Effect of digital-enabled multidisciplinary therapy conferences on efficiency and quality of the decision making in prostate cancer care

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ABSTRACT

Objectives To investigate the impact on efficiency and quality of preprostatectomy multidisciplinary therapy conferences (MDT) at Karolinska University Hospital related to the use of a digital solution compared with standard of care. Further, to explore whether gains in MDT efficiency and quality impact oncological or functional patient outcomes.

Methods We conducted a prospective, observational study of preoperative prostate cancer MDT at Karolinska between February 2017 and March 2021, including 1329 patients. We compared efficiency and quality of the standard MDT and the MDT using the digital solution IntelliSpace Precision Medicine Multidisciplinary Team Orchestrator (ISPM) based on the previously used MDT-MODe approach. Clinical and patient-reported functional outcomes were derived from the medical records and the Swedish National Prostate Cancer Register.

Results While ISPM was used during the MDT meeting, the time spent per patient was reduced by 24% (p<0.001) and most of the MDT-MODe items were scored significantly higher. There was a reduction in pelvic lymph-node dissection procedures in the ISPM cohort (p=0.001) and an increased proportion of unilateral nerve-sparing procedures (p=0.005), while all other outcome-related measures were not significantly different between the two patient groups.

Discussion and conclusion To increase the value of the MDT, all data relevant for treatment decision need to be purposefully presented and compiled, which also enables secondary use of the data. The use of a digital solution during preoperative MDTs for prostate cancer decision making at Karolinska University Hospital improved the efficiency and quality of this multidisciplinary team meeting without impacting patient outcomes.

INTRODUCTION

The multidisciplinary therapy conference (MDT) has become a corner stone of cancer care. Patients who are discussed in an MDT, where a team of hospital staff gather to summarise relevant data and decide on treatment recommendations, are more likely to receive appropriate staging and treatment plans, but it is unclear whether this also results in improved patient outcomes. Among parameters that may affect the value of an MDT, leadership, clarity of objectives, technical equipment for visualisation and electronic documentation, continuous audit of the process, access to complete case information and clarified roles of healthcare professionals have been identified as potentially vital prerequisites for a systematic MDT approach. The MDT often gathers a large number of health professionals, and, with more complex diagnostic and therapeutic options, the quality and efficiency of the decision-making process becomes increasingly important.
MDT conferences are rarely fully digitalised or adequately structured, which may affect the quality and efficiency of the decision-making process. Data are not compiled and presented visually in a structured way and clinical parameters are presented verbally, which may lead to delays in the discussion when information needs to be repeated. Lack of continuous access to the clinical parameters during the MDT session may lead to information loss and hamper the multidisciplinary character of the MDT, thereby increasing the risk of non-optimal treatment decisions. Moreover, if the consensus decisions are not captured in the electronic medical records (EMR) in real-time, this may lead to errors, misunderstandings and delay in data transfer to the EMR.

With the field of digital health evolving rapidly, solutions for MDTs have been developed and assessed. Structuring MDTs by use of such solutions has been shown to increase adherence to national guidelines and efficiency in several tumour forms.

To increase the MDT efficiency without compromising quality of patient care, multiple quality-assessment tools and discussion checklists have been developed. Whether these tools also positively impact patient outcomes remains unknown. In this study, we hypothesised that use of a digital, patient-centric, diagnosis-specific solution developed jointly by us (IntelliSpace Precision Medicine Multidisciplinary Team Orchestrator, further referred to as ‘ISPM’ throughout this text) during preprostatectomy MDTs at Karolinska University Hospital would improve the efficiency and quality of the MDT. The primary aim of the study was to investigate whether the use of the ISPM application saved meeting time and improved the quality of the decision process. The secondary aim was to assess whether the oncological and functional patient outcomes were affected by the implementation of ISPM.

**METHODS**

We have done a prospective observational cohort study comparing patient cohorts before and after the introduction of the clinical decision-support tool ISPM. The study was conducted between February 2017 and March 2021 at Karolinska University Hospital including patients discussed at preprostatectomy MDTs before undergoing robot-assisted radical prostatectomy.

**Study setting**

Hospital care in Sweden is entirely funded by taxes, and is therefore, as a rule, population based. Karolinska University Hospital is a Swedish tertiary referral hospital treating patients in all risk categories but with emphasis on high-risk patients referred from all regions of Sweden.

The weekly preprostatectomy MDT meeting is attended by 10–12 specialists in urology and radiology and aims to find a surgical strategy for an optimal balance between radical removal of the prostate cancer and postoperative functional outcomes.

Before we introduced ISPM, staff urologists took turns chairing the MDT, verbally reporting the clinical data from printed EMR excerpts, followed by a presentation of the MR images by a radiologist. The staff then discussed the optimal strategy for degree of nerve-sparing surgery, extent of sphincter sparing dissection in the apex, lymph-node dissection or not, degree of radicality in the bladder neck and the seminal vesicles. The concluded surgical treatment strategy plans were documented by the respective chair urologist in the EMR after the conference.

After the introduction of ISPM, all relevant clinical and radiological data were entered in the ISPM platform prior to the MDT meeting. In contrast to the baseline setting, clinical and radiological data were continuously visualised on the ISPM dashboard during the MDT meeting alongside the MR images until the surgery treatment plan had been captured in ISPM using the treatment plan documentation tool of the application (figure 1).

A baseline measurement in the standard MDT setting (before the use of ISPM) was carried out (February 2017–September 2019), and, consecutively, data were collected while ISPM was in use (October 2019–March 2021). The efficiency and quality of the MDTs was compared by timing the discussion and using a modified version of the Metric of Decision-Making (MDT-MODE). Nine items measuring quality were scored using a Likert scale (1, 3 and 5) with higher score indicating higher quality (for details of the modified version of the MDT-MODE used in this study, see online supplemental table 1).

We grouped the MDT-MODE items into two main categories: MDT-MODE items relating to the availability and presentation of decision-relevant data, and MDT-MODE items related to the efficiency of MDT execution and team member interaction. Two observers, not participating in the therapy discussion, took turns assigning the MDT-MODE scores. An inter-rater variability analysis was conducted by letting the two observers assign scores to the same MDTs on three separate occasions to ensure agreement.

**Software platform**

The ‘ISPM’ software solution enables preparing, scheduling, visualisation, presentation and documentation of information and decisions taken in MDT case discussions. Using SQL queries, the system collects and transforms structured and unstructured data from the hospital data lake into a prostate data model and stores the result into an FHIR database following SNOMED-CT codes. In the study implementation, variables of interest but not available in the research copy of the Karolinska data lake were manually entered in ISPM.

**Patient population**

In all, 924 patients were discussed at MDTs in the period February 2017–September 2019, before the implementation of the ISPM software (‘baseline’ cohort), and 405 at conferences between October 2019 and March 2021 using ISPM (‘ISPM’ cohort). Only patients undergoing prostatectomy as primary treatment for prostate cancer...
at Karolinska University Hospital within 30 days after their preoperative conference were included, to increase the likelihood that the conference decision was implemented. We assigned MDT-MODE scores to 164 baseline and 163 ISPM patients, at 21 and 22 MDTs, respectively.

**Oncological and functional patient outcomes**

All clinical and patient-reported outcome data were obtained from routinely collected clinical or quality follow-up data. Positive surgical margin (as sign of remaining cancer and hence non-radical treatment) was used as a surrogate for oncological quality with significant positive margin defined as at least three millimetres length. Other relevant postsurgical and perisurgical outcomes, such as extended lymph-node dissection, positive lymph nodes, and nerve-sparing surgery, were also analysed. Functional outcomes were obtained using the questionnaires in the Swedish National Prostate Cancer Register (NPCR) that all prostate cancer patients in Sweden are invited to answer before undergoing primary treatment and twelve months after treatment. The questionnaires are administered in collaboration with the Swedish Regional Cancer Centres and NPCR and can be found at https://npcr.se/eprom/dokument. In this study, we defined urinary continence as ‘use of less than one protective urinary pad per day’ and urinary incontinence as ‘use of one or more protective urinary pad per day’. Erectile function was measured using the International Index of Erectile Function questionnaire (IIEF-5)\(^\text{11}\) with erectile dysfunction defined as less than 12 points. Quality of life regarding ‘erectile function satisfaction and continence satisfaction’ was defined as a self-report of either not bothering the patient at all or only to a small degree. Tumour grade was scored using ISUP grading.\(^\text{12}\)

**Statistical analysis**

In tables 1 and 2 (and online supplemental table 2,3), comparisons of the characteristics of the studied population with respect to the use of ISPM at MDTs were structured according to the following: the distributions of numerical variables or ordinal variables with more than two levels were compared using the Mann-Whitney U test. The distributions of categorical variables with more than two categories were compared using the \(\chi^2\) test, whereas the distributions of categorical variables with two categories where one category was identified as the outcome of interest were compared in terms of prevalence ratios and the likelihood ratio test associated with an estimated log-binomial model. Levene’s test, centred at the median, was used to assess the difference in variance between non-normally distributed variables.

For figures 2A and 3A–3D, the distributions of ordinal variables were compared using the Mann-Whitney U test. For figure 2B, the association between the usage of ISPM and the duration of discussion for each individual patient at the MDTs was studied using a linear regression model including the number of patients evaluated at a conference, the usage of ISPM and their interaction as explanatory variables.
All calculations were performed in R V.4.0.0.
We have used the SQUIRE 2.0 (Standards for QUality Improvement Reporting Excellence) guidelines in preparation for this manuscript.13

RESULTS
Patient cohorts
The two cohorts (baseline and ISPM) were similar with respect to demographic and clinical characteristics, mean patient age, postoperative ISUP grade group, tumour stage, and erectile function (table 1). The response rate to the NPCR questionnaires measuring preoperative functional status was significantly higher among patients discussed using the ISPM solution, 70.9% vs 32.6% when ISPM was not used (p<0.001). Among those who responded, incontinence was more common in the baseline group, but the difference was small in absolute numbers, 3.4% (10 out of 298 patients) compared with 0.3% (1 out of 287 patients).

Time efficiency of the MDT
The average time spent discussing each patient was 24% shorter in the ISPM compared with the baseline setting (3.8 vs 5.0 min; p<0.001; figure 2A). There was also a significant difference in variances between comparison

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Patient demographics of the baseline versus the ISPM cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>No of patients</td>
<td>n=924 (69.5%)</td>
</tr>
<tr>
<td>No of patients in MDT-MODE</td>
<td>n=164 (50.2%)</td>
</tr>
<tr>
<td>No of patients per conference</td>
<td>Mean=7.8 (SD=2.9)</td>
</tr>
<tr>
<td>No of staff per conference</td>
<td>Mean=11.7 (SD=2.7)</td>
</tr>
<tr>
<td>Patient age (years)</td>
<td>Mean=65.5 (SD=7.4)</td>
</tr>
<tr>
<td>Postoperative ISUP grade group</td>
<td></td>
</tr>
<tr>
<td>ISUP 1</td>
<td>74 (8.3%)</td>
</tr>
<tr>
<td>ISUP 2</td>
<td>424 (47.6%)</td>
</tr>
<tr>
<td>ISUP 3</td>
<td>274 (30.8%)</td>
</tr>
<tr>
<td>ISUP 4</td>
<td>44 (4.9%)</td>
</tr>
<tr>
<td>ISUP 5</td>
<td>74 (8.3%)</td>
</tr>
<tr>
<td>Missing*</td>
<td>34 (3.7%)</td>
</tr>
<tr>
<td>Postoperative T stage (pT)</td>
<td></td>
</tr>
<tr>
<td>pT2</td>
<td>535 (59.8%)</td>
</tr>
<tr>
<td>pT3a</td>
<td>258 (28.8%)</td>
</tr>
<tr>
<td>pT3b</td>
<td>100 (11.2%)</td>
</tr>
<tr>
<td>pT4</td>
<td>2 (0.2%)</td>
</tr>
<tr>
<td>Missing*</td>
<td>29 (3.1%)</td>
</tr>
<tr>
<td>Preoperative incontinence</td>
<td></td>
</tr>
<tr>
<td>Continent</td>
<td>296 (96.7%)</td>
</tr>
<tr>
<td>Incontinent</td>
<td>10 (3.3%)</td>
</tr>
<tr>
<td>Missing*</td>
<td>618 (66.9%)</td>
</tr>
<tr>
<td>Preoperative IIEF-5 score</td>
<td></td>
</tr>
<tr>
<td>Mean=14.2 (SD=9.5) (#missing*=618 (66.9%))</td>
<td>Mean=14.4 (SD=9.6) (#missing*=122 (30.1%))</td>
</tr>
<tr>
<td>Preoperative erectile dysfunction - outcome: impotence (IIEF-5 score &lt;12)</td>
<td></td>
</tr>
<tr>
<td>Frequencies</td>
<td>133/306 (43.5%) (#missing*=618 (66.9%))</td>
</tr>
<tr>
<td>Prevalence ratios</td>
<td>1.0 (Ref.)</td>
</tr>
<tr>
<td>Response frequency to preoperative questionnaire</td>
<td>309 (33.4%)</td>
</tr>
</tbody>
</table>

*Percentage missing calculated on the entire cohort.
IIEF-5, International Index of Erectile Function questionnaire; ISPM, IntelliSpace Precision Medicine Multidisciplinary Team Orchestrator; ISUP, International Society of Urological Pathology; LRT, likelihood ratio test; MDT, multidisciplinary therapy conference; M-W, Mann-Whitney U test.
groups (Levene’s test; p<0.001), indicating a more predictive duration per patient when using ISPM. During the baseline period, the time spent discussing each patient decreased with increasing number of cases in the meeting (Pearson correlation=−0.23; p=0.04). During the ISPM period, there was no such significant correlation (Pearson correlation=−0.075; p=0.36; figure 2B).

Quality of the MDT
There were higher MDT-MODE scores for the information presentation items psychosocial, comorbidity (p<0.01) and pathology (p<0.05) during the ISPM period, while there was no difference in the presentation of patient’s views, imaging, and patient history (figure 3A). Team interaction items regarding quality of leadership (Chair) and contribution of specialty (Members) also received higher scores in the ISPM setting (p<0.001; figure 3B). Furthermore, the fraction of participants actively taking part in the MDT discussion increased using ISPM (p<0.05; figure 3C). Moreover, we observed that there were significantly fewer questions on already presented data raised in the meeting while ISPM was in use (p<0.01; figure 3D).

Oncological and functional outcomes
There was no statistically significant difference with respect to oncological outcomes between the baseline and the ISPM cohorts. The proportion of men with positive surgical margins was 27.7% in the baseline group and 25.9% in the ISPM group (p=0.66; table 2; online supplemental table 2).

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Oncological, perioperative and 12-month functional (urinary, sexual) patient outcomes of the baseline versus the ISPM patient cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td><strong>ISPM</strong></td>
</tr>
<tr>
<td>Positive surgical margin</td>
<td>251/906 (27.7%) (#missing=18 (1.9%))</td>
</tr>
<tr>
<td>Frequencies</td>
<td>251/906 (27.7%) (#missing=18 (1.9%))</td>
</tr>
<tr>
<td>Prevalence ratios</td>
<td>1.0 (Ref.)</td>
</tr>
<tr>
<td>Nerve-sparing— any</td>
<td>805 (88.2%)</td>
</tr>
<tr>
<td>Any nerve-sparing</td>
<td>805 (88.2%)</td>
</tr>
<tr>
<td>No nerve-sparing</td>
<td>108 (11.8%)</td>
</tr>
<tr>
<td>Missing*</td>
<td>11 (1.2%)</td>
</tr>
<tr>
<td>Nerve-sparing unilaterally or bilaterally— dichotomised, with pairwise comparisons</td>
<td>140 (36.2%)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>392 (42.9%)</td>
</tr>
<tr>
<td>Unilateral</td>
<td>413 (45.2%)</td>
</tr>
<tr>
<td>No nerve-sparing</td>
<td>108 (11.8%)</td>
</tr>
<tr>
<td>Missing*</td>
<td>11 (1.2%)</td>
</tr>
<tr>
<td>Pelvic lymph-node dissection</td>
<td>543 (60.0%)</td>
</tr>
<tr>
<td>No</td>
<td>543 (60.0%)</td>
</tr>
<tr>
<td>Yes</td>
<td>362 (40.0%)</td>
</tr>
<tr>
<td>Missing*</td>
<td>19 (2.1%)</td>
</tr>
<tr>
<td>Lymph-node metastases among patients that underwent pelvic lymph-node dissection</td>
<td>88 (83.0%)</td>
</tr>
<tr>
<td>No (N0)</td>
<td>302 (83.4%)</td>
</tr>
<tr>
<td>Yes (N1)</td>
<td>60 (16.6%)</td>
</tr>
<tr>
<td>Missing*</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Erectile dysfunction at 12 months after surgery— outcome: impotence (IIEF-5 score &lt;12)</td>
<td>172/229 (75.1%) (#missing* =176 (43.5%))</td>
</tr>
<tr>
<td>Frequencies</td>
<td>172/229 (75.1%) (#missing* =176 (43.5%))</td>
</tr>
<tr>
<td>Prevalence ratios</td>
<td>1.0 (Ref.)</td>
</tr>
<tr>
<td>Incontinence at 12 months after surgery— outcome: incontinence</td>
<td>171/619 (27.6%) (#missing* =305 (33.0 %))</td>
</tr>
<tr>
<td>Frequencies</td>
<td>64/231 (27.7%) (#missing* =174 (43.0%))</td>
</tr>
<tr>
<td>Prevalence ratios</td>
<td>1.0 (Ref.)</td>
</tr>
</tbody>
</table>

*Percentage missing calculated on the entire cohort.
†Pairwise comparison; Bonferroni-Holm corrected for multiple testing.
IIEF-5, International Index of Erectile Function; ISPM, IntelliSpace Precision Medicine Multidisciplinary Team Orchestrator; LRT, likelihood ratio test; M-W, Mann-Whitney U test.
Figure 2  A Time spent in the MDT meeting per patient in the baseline setting (164 patients) versus the ISPM setting (163 patients). Box plot with median and IQR; whiskers denote ±1.5×IQR. ***P<0.001 (B): interaction between mean time (minutes) spent per patient and number of patients scheduled and discussed during the MDT. Dots indicate the mean durations at conferences with a particular number of patients being discussed. Regression lines are derived from 164 (baseline) and 163 (ISPM) patients per group. ISPM, IntelliSpace Precision Medicine Multidisciplinary Team Orchestrator; MDT, multidisciplinary therapy conference.

Figure 3  MDT-MODE items concerning information presentation. *P<0.05, **P<0.01. (B) MDT-MODE items concerning leadership and team interaction. ***P<0.001. (C) Percentage of staff members actively participating per patient case discussion and decision making in the MDT. *P<0.05 (D) Percentage of patients for which questions were raised during the MDT meeting to repeat already presented information. **P<0.01. ISPM, IntelliSpace Precision Medicine Multidisciplinary Team Orchestrator; MDT, multidisciplinary therapy conference; MDT-MODE, Metric of Decision-Making.
The overall frequency of nerve-sparing and non-nerve-
sparing surgery was virtually similar in the comparison
groups, but the patterns differed slightly with more
unilateral nerve-sparing surgery in the ISPM group and
more bilateral nerve-sparing and non-nerve-sparing in
the baseline group (table 2).

An extended pelvic lymph-node dissection was carried
out more often in the baseline cohort, 39.1% vs 26.4%
for the ISPM cohort, respectively (p=0.001; table 2), but
there was no difference in proportion of histologically
confirmed metastases (16.6% in the baseline vs 17.0% in
the ISPM cohort; p=0.92; table 2).

The functional outcomes 1 year after surgery were
similar for the two groups. Erectile dysfunction (IIEF-5
score <12) at 12 months was present among 74.4% (base-
line) and 75.1% (ISPM) (p=0.90; table 2) of patients, and
incontinence (daily use of one or more urinary pads)
was present among 27.6% (baseline) and 27.7% (ISPM)
(p=0.98; table 2; online supplemental table 3).

DISCUSSION

We found that implementing ISPM in a multidisciplinary
tumour conference was associated with increased effi-
ciency of the conference and less time needed to discuss
each patient case. The results also indicated that the vari-
ability of the length of each case discussion was reduced
with the use of ISPM. At the same time, the quality of the
teamwork and the decision-making process was improved
with the use of ISPM. These improvements were not,
however, reflected in improved oncological or functional
patient outcomes.

Using ISPM, discussing one patient took on average 72 s
less, which corresponds to a 24% reduction, or approxi-
ately 9–10 min shorter MDT in the current setting.
Considering that there was a mean of 11.6 participants,
more than one person-hour was saved during each
session. This time saving is in agreement with results from
another group developing a similar oncological clinical
decision support system for other cancer types.8 14

MDTs are in general scheduled events with a finite
duration while the number of patient cases fluctuates and
a structured process for the presentation and discussion of
each case is paramount for retaining the quality of the
decision making throughout the conference. We found
both decreased variability of the duration of each case
discussion and a consistent duration per case regardless of
the number of patients discussed at the conference,
indicating that the use of ISPM leads to a more structured
and predictable process.

Although the quality of the MDTs increased when ISPM
was used, this was not reflected in improved oncological
or functional patient outcomes in our data. It should
be noted that, already prior to the implementation of
ISPM, the format of the preoperative prostate-cancer
MDTs at Karolinska had been structuralised—although
not into a digital format—with an apparent effect on the
nerve-sparing strategy as well as on the risk of positive
surgical margins.15

While it has been shown that MDTs lead to more accu-
rate staging,16 higher adherence to clinical guidelines,17
and shorter time to treatment after diagnosis,18 several
prior studies have failed to show improved outcome
among patients discussed in MDT meetings19–21 while
other have reported better outcomes.22–24 The MDT is
a costly process, and it is important that future studies
justify the costs through evidence of better outcomes.

A structured digital format for the MDT entails several
potential further advantages apart from efficiency and
quality in the decision making. For example, the resulting
database can be used for real-time quality assessment, feed-
back to pathologists, radiologists, surgeons and radiother-
apists. Also, it enables development of prognostic models
for better prediction tailored to the centres’ own patient
cohorts. Patient-reported outcome measures can be used
in the communication with the patient during follow-up
for a more structured care of the side effects of treatment
and for spending more time with the patient on solving
problems rather than understanding them. None of these
advantages were assessed in this study but are all strong
potential benefits of a digital platform such as ISPM.

Without simultaneous evaluation of positive surgical
margins and functional outcomes, quality assessment of
prostate cancer surgery is of little use since there is a
reciprocal relation between radicality and postoperative
function. Digital platforms connecting data points on all
dimensions will facilitate more precise quality assessment.
Ultimately, applying deep learning to make fuller use of
these rich clinical, morphological and patient-reported
data is a promising future development.

The main limitation of this study is the observational
design with non-concurrent comparison groups. The
baseline measurement was carried out over a period of 33
months before the ISPM solution was implemented. Both
treatment and outcome of prostate cancer change over
time25 and differences between the baseline and ISPM
periods may be attributable to other time-varying factors,
such as staff turnover. Furthermore, the lower frequency
of pelvic lymph-node dissections in the ISPM period may,
apart from a true effect of using the digital platform, be
due to subtle changes in our operative indications for the
procedure.

Access to patient-reported data is a major clinical need
in healthcare in general, but particularly in the care of
prostate cancer. The response rate to preoperative ques-
tionnaires was low in the baseline group, 32.6% compared
with 70.9% the ISPM group. This difference reflects our
effort made during the study period to increase patient
participation in the national questionnaires on functional
outcome rather than an effect of the digital platform.

Conclusion

Our implementation of the ISPM clinical decision
support system in MDT sessions at Karolinska University
Hospital was associated with more efficient presentations
and decision making in the conference as well as higher perceived quality of the decision process, but not with improved patient outcomes.

**Contributors** RH, MdS-K, FJ, PV, HH, MJ, OA and PHV conceived the study; RH, PV, OA and PHV wrote the study plan with input from ER, FJ, HH, MJ, ER, RH, MdS-K, FJ, PV, HH, MJ, OA and PHV contributed to the design of the software; ER, VS, FJ, PV, MdS-K, PHV collected the data; ER, VS, PHV performed the statistical analyses with input from RH, MCGW; ER, MCGW drafted the manuscript; all coauthors contributed substantially to the revision of the manuscript and approved the final version; ER and RH contributed equally to this paper; OA is principal investigator of the clinical study and guarantor of the work.

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**Competing interests** RH, MdS-K, PV, MCGW, HH and MJ are employees of Philips Research, Eindhoven, Netherlands.

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