Research Article

A New Software Platform to Improve Multidisciplinary Tumor Board Workflows and User Satisfaction: A Pilot Study

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Abstract

Background: Workflow and preparation for holding multidisciplinary cancer case reviews (i.e., Tumor Boards) is time-consuming and cumbersome. Use of a software platform might improve this process. This pilot study assessed the impact of a new software platform on tumor board preparation workflow and user satisfaction compared to current methods. **Materials and Methods:** Using current methods and the NAVIFY Tumor Board Solution, this study assessed the number of tasks and time to prepare tumor board cases. Participants completed online surveys assessing ease of use and satisfaction with current and new platforms. **Results:** A total of 41 sessions included two surgeons, two oncologists, two pathologists, and two radiologists preparing tumor board cases with 734 tasks were recorded. Overall, there was no difference in the number of tasks using either preparation method (341 current, 393 NAVIFY Tumor Board solution). There was a significant difference in overall preparation time as a function of specialty ($F = 71.74$, $P < 0.0001$), with oncologists, radiologists, and surgeons having reduced times with NAVIFY Tumor Board solution compared to the current platform and pathologists having equivalent times. There was a significant difference ($F = 38.98$, $P < 0.0001$) for times as a function of task category. Review of clinical course data and other preparation tasks decreased significantly, but pathology and radiology review did not differ significantly. The new platform received higher ratings than the current methods on all survey questions regarding the ease of use and satisfaction. **Conclusions:** The study supported the hypothesis that the new software platform can improve Tumor Board preparation. Further study is needed to assess the impact of this platform in different hospitals, different data storage systems, with different observers, and different types of Tumor board cases as well as its impact on the quality of the tumor board discussion.

Keywords: Software platform, task analysis, tumor board preparation, user satisfaction

Introduction

Multidisciplinary clinical care teams regularly convene oncology tumor board meetings (“Tumor Boards”) in which multiple specialist physicians collaboratively review individual patient cases and make clinical care decisions.[1-3] Clinicians use tumor boards to gain a holistic understanding of each patient’s medical status for decision-making and to ensure agreement within a clinical care team regarding the patient care and treatment options. They are also used for educational purposes. The clinical data presented during Tumor Boards may be generated or selected for review by an oncologist, radiologist, pathologist, surgeon, radiation oncologist, nurse, social worker, or other members of a clinical care team. Each of the participating members assembles their respective supporting data to present at the Tumor Board.

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A recent survey by the American Society of Clinical Oncology[4] found that, even internationally, Tumor Boards are commonplace. The majority of survey respondents (96%) was reported as an overall benefit for their patients and noted that they also have high-educational value. This survey also asked for suggestions to improve Tumor Boards. Improving infrastructure, including advanced systems to facilitate documentation, was one of the top suggestions, as the workflow and preparation process for Tumor Boards can often be time-consuming and cumbersome.

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One of the difficulties with the current preparation process is that typically, information resides in disparate or isolated hospital databases or source systems (e.g., electronic medical record [EMR], laboratory information system [LIS], picture archiving, and communication system [PACS]).[5,6] Data must be gathered from each system and compiled in a presentable format in anticipation of a Tumor Board. Clinicians generally assemble such information in isolation from each other before the Tumor Board. This creates challenges such as potential miscommunication, overlooked or duplicate information, or not using the most current information. These, and other potential workflow inefficiencies caused by the current Tumor Board process, often lead to an increased burden on the clinical care team. They can also prolong the time needed to determine what treatment plan is most appropriate for a patient. Structural and functional components associated with Tumor Boards may also contribute to the mixed evidence and opinions regarding the impact of Tumor Boards on the patient care and/or outcomes improvement.[7-15]

There is increasing evidence that health information technology (HIT) can help transform current data collection processes to be more efficient and effective by providing the right tools.[16-18] There have been a variety of proposed HIT-based solutions for improving patient data management and workflow associated with multidisciplinary access and use. However, each often addresses a specific aspect of the process or deals with only a specific application area. For example, Meier *et al*. designed a multimedia electronic patient record called "oncoflow" for head-and-neck tumor therapy; however, it was not specifically designed for Tumor Boards.[19]

According to Mangesius *et al*., one of the limitations of many tumor boards is the diversity of ways in which they are conducted and workflows used.[20] There is very little standardization functionally or technically even within institutions. IT frameworks and solutions could readily overcome many of the challenges of accessing, collecting, organizing, and presenting information for tumor boards. Krauss *et al*. also noted the great diversity in settings and protocols for multidisciplinary team meetings. They concluded that a unified workflow model may be difficult to achieve, but research on technical solutions and process interoperability may help.[21] For example, Farrugia *et al*. noted that simply utilizing a documentation template in multidisciplinary breast cancer meetings led to an increase in recorded adherence to national guidelines.[22] Luck *et al*., also noted that developing and providing dedicated toolkits for peer-to-peer collaborations (including tumor boards) and data sharing can effectively leverage HIT to improve patient care.[23]

The NAVIFY Tumor Board solution is an oncology informatics platform (Roche Diagnostics Information Solutions; Belmont, CA) that addresses these issues. It facilitates the extraction of key data from clinical source data systems and presents holistic, relevant information to clinicians during case preparation, in intuitive workflows at the point-of-care. To demonstrate its value for key stakeholders considering its adoption into clinical practice to prepare for multidisciplinary Tumor Boards, The impact of the platform on workflow and user acceptance needs to be assessed. The goal of this pilot study was to conduct a preliminary assessment of the impact of NAVIFY Tumor Board solution in the preparation of Tumor Board cases compared to the current method(s) of preparing cases for review. In this paper, we highlight some of the aspects particularly of interest to pathologists. Although the NAVIFY Tumor Board solution platform is designed to facilitate the entire Tumor Board process from case preparation to the actual case presentation, this study did not assess the impact of the software platform on those components. These can be examined in future studies.

Materials and Methods

Current tumor board preparation process

This study was conducted at the Hospital del Mar (Barcelona, Spain). It focused on breast cancer as a model since 100% of breast cancer cases are presented at the Tumor Board. Theoretically, each specialist has access to all types of required data and images. However, what they access and how they do so typically differs by specialty, the individual specialist, and the specific case being prepared. In general, surgeons and/or oncologists prepare for Tumor Board mainly by reviewing previous clinical notes and clinical tests available. Radiologists generally review mammograms, ultrasound, magnetic resonance, and positron emission tomography/computed tomography, for relevant findings. Pathologists typically review the excision/biopsy slides and/or results, biomarker status, and other relevant data. Only whole slide images (WSIs) were used in this study because Hospital del Mar breast pathology slides are always scanned. Glass slides could be reviewed as well if available and preferred.

Currently, each specialist reviews independently and aggregates relevant information in various media. This includes paper-based notes, computer-printed documents, screenshots, and PowerPoint files with images and information copy/pasted into the presentation document.

Software platform

The NAVIFY Tumor Board solution provides an end-to-end, collaborative workflow that enables coordinating, scheduling, preparing, presenting and documenting information for multidisciplinary Tumor Boards [Figure 1]. Rather than having clinicians search for relevant clinical data in disparate EMR, PACS, LIS, digital pathology, and other hospital IT systems, the software provides summarized data that reduce manual data consolidation efforts. A longitudinal timeline view that includes relevant tests, imaging studies, biopsies, genomic tests, and procedures is created. Each timeline element contains a full report with accompanying structured data. Contextual links to source IT systems are integrated within the software to improve ease of access and search time. The timelines can be filtered by categories (e.g., radiology, pathology, molecular). The software includes the ability to comment on images and

reports in a dialog module, allowing users to communicate with each other as they prepare cases.

The software platform is not designed to replace existing software tools and viewers for digital pathology or radiology diagnostic interpretations. It does contain viewers that have many of the functions of these other viewers but are tailored to the specific tasks involved in Tumor Board preparation [Figure 2 for an example pathology image presentation]. For optimal performance and impact, the platform relies on digital pathology (WSIs) and radiology acquisition and storage systems being in place. For example, in the version used in this study the user could open the Virtuoso (Ventana Medical Systems) WSI viewer directly from the patient review mode.

Clinicians can identify and save relevant clinical patient information, radiographic studies, digital pathology images and reports (WSIs or gross images if relevant), and other relevant data. Clinicians can add notations to patient reports, as well as to pathology and radiology images. The Pilot software did not have anonymization/de-identification functionality; however, future versions of the software will have this functionality available. Rather than creating PowerPoint files that reside on thumb drives or servers that are not added to the EMR, NAVIFY Tumor Board solution (NTBS) automatically archives the collated data. The therapeutic decisions and follow-up steps can be documented, saved, and added to the EMR.

To fully enable end-to-end Tumor Board workflow, the NAVIFY Tumor Board solution has the capability to connect to a wide range of hospital IT systems (e.g., EMR, PACS, Pathology [AP/CP] LIS, and Molecular Dx). It can also incorporate PowerPoint, text, PDFs, JPEG images, and other data elements. The data flow from these systems is unidirectional and/or bidirectional depending on the local infrastructure. Data flows are near real-time as supported by the data integration infrastructure. Data flow is supported by an integration layer that sits between the hospital IT systems and the NAVIFY Tumor Board solution. The integration layer provides connectivity to hospital IT endpoints, connecting to web services, HL7 feeds, and other standard data feeds. Once it ingests the data, it parses the relevant data fields and then maps the data to a canonical data model that can be interpreted by Tumor Board users.

Participants and observations

The study included observation of two surgeons, two oncologists, two pathologists, and two radiologists that regularly participate in the Hospital del Mar Breast Cancer Tumor Board. Three research technicians, trained on how to record the data, observed the clinicians in two sessions without interfering with their workflow. The technicians used a database application with a list of task activities typically carried out by clinicians preparing for tumor board presentations using current methods (see below). The technicians noted, for each case and each clinician, which tasks were carried out along with the respective start and end times. These data were used to calculate the number of tasks engaged in for each case, total case preparation time, and the time spent on each task activity using the current and NAVIFY Tumor Board solution methods. When tasks not on the list occurred, they were recorded as "other" and timed. Data were collected over an 11-month period from November 2015 to September 2016.

Study design

This was an observational study to characterize Tumor Board preparation in current routine practice compared to preparation using the NAVIFY Tumor Board solution. To maximize statistical power and to reduce possible confounds due to case variations, each clinician, in a real practice scenario, compiled the same set of cases for Tumor Board once using their current methods and once with the NAVIFY Tumor Board solution. In order not introduce bias, all cases were first compiled in the traditional way then with the NAVIFY Tumor Board solution. A wash-out period of at least 4 weeks passed between sessions which is adequate to reduce recall effects.[24] Participants received training on how to use the NAVIFY Tumor Board solution system before the actual study. For the study, they were instructed to prepare each case for a Tumor Board presentation using the respective preparation methods (current vs. NAVIFY Tumor Board solution). In both scenarios, the goal was the same (to generate case materials for Tumor Board). However, since each method affords different

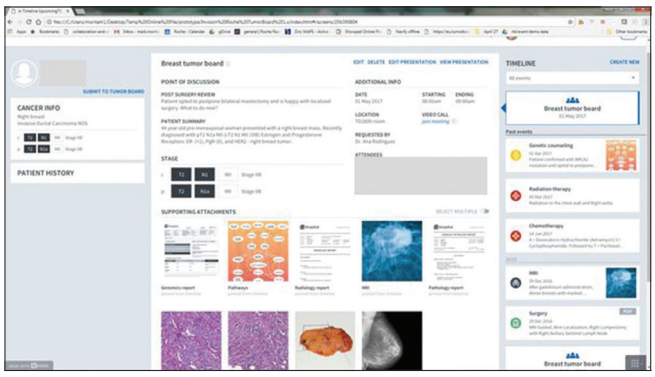

Figure 1: Screenshot of the NAVIFY Tumor Board Solution user interface showing the various types of data and images available to users plus timeline information

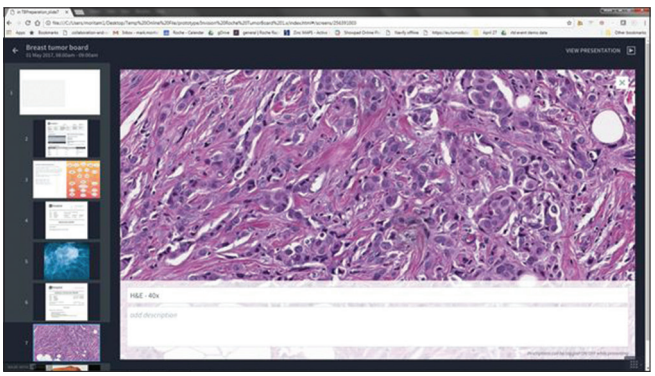

Figure 2: Example of a pathology image displayed in the NAVIFY Tumor Board Solution interface

ways to access and manipulate the various data and image elements, each user's interaction and tasks executed with each method differed as a function of the case being prepared and the users' approach to the case at a given point in time.

The study was approved by the Hospital del Mar Ethics Board and fulfilled the law of protection of personal data (15/1999). Throughout the study, data were collected, de-identified, coded, and analyzed anonymously.

As noted above, the research team (LG) initially observed the case preparation process of Tumor Board participants at the Hospital del Mar and developed a list of common case preparation tasks/activities. From this list, a data collection form was developed by consensus for standardized data capture that minimized variation in identification and timing during the study observations by the three technicians. For example, the most common tasks observed for pathologists using the current method are listed below in Table 1. Note that it includes more "clerical" tasks such as checking the list of patients as well as the more clinical tasks such as viewing the pathology images. These are considered "other" tasks. Similar tasks were identified for the oncologists, radiologists and surgeons. The tasks lists were updated for case preparation with the NAVIFY Tumor Board solution. Each task/activity may or may not have been needed for every case Engagement in a given task varied by participant and case, and any additional tasks were noted and timed.

Table 1: List of possible tasks/activities pathologists typically engage in using the current method for preparing for tumor boards

Email the case manager (nurse) with ID for presentation in TB
Receive a list of patients that will be presented in the next TB via email
Check the list of patients
Copy/paste ID from email into LIS
Review pathology report
Review slides (WSI and/or glass*)
Check and select most relevant images from WSI and/or glass slides
Most important data to review: Type of tumor, margin status, lymph node status, pathological stage
Copy/paste ID from email into EMR
Go to clinical notes section
Review last clinical course and revise notes about patient
Relevant data in clinical course: age, gender, background, current problem(s), physical exam, treatments
Go to clinical test tab of EMR
Go to radiology test tab of EMR to review radiology images and reports
Review blood analytics
If difficult or interesting case requiring input consult with specialist
Review available guidelines (hospital portal, literature, etc.)
Review literature (Hospital Portal, PubMed, Books, etc.)
Determine if more tests are pending
Communicates directly with specialist
Order more tests
Case prepared for the TB

*Only WSI were used in this study because Hospital del Mar breast pathology slides are always scanned. Glass slides could be reviewed as well if available and preferred. TB: Tumor board, LIS: Laboratory Information System, WSI: Whole slide images, EMR: Electronic medical record

Prior to the study, participants were asked to complete an online survey (developed using Qualtrics (Provo, UT)) assessing ease of use and satisfaction with their current method of preparing for Tumor Boards. The questions used a 5-point rating scale ranging from "Extremely easy" to "Extremely difficult" with an added option of "I do not use/access." They were also asked to indicate how many cases they usually prepare for a typical Tumor Board session and how long they spend. After using the new software platform, they were asked to complete a survey addressing the same items regarding the use of the software solution.

Statistical analyzes

The analysis of the task/activity data used a repeated measures Analysis of variance (ANOVA) to compare case preparation time as a function of task and role (surgeon, radiologist, oncologist, and pathologist) with and without the NAVIFY Tumor Board solution. Wilcoxon Signed Rank tests were used to compare responses to the survey questions. $P < 0.05$ was considered statistically significant.

Results

The data collection period included 41 observation sessions reviewing the same cases in the traditional manner and with the NAVIFY Tumor Board solution (radiologists = 8; pathologists = 12; surgeons = 14; oncologists = 7). Overall, there were 734 individual tasks recorded in the 41 sessions, with no significant difference as a function of method used (341 with current method, 393 with NAVIFY Tumor Board solution). There was, however, a significant difference in the number of individual tasks as a function of specialty ($\chi^2 = 11.35$, $P = 0.01$). Oncologists completed 47 versus 41 tasks, pathologists 86 versus 75, radiologists 128 versus 145, and surgeons 80 versus 132. The types of tasks differed as well. Pathologists primarily reviewed pathology data in both platforms but did not review radiology data at all. Radiologists engaged in all tasks, but primarily reviewed radiology tests. Oncologists and surgeons engaged in all tasks but primarily reviewed clinical course information.

To facilitate subsequent analyzes, groups of individual tasks that were most common to all specialties were categorized into three major categories as follows: review clinical course, review pathology, and review radiology. A fourth category captured all other tasks not related to these three categories [e.g., the first three tasks in Table 1]. Figure 3 shows how the number of tasks performed during case preparation with the current and NAVIFY Tumor Board solution methods varied as a function of specialty.

For the first analysis, for paired cases that each clinician read (current and NAVIFY Tumor Board solution methods) the total times for case preparation were compared with a repeated measures ANOVA using specialty as the independent

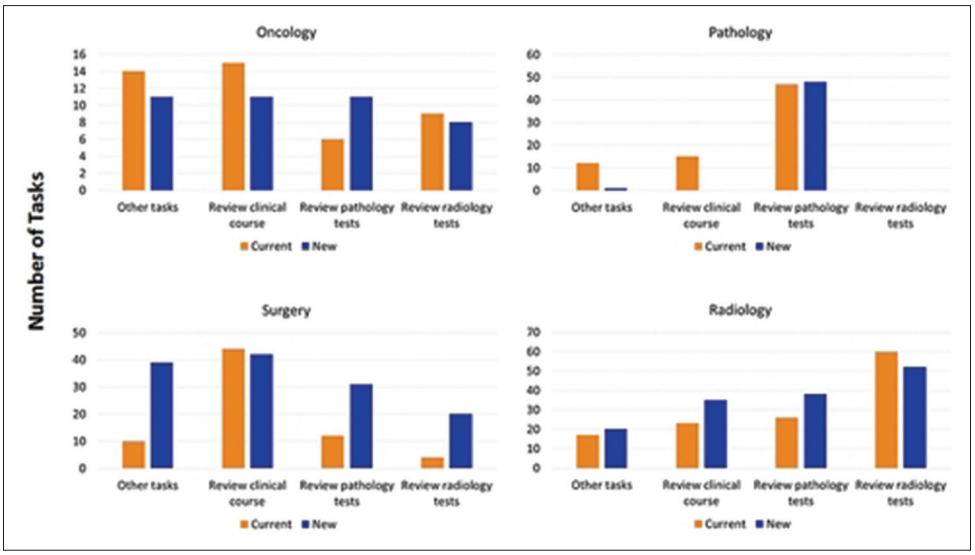

Figure 3: Number of tasks for current versus NAVIFY Tumor Board Solution methods by specialty

variable. There was a significant difference as a function of specialty ($F = 71.74$, $P < 0.0001$), with oncologists, radiologists and surgeons having reduced times with the NAVIFY Tumor Board solution compared to the current method. Pathologists had equivalent times [Figure 4 and Table 2].

The second analysis examined paired preparation times using task category (review clinical course, review pathology tests, review radiology tests, and other preparation tasks) as the independent variable. This analysis included the instances where tasks were performed using one method but not the other (zero time) (which occurred both ways – sometimes a task would be done with the current method but not the NAVIFY Tumor Board solution and sometimes vice-versa). There was a significant difference ($F = 38.98$, $P < 0.0001$) for times as a function of task category. While review of clinical course data and other preparation tasks decreased significantly, pathology and radiology review did not differ significantly [Table 3].

According to the results of the survey regarding typical Tumor Board experience using the current method, 50% typically prepare 4–6 cases per Tumor Board, 38% 1–3 cases, and 12% 7–10. The average time spent to prepare each case was 1–2 min for 25% of participants, 5–10 min for 63%, and more than 10 min for 12%. It should be noted that these times were self-reported and thus may not represent true case preparation times. They are also specific to breast cancer case preparation so may differ for other types of case preparations.

The results of the surveys on specific aspects of Tumor Board preparation before and after use of the software solution are shown in Table 4. A negative *Z*-value indicates that the NAVIFY Tumor Board solution was ranked higher than the current process. If responses were missing (e.g., pathologists not reviewing radiology images) the data were excluded from the analysis. Results for overall satisfaction across participants are shown in Figure 5.

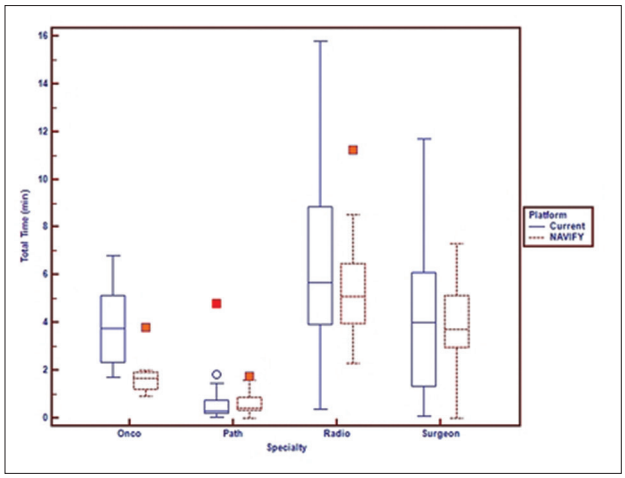

Figure 4: Box plots for total case preparation time using current and NAVIFY Tumor Board Solution methods as a function of specialty

Conclusions

Overall, using the NAVIFY Tumor Board solution for Tumor Board case preparation resulted in reduced or similar time to prepare cases, even though the number of tasks performed did not differ significantly. This is in-line with other studies that have introduced HIT into the Tumor Board preparation process.[16-19,22] It is interesting that overall in both modes (current and NAVIFY Tumor Board solution) case preparation times were generally >10 min. There could be a variety of explanations for this as one might expect it to take longer. It could be due to the fact that we only included breast cancer cases and the clinicians are so used to preparing these cases (as 100% are presented at Tumor Board) that their data collection and compilation routines are fairly well established. It could also be that since they are so well established, they often do not engage in much in-depth analysis of the various case components (e.g., reading pathology and radiology

Table 2: Mean and standard deviation values for overall case preparation time (min) as a function of specialty for current process versus NAVIFY tumor board solution

Specialist	Mean (SD)		
	Current process (min)	NTBS (min)	Difference in duration (min)
Oncologist	3.87 (1.79)	1.80 (0.89)	−2.07 (1.58)
Pathologist	0.54 (0.73)	0.60 (0.40)	0.06 (0.83)
Radiologist	6.27 (3.77)	5.49 (2.11)	−0.78 (3.84)
Surgeon	4.16 (3.11)	3.84 (1.71)	−0.31 (3.09)

SD: Standard deviation, NTBS: NAVIFY Tumor Board solution

Table 3: Mean and standard deviation values for task durations (minutes) as a function of task and current versus the new software solution

Task	Mean (SD)		
	Current process (min)	NTBS (min)	Difference (min)
Review radiology	2.48 (3.12)	2.73 (1.98)	−0.21 (1.46)
Review pathology	0.49 (0.75)	0.67 (0.41)	0.18 (0.86)
Review clinical course	1.65 (2.44)	0.85 (0.83)	−0.80 (2.38)
Other preparation tasks	0.71 (1.14)	0.49 (0.79)	−0.21 (1.46)

SD: Standard deviation, NTBS: NAVIFY Tumor Board solution

Table 4: Survey results of the Wilcoxon signed rank test comparisons of current case preparation method with NAVIFY tumor board solution

Question	*Z*; *P*
How satisfied are you with current/new platform tools to prepare TB cases?	−2.201; 0.0277
How easy is it to carry out consults with colleagues?	−2.201; 0.0277
How easy is it to review radiology tests?	−2.201; 0.0277
How easy is it to review pathology results?	−2.023; 0.0431
How easy is it to check the TB agenda?	−2.023; 0.0431
How easy is it to access patient information?	−1.604; 0.1088
How easy is it to review clinical course information?	−0.548; 0.5839

reports), but rather review them more closely on the day of the Tumor Board itself. More investigation and comparison with other types of cases, other clinicians, and other institutions are required.

Interestingly, when examining the times for each task category, review of clinical course had significantly reduced overall task times as did "other" preparation tasks. On the other hand, review of pathology and radiology images and data did not differ as a function of which method was used. This may be due to the nature of the task and the type of data involved. Radiology and pathology data are typically stored in their own information systems and retrieving data from these dedicated systems (i.e., PACS, Radiology Information System [RIS] and Pathology Information System [PIS]) involves processes, steps, and materials (pathologic and radiographic images) that a data retrieval and organization

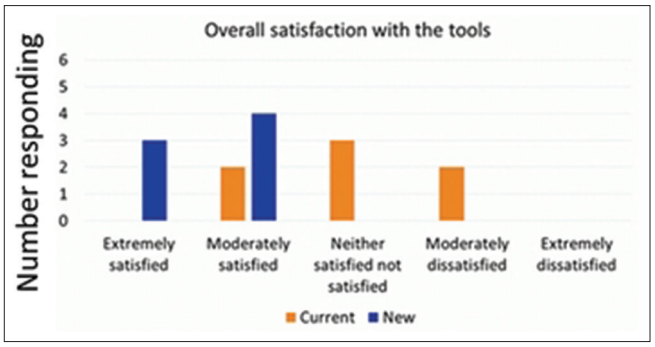

Figure 5: Overall satisfaction with current process and NAVIFY Tumor Board Solution

system like the solution used here cannot directly impact. It is possible that the NAVIFY Tumor Board solution does not speed up the review process, but rather allows the radiologist or pathologist to concentrate only on the review rather than the data collection tasks which are sped up. It may also be due to the fact that these data are simply more complicated than clinical course data or other tasks such as checking the Tumor Board agenda so preparation tools may have less of an impact. That is not to say that the workflow for these disciplines cannot be improved. With the advent of deep learning and other artificial intelligence tools, the selection of relevant images (or regions of interest from images) may 1 day be carried out automatically, reducing the need for radiologists and pathologists to manually select and annotate these complex images.

The survey results indicated that use of the new platform resulted in overall higher ratings on all of the question regarding ease of use and satisfaction. Ease of checking the Tumor Board agenda, radiology results, pathology results, consulting with colleagues and overall satisfaction all had statistically significant improvements.

This pilot study had the limitations of being confined to a single institution making it difficult to generalize to other institutions with other IT systems. We also had limited ability to assess inter-user variability given only 2 participants were observed within each specialty. The results, however, were based on 41 observation sessions that were fairly evenly distributed across the four types of clinicians. There were 734 tasks recorded, representing a relatively large sample of observations. It is also limited by the fact that we studied only one pathology– breast cancer. As noted previously this choice was based on that fact that the Hospital del Mar presents all of their breast cancer cases at the Tumor Board. Breast cancer cases may require less preparation from pathologists and radiologists since discussions tend to focus more on treatment protocols and patient management so relatively basic information is required for their participation. Other types of tumors (e.g., hematology) and diseases (e.g., liver disease) often require pathologists in particular to review clinical and laboratory data to render more comprehensive diagnostic decisions that more directly impact patient management.

Overall, the study supports the hypothesis that the NAVIFY Tumor Board solution does not increase case preparation time compared to current methods. It provides standardization of Tumor Board preparation methods, and user perceptions about ease of use and overall satisfaction were positive. Further studies are needed to assess the impact of this platform in different hospitals, and different data storage systems. It needs to be conducted with more physicians and different types of tumor cases (this study used only breast cancer). For example, it would also be useful to investigate in further detail, perhaps with more directed observations, why there was little change in reviewing radiology and pathology data. Was it due to a limitation in the new platform or a limitation in the PACS or RIS/PIS? Or is simply that pathology and radiology image review necessitate an amount of time that cannot be impacted? Finally, future uses and evaluation studies of the NAVIFY Tumor Board solution may demonstrate that the ultimate goal of this new solution to expedite Tumor board preparation, may improve patient treatment decisions, resulting in a positive impact on patient outcomes.

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Conflicts of interest

There are no conflicts of interest.

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