

Vivid™ Pioneer

Usability study

Introduction

In a usability study, 22 cardiologists worked with GE HealthCare's premium echocardiography system – the Vivid E95 – as well as the new ultra-premium Vivid Pioneer system. Each cardiologist scanned two volunteers: one with valvular heart disease (VHD) and one with a body mass index (BMI) over 30. Both volunteers were examined using the two different devices in sequence. Ten 2D acquisitions followed by five 4D acquisitions were performed on each volunteer and with each device.

Following the completion of the sessions, task times, keystrokes per task and the subjective data were evaluated. This study was carried out by Use-Lab GmbH, an independent human factors consultancy on behalf of GE HealthCare.

Abstract

Objective: The usability study described in this whitepaper was performed to evaluate strengths of the Vivid Pioneer system and potential advantages compared to the Vivid E95 system with a focus on: image quality, time saving, fewer keystrokes and user experience dimensions.

Furthermore, the study considered advantages of Vivid Pioneer compared to the systems participants used at their workplace (competitor and GE HealthCare).

Methodology: 22 cardiologists who regularly perform echocardiography performed a series of acquisitions as described above. The systems were pre-set to acquire 3 loops per acquisition. For the 4D acquisitions, participants were instructed to change on depth, width and gain and leave all other settings at the default.

The order in which participants used the systems as well as the order of high BMI vs. VHD volunteers was varied between participants to minimize order effects.

After each scanning section (four total, two per volunteer), participants rated the image quality and color image quality of the previous section of images. Following use of a given system, participants completed a short questionnaire. An acquisition-by-acquisition

comparison of each loop-pair followed the completion of all tasks: Participants were asked to judge on a five-point scale which image quality was superior. Finally, they filled out a questionnaire comparing the Vivid Pioneer with the Vivid E95, as well as with the primary system used by the participant at their workplace.

Following the sessions, Use-Lab performed video analysis to assess task times and keystrokes per task.

Results: 86% of cardiologists consider the 2D image quality provided by Vivid Pioneer excellent. 86% of cardiologists rated it easier to identify valvular pathologies with Vivid Pioneer compared to Vivid E95. Cardiologists required an average of 13% less time to acquire 4D images when using Vivid Pioneer compared to Vivid E95. Comparison showed that participants require significantly fewer keystrokes to acquire an image they were satisfied with ($p < 0.05$, Wilcoxon signed rank, one-sided). 86% of cardiologists think that their ability to identify valvular pathologies with 4D imaging is better on Vivid Pioneer than on Vivid E95. In addition, 71% of competitive system users think they would be better able to detect valvular pathology in 4D using Vivid Pioneer than with their primary device.

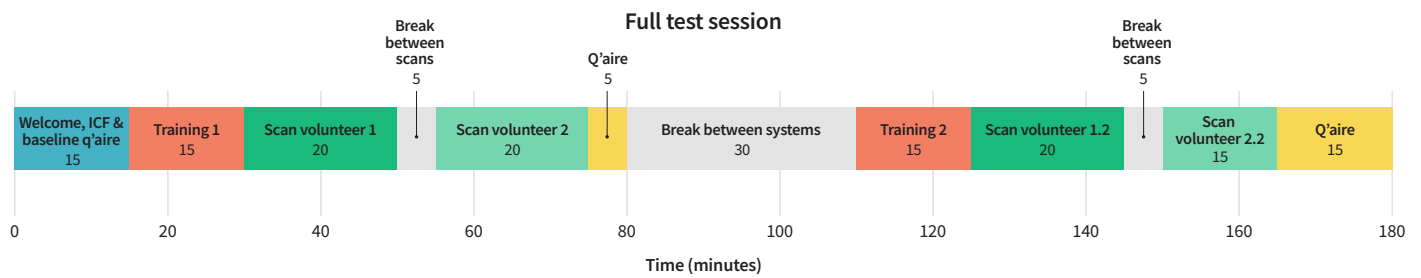


Figure 1: Procedure carried out with each participant

Background

Vivid Pioneer is GE HealthCare's new ultra-premium ultrasound system specialized for cardiac imaging. It provides excellent image quality, an easy-to-use interface and new default settings. In this study, cardiologists worked with Vivid Pioneer as well as Vivid E95 with the goal of evaluating Vivid Pioneer independently and comparatively.

The ultra-premium Vivid Pioneer is GE HealthCare's most advanced and adaptive cardiovascular ultrasound platform designed for extraordinary imaging, powered by the next-generation cSound™ Pioneer that corrects the inherent focusing limitation of ultrasound image formation, and sharpens fine structures and boundaries while reducing speckle and graininess for a cleaner, more detailed image.

Methodology

This usability study was single-blinded – GE HealthCare was not given access to personally identifiable information.

This study was carried out and results were analyzed by independent third party, Use-Lab GmbH, who also recruited and compensated the participants and volunteers. The study took place in Use-Lab's simulation lab in Steinfurt, Germany.

Participants

22 cardiologists (with echocardiography experience ranging from 4 to 25 years) who regularly perform echocardiography on premium devices participated in the study.

Of the 22 physicians, seven used competitor devices (Philips) while 15 worked primarily with GE HealthCare's Vivid E95.¹

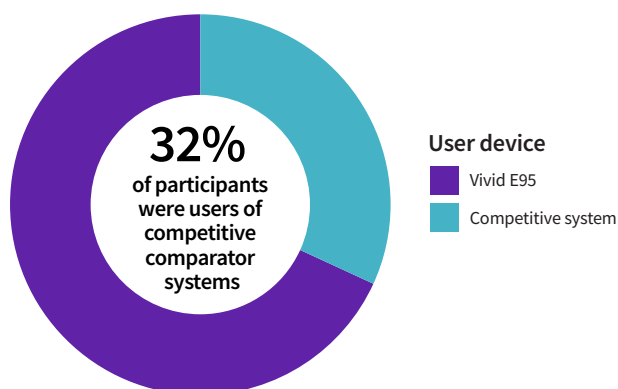


Figure 2: Participant split based on brand experience

Workflow

Figure 1 shows the procedure performed with each participant.

Training consisted of a slide deck provided by GE HealthCare that included knobology and relevant aspects of the interface that participants might not be aware of. Participants had a total of 15 minutes to look at the slides and interact with the device in this phase.

Exams: Participants performed a total of fifteen scanning tasks each. Each task consisted of one acquisition; both systems were set to record three loops:

- PLAX 2D with and without CF
- PSAX 2D with and without CF
- 4CH 2D and 4D each with and without CF
- 2CH 2D with and without CF
- APLAX 2D and 4D with and without CF + 4D CF with LVOT

After PLAX 2D with CF and APLAX 2D with CF on Vivid Pioneer, participants were asked to activate the Radiantflow™ function and were asked about its utility.

Participants scanned two volunteers. Fifteen volunteers were recruited for the study. They were assigned to one of two groups: The VHD group, consisting of participants with detectable VHD and a BMI below 30, and the high BMI group, consisting of participants with a BMI of 30 or greater, regardless of whether VHD was present.

During a session, the participants scanned each volunteer twice – once with Vivid E95 and once with Vivid Pioneer. Thus, participants completed each task a total of four times. The order of volunteers and systems was varied between participants.

Tasks were given in two sections per volunteer and device: 2D imaging in a “best-you-can-do” condition in which participants could modify the settings however they pleased; and 4D imaging in an “out-of-the-box” condition in which participants were instructed to change no settings with the exception of width, gain and depth. Across all tasks, participants were given the goal of a diagnostic image with which they were satisfied.

Tasks were defined as beginning with the first interaction of a participant with the touchscreen monitor or ultrasound keys after the moderator had given a task² and ending with the final press of the button to take the final image of a task. These definitions were

used for time and keystroke counting. If a participant said they were not able to find the anatomy in a given task or that they had otherwise misunderstood the task, the datapoint and its counterpart with the other system were removed from analysis.

Keystrokes were defined for each interactive element of the ultrasound system keyboards and touchscreen. After a test session was completed, a Use-Lab team member counted the keystrokes for each task; four Use-Lab team members were considered “qualified” to count keystrokes following an analysis of two participants each resulting in an inter-rater reliability of 0.8. Keystrokes are compared within task, within participant.

Similarly, times were assessed per task. Tasks in which a participant spoke more than usual or posed many questions were excluded from the time analysis. Task durations were independently assessed by four Use-Lab team members.

Times are compared within task within participant.

Image quality assessment items followed each section (completion of 2D or 4D acquisitions on one volunteer). Two questions addressed the image quality in general and the color scanning in particular for the preceding section, leading to eight values per participant.

Post-system questionnaires consisted of questions relating to participants’ experiences with the system they had just worked with and hypotheses about how that system might work in their workplace.

Portability questions followed the scanning session with the Vivid Pioneer system. The moderator introduced the system’s ability to scan on battery and the standby mode, and collected participant feedback on these options.

The break between systems consisted of a distractor task with a handheld, mobile ultrasound system and a simulated vascular setup to take participants out of an echo and GE HealthCare mindset. This task was followed by a 15-minute questionnaire about general system use. In total, the break was 30 minutes.

An image quality comparison was conducted after all acquisitions were complete. The systems were placed side-by-side (Vivid Pioneer always on the left) and participants were asked to evaluate on which system the image quality was better for each acquisition. Ratings were completed on a five-point scale with a neutral middle.

Final questionnaires asked participants to compare the Vivid Pioneer and Vivid E95 systems as well as the Vivid Pioneer and their everyday systems (which might also have been Vivid E95).

Questions focused on recognizing structures and pathology, ease of learning for new users, and image quality. Questions posed on four- and five-point scales are evaluated with top-box analyses, by which the two most positive options are grouped together.

Results

Analyses led to a total of 651 evaluable image quality comparison task-pairs (task performed on both systems), 593 for time-on-task and 618 for keystrokes.

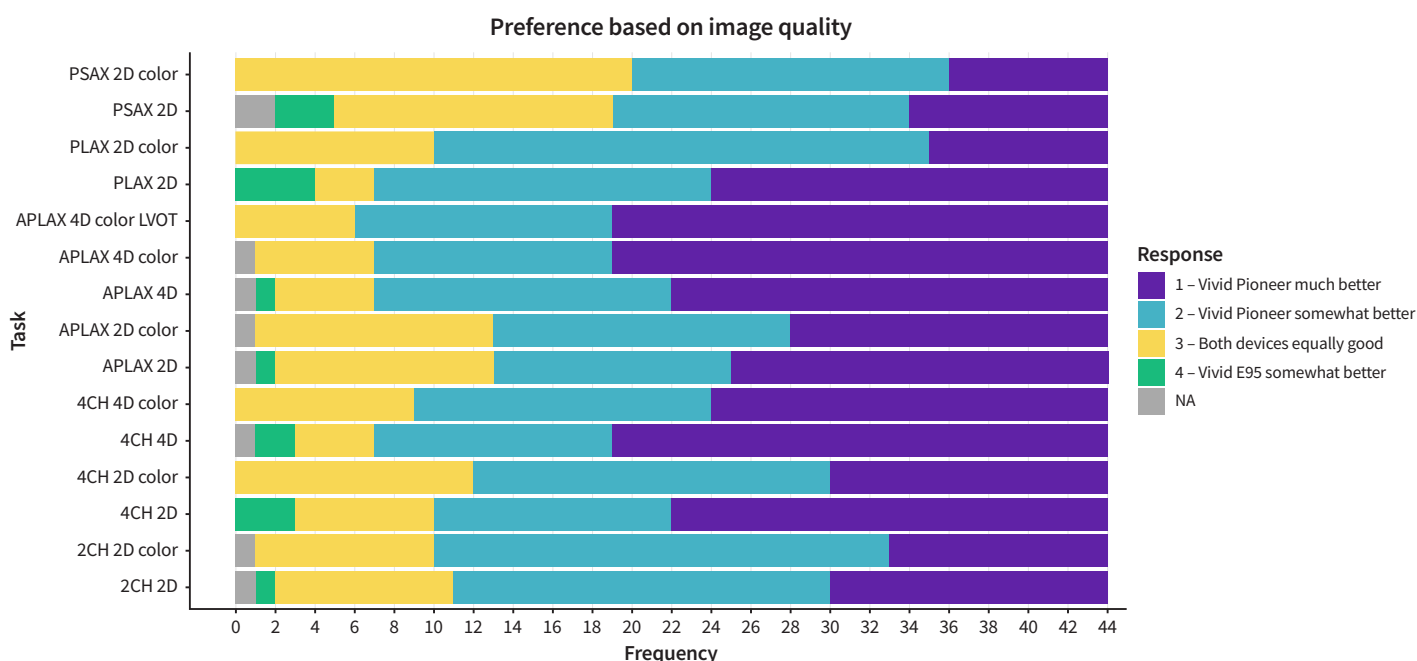
Vivid Pioneer has excellent image quality: 86% of cardiologists think that Vivid Pioneer provides excellent 2D image quality, while 77% agree that Vivid Pioneer delivers excellent 4D images out-of-the-box (high-quality diagnostic images from the first scan – no manual adjustments, except for depth, width and gain). In addition, 90% of cardiologists rated heart structures as easy to identify with Vivid Pioneer, with 86% also agreeing that Vivid Pioneer provides overall extraordinary image detail.

Furthermore, participants overwhelmingly prefer image quality on Vivid Pioneer compared to Vivid E95, as the chart shows below.

Easy identification of valvular pathologies: 86% of cardiologists rated it easier to identify valvular pathologies with Vivid Pioneer compared to Vivid E95. In addition, 63% of participants rated the 4D Color Flow as excellent.

“Better detection of boundaries, better color detection and resolution.”

– Cardiologist on superiority of 4D identification of valvular pathology



Greater confidence with 4D and 2D imaging: 86% of cardiologists think that their ability to identify valvular pathologies with 4D imaging is better on Vivid Pioneer than on Vivid E95. When comparing Vivid Pioneer to their primary device, 90% of cardiologists considered it to be superior. In addition, 71% of competitive system users think they would better be able to detect valvular pathology in 4D using Vivid Pioneer than with their primary device.

With 2D imaging, 90% of cardiologists think Vivid Pioneer would boost their confidence in identifying valvular pathologies.

“Significantly better tissue contrast and edge smoothing in many images – overall contrast improved.”

– Cardiologist on superiority of 2D identification of valvular pathology

Radiantflow usefulness: 17 out of 22 cardiologists considered Radiantflow to be a useful tool in their clinical assessment. Among others they highlighted several advantages:

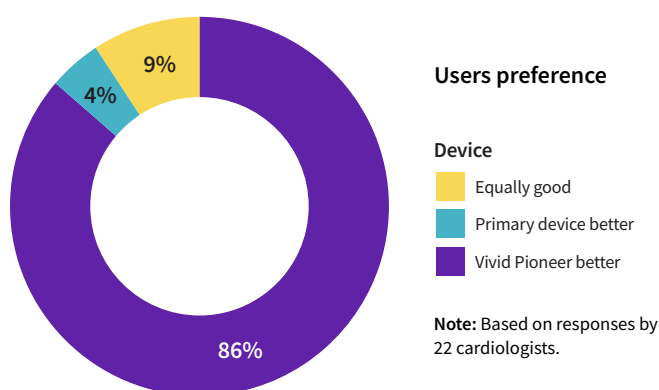
“Better visualization of the interaction of jets – shows where blood flows, turbulences and how insufficiencies change blood flow.”

“Can differentiate mitral LVOT better – this is important.”

“You can see the aortic insufficiency better, in terms of behavior and direction of the jet.”

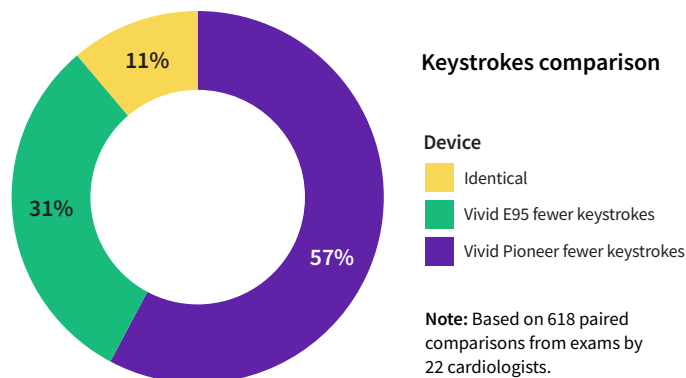
Greater screening procedure confidence: 90% of cardiologists who experienced Vivid Pioneer think it would increase their confidence in screening procedures compared to their primary device.

Users prefer Vivid Pioneer: 100% of Vivid E95 users prefer Vivid Pioneer over their current device, while 57% of users from competitor systems also favor Vivid Pioneer as their preferred choice. Overall, 86% of cardiologists who experienced Vivid Pioneer said they would prefer Vivid Pioneer over the premium system they currently work with most frequently.



Vivid Pioneer saves time: Cardiologists required an average of 13% less time to acquire 4D images when using Vivid Pioneer compared to Vivid E95 ($p < 0.05$, Wilcoxon signed rank, one-sided).

Vivid Pioneer saves keystrokes: Comparison showed that participants required significantly fewer keystrokes to acquire an image they were satisfied with ($p < 0.05$, Wilcoxon signed rank, one-sided). On average, cardiologists required 20% fewer keystrokes for out-of-the-box images on Vivid Pioneer compared to Vivid E95.



Easy to use for first-time users: 90% of cardiologists think it would be easier to train new users on the Vivid Pioneer compared to their primary system. In addition, 85% percent of cardiologists who work with a competitor system think it would be easier to train new users on Vivid Pioneer than on their primary device. 68% of participants also thought that Vivid Pioneer could reduce inter-operator variability in image acquisition.

Convenience of battery power and portability: Cardiologists were asked about their thoughts on battery power and portability. Among others they highlighted several advantages:

Portability:

“If I had this device, I would take it from patient to patient, and it would save me half an hour. Our current device takes 7-8 minutes to boot.”

“This is very helpful. We do a lot of ultrasound in ICU and are always moving the device. Right now, you lose up to five minutes each time you have to boot.”

Battery powered:

“A delay would make me impatient and could be hemodynamically relevant. This Power Interruption mode is excellent in every way. The current state is a real problem, and we would be very happy with this solution.”

“Power Interruption mode saves time, and you can find a new power source. This would allow images to be saved and increase transparency.”

Conclusion

The results of this comparative usability study show that Vivid Pioneer demonstrates superior image quality compared to Vivid E95 as well as having the potential to save users time – demonstrated by the achieved time savings and keystroke savings. The positive subjective results regarding learnability and ease of use suggest users can easily switch from their primary device to Vivid Pioneer.

About GE HealthCare Technologies, Inc.

GE HealthCare is a trusted partner and leading global healthcare solutions provider, innovating medical technology, pharmaceutical diagnostics, and integrated, cloud-first AI-enabled solutions, services and data analytics. We aim to make hospitals and health systems more efficient, clinicians more effective, therapies more precise, and patients healthier and happier. Serving patients and providers for more than 125 years, GE HealthCare is advancing personalized, connected and compassionate care, while simplifying the patient's journey across care pathways. Together, our Imaging, Advanced Visualization Solutions, Patient Care Solutions and Pharmaceutical Diagnostics businesses help improve patient care from screening and diagnosis to therapy and monitoring. We are a \$19.7 billion business with approximately 53,000 colleagues working to create a world where healthcare has no limits.

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1. Physicians were asked to indicate the (premium) device they worked with most often. If they could not differentiate clearly, they were instructed to select the device they preferred working with.
2. Due to the high level of repetition in tasks, participants sometimes started working before the task instructions were fully delivered. In these cases, the first interaction after the content of the task was clear was counted as the start.

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