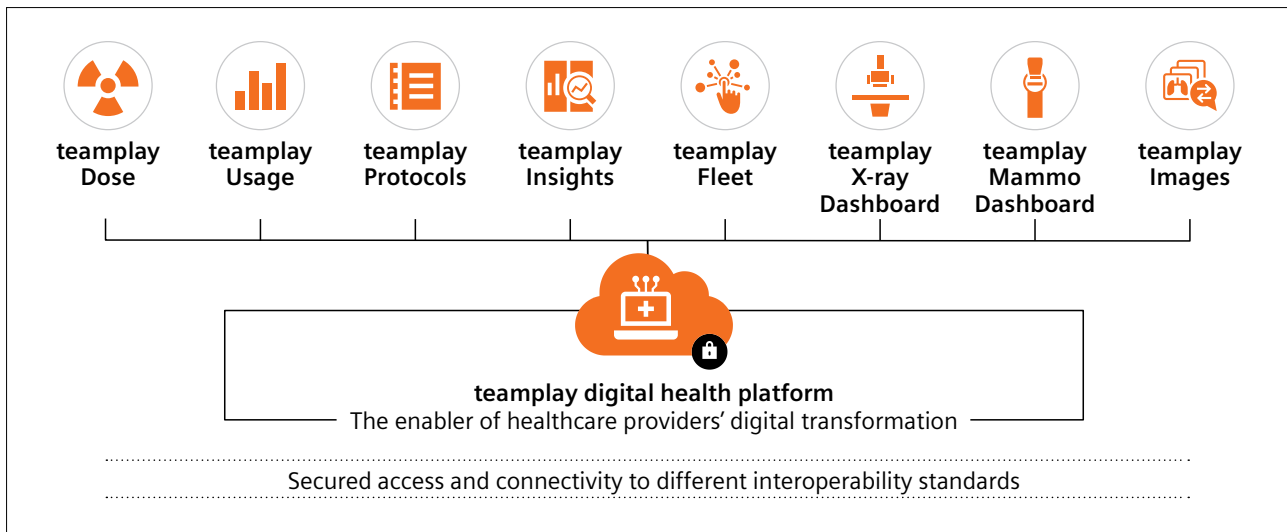
### Steady stream of enhancements and easy scalability with teamplay Dose

teamplay Dose stays current with dose-related needs as well as changing regulatory requirements – thanks to cloud deployment, continuous release cycles and data feeds from around the world. Even if data input formats change in the future, teamplay Dose will stay up-to-date. This includes its benchmark repository, which is regularly updated several times a year.

With ease, teamplay Dose adapts to the rapidly-evolving SOPs in dose management. As such, it is the ideal choice for healthcare providers seeking to implement a flexible, high-performance dose management system.

The transparent Siemens Healthineers SaaS model offers single- and multi-year contract options and includes on-going maintenance and support. Thanks to cloud-based deployment, fast feature advancements with continuous releases are a given. SaaS also ensures that all sites within one institution have access to the same, up-to-date software version – without in-house upgrade projects and related efforts.

As part of the teamplay digital health platform, teamplay Dose can help customers manage multiple sites with a scalable approach. Platform-based data aggregation enables seamless collaboration with single sign-on (SSO) authentication, best-practice sharing, and standardization as desired transformational change.



**Figure 6:** The teamplay digital health platform offers seamless interoperability and provides the starting point for solution extensions into adjacent offerings.

For larger multi-site hospitals, teamplay Dose outperforms on-premises products in terms of both effort and cost.<sup>1</sup>

The SaaS approach of teamplay Dose not only enables seamless interoperability, but also allows solutions to be incrementally expanded as medical imaging departments evolve. And, because reducing dose often requires a holistic approach, adjacent offerings like teamplay Protocols<sup>2</sup>, teamplay Contrast<sup>3</sup>, teamplay Usage, and teamplay Insights perfectly complement teamplay Dose – and can be added as needed.

teamplay Protocols<sup>2</sup>, for example, can be used to centrally access and optimize protocols on the remote Siemens Healthineers scanner. Here, the DMS can be used to efficiently determine the root cause of dose outliers. If a dose outlier can be attributed to a, for example, faulty CT scan protocol, teamplay Dose in combination with teamplay Protocols<sup>2</sup> provides a solid basis for suitable countermeasures, highlighting the need for optimization through analysis per protocol, per operator<sup>4</sup>, and per system.

To balance radiation dose exposure, contrast media exposure, and image quality, the application teamplay Contrast<sup>3</sup> is a powerful solution for analyzing, reviewing, and reporting contrast KPIs and their variability, as well as for easily detecting contrast agent outliers.

Dose events and utilization are often interlinked. For this reason, it's not only crucial to monitor and optimize patient radiation dose, but also to improve the utilization and throughput KPIs of healthcare provider's imaging fleet. Here, teamplay Usage can deliver insights into exam scheduling, operator workloads, table turnaround times, and more.

In addition, teamplay Fleet offers the needed transparency in order to relate dose patterns and trends to potential service and maintenance events.

For use cases that go beyond pure dose monitoring and management – those requiring deeper performance insights into complex workflows and patterns – teamplay Insights combines different data sets in user-customized dashboards. This application makes it possible to generate PDF reports that can be automatically sent to a defined list of users at a pre-selected frequency. This supports quality-related reporting and compliance. On top of this, teamplay Insights can automatically export data via APIs to Business Intelligence systems.

## Conclusion

With new and evolving legislature regulating exposure to ionizing radiation, the responsibilities of medical physics experts have expanded even more. Dose management systems are necessary tools that make it possible to systematically monitor patient radiation dose and exceedances of dose reference values, thus fulfilling the obligation to report significant dose events to the supervisory authority without delay. Dose management systems that are based on broad data aggregation, and able to quickly respond to the current needs in radiology departments, offer a significant advantage to other DMS.

Of the DMS solutions available today, teamplay Dose from Siemens Healthineers is among the most flexible, scalable, and easy-to-use. The cloud-deployed solution supports radiation dose monitoring across multi-modalities and multi-vendors. teamplay Dose intelligently aggregates dose data from various data sources, keeps pace with the evolving regulations in dose management, and offers a broad range of continuously updated features and functionalities – making it suitable for radiology departments seeking a flexible, high-performance dose management system for Dose Management Excellence.

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## Abbreviations

**AAPM:** American Association of Physicists in Medicine

**ACR:** American College of Radiology

**ADT:** Admission, Discharge, and Transfer

**AGD:** Average Glandular Dose

**AI:** Artificial Intelligence

**ALARA:** As Low As Reasonably Achievable

**API:** Automatic Programming Interface

**CR:** Computed Radiography

**CT:** Computed Tomography

**CTDI:** Computed Tomography Dose Index

**DAP:** Dose Area Product

**DICOM:** Digital Imaging and Communication in Medicine

**DLP:** Dose Length Product

**DMS:** Dose Management System

**DRL:** Diagnostic Reference Level

**DX:** Digital Radiography

**EMR:** Electronic Medical Record

**GDPR:** General Data Protection Regulation

**HIPAA:** Health Insurance Portability and Accountability Act

**HIS:** Hospital Information System

**HL7:** Health Level 7

**IR:** Interventional Radiology

**MG:** Mammography

**MPPS:** Modality Performed Procedure Step

**NM:** Nuclear Medicine

**OCR:** Optical Character Recognition

**PACS:** Picture Archiving and Communication System

**PET-CT:** Positron emission tomography-computed tomography

**RDSR:** Radiation Dose Structured Report

**RF:** Radio Fluoroscopy

**RIS:** Radiology Information System

**RPID:** RadLex Protocol ID

**SaaS:** Software as a Service

**SC:** Secondary Capture

**SOP:** Service Object Pair

**SPECT:** Single-Photon Emission Computed Tomography

**SSDE:** Size-Specific Dose Estimate

**SSO:** Single Sign-On

**WED:** Water-Equivalent Diameter

**XA:** X-ray Angiography

**XR:** X-ray

- <sup>1</sup> The statements by Siemens' customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption) there can be no guarantee that other customers will achieve the same results.
- <sup>2</sup> teamplay Protocols supports selected Siemens Healthineers scanners. teamplay Protocols itself cannot be used to change scanner protocols, but it provides access to offerings (e.g., Expert-i) which can be used to implement changes. Please contact your Siemens Healthineers representative for more details.
- <sup>3</sup> This application is only available as a beta release at the time of publication. Hence, it is subject to program-specific terms and conditions and its future availability cannot be guaranteed. For further information, please contact your local Siemens Healthineers representative.
- <sup>4</sup> Depends on data privacy configuration. Features are only available when the option "Reporting by operator" is set.

teamplay products and features are not commercially available in all countries. Due to regulatory reasons their future availability cannot be guaranteed. Please contact your local Siemens Healthineers organization for further details.

The information in this document contains general technical descriptions of specifications and options as well as standard and optional features that do not always have to be present in individual cases.

This whitepaper is meant to represent the current state of the teamplay performance management applications. Siemens Healthineers reserves the right to modify the design, packaging, specifications, and options described herein without prior notice. Please contact your local Siemens sales representative for the most current information.

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#### **Siemens Healthineers Headquarters**

Siemens Healthineers AG  
Siemensstr. 3  
91301 Forchheim, Germany  
Phone: +49 9191 18-0  
siemens-healthineers.com