

Design of Optimized Ultrasound Clinical Work-Flow; Usability Perspective

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Purpose Usability is an important factor in our life. This paper presents an approach to design the clinical work-flow for ultrasound system. And, we tried to apply this work-flow in diagnosis ultrasound system.

Materials and Methods For user learnability, we follow international standard IEC 60601-1-1 and IEC 62366 which describes usability of medical instrument. User requirement are applied by 10 clinicians who are well aware of usability. We considered user environment and designed clinical work-flow into two types: general use and emergency use. The designed clinical work-flow was evaluated by 10 clinicians and results derived from the evaluation were analyzed.

Results We could successfully design optimized clinical workflow of ultrasound system.

Conclusion This paper suggests usability testing for optimized ultrasound clinical workflow. Using this clinical work flow, users can enhance their clinical performance and reduce operation time.

Key Words Usability · Ultrasound · Clinical work-flow.

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Introduction

Medical ultrasound diagnostic machines are expected to \$630 million market in 2013 criteria. The radiology, cardiology, gynecology markets are saturated. But such as orthopedic, Urology, Emergency Medicine, Anesthesiology market has been rapidly expanding. The demand for portable ultrasound imaging device is increased. Medical device usability establish the validity, efficiency and operator satisfaction. The design requirements are considered users, patient's safety and operating efficiency. Also, medical device which based on usability engineering process minimize human error. For objective medical device design, user requirements are applied by 10 clinicians who are well aware of usability. This paper suggests usability testing for optimized ultrasound clinical workflow. Using this clinical work flow, users can enhance their clinical performance

and reduce operation time.

Materials and Methods

Benchmarking products

For useful clinical work-flow design, we benchmark two overseas medical devices. One of the products is a vscan ultrasound machine of GE and the other is a s-series of SONOSITE (1). Vscan is a small ultrasound imaging system of mobile phone size and running on battery. It can be used for cardiac, abdominal, pediatric, urine, fetal, peripheral vascular, thoracic, pleural motion and fluid detection. Vscan is a portable device which can use everywhere. S-series is available on the market. It can be used for cardiac, abdominal, pediatric, urine, fetal, peripheral vascular, thoracic, pleural motion and fluid detection. This product is a typical point of care ultrasound machine which offer high

resolution image in real time.

Analysis of Benchmarking products and problem

We design ideal clinical work-flow diagnostic ultrasound based on analyzing two devices. 80% of all large-scale systems has created a system variable effect comes from 20%. Fig. 1 is the results of complaint when using the vscan of GE. It was analyzed in detailed inconvenience. As you can see, the biggest problem is filling out the patient information. Vscan’s patient information is automatically filling out in number.

Fig. 2 is the results of complaint when using the s-series of SONOSITE. It was also analyzed in detailed inconvenience. In case

of s-series, the biggest problem is deep depth. Users have to select at least 2 steps on procedure in s-series. According to the study, people feel confused when they select more than two steps on procedure or path. It should be considered accessibility when design the clinical work-flow.

International Standard IEC 62366

We follow international standard IEC 60601-1-1 and IEC 62366 which describes usability of medical device (2). User interface design must focus on user needs and requirements (3).

Results

Frequently and important function must be made accessible. 80% of the system effect has created a system variable effect comes from 20%. Frequently Functions are Depth, Freeze, Gain in diagnosis ultrasound system. These functions should emphasize in the main display. We should think similar functions. Similar functions must form groups and arrange instinctive in display. Users have to select at least 2 steps on procedure. According to the study, people feel confused when they select more than two steps on procedure or path. It should be considered accessibility when design the clinical work-flow. Using this clinical work-flow, users can enhance their clinical performance and reduce operation time. In conclusion, If you consider these interfaces, you can design useful clinical work-flow.

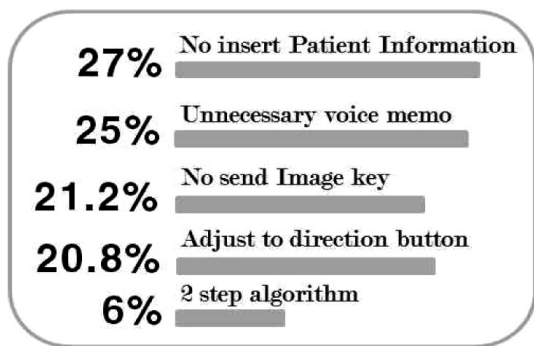


Fig. 1. Vscan usability problem.

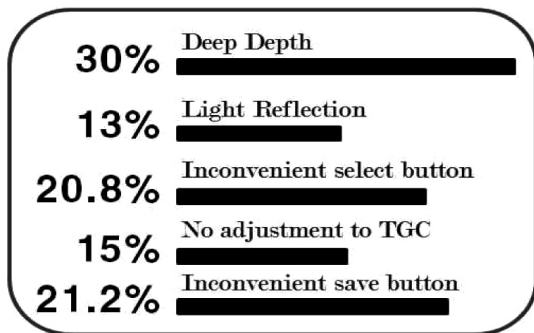


Fig. 2. S-series usability problem.

Discussion

Medical ultrasound diagnostic machines are expected to \$630 million market in 2013 criteria. We present an approach to design the clinical work-flow for ultrasound system. And, we tried to apply this work-flow in diagnosis ultrasound system. As a result, Frequent and important function must be made accessible. Frequent functions are Depth, Freeze, Gain in diagnosis ultrasound system. When design diagnosis ultrasound clinical workflow, we have to think frequent functions. And, minimize depth. It means that users feel confused when they select button at least 2. The design requirements are considered users, patient’s safety and operating efficiency. Also, medical device which based on usability engineering process minimize human error.

Conclusion

Usability is an important factor in our life. This paper presents that how to design optimized the clinical work-flow for ultrasound system. And, we tried to apply this work-flow in diagnosis ultrasound system. For user learnability, we follow in-

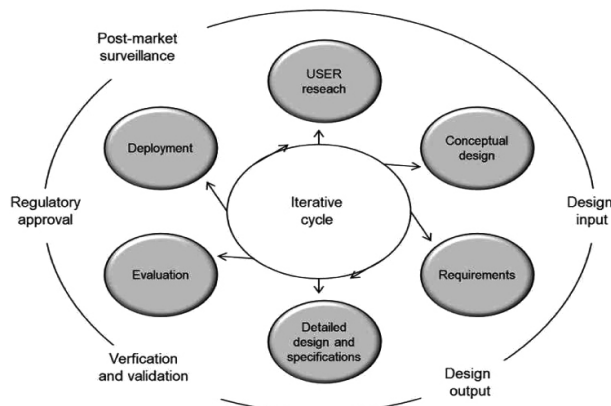


Fig. 3. Usability Engineering Process (IEC 62366:2014).

ternational standard IEC 60601-1-1 and IEC 62366 which describes usability of medical instrument. Also, we benchmark two overseas medical devices. User requirements are applied by 10 clinicians who are well aware of usability. The designed clinical work-flow was evaluated by 10 clinicians and results derived from the evaluation were analyzed. We could successfully design optimized clinical workflow of ultrasound system. Using this clinical work-flow, users can enhance their clinical performance and reduce operation time.

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REFERENCES

1. Mancuso FJN, Siqueira VN, Moises VA, Gois AFT, de Paola AAV, Carvalho ACC, et al. Focused Cardiac Ultrasound Using a Pocket-Size Device in the Emergency Room. *Arquivos Brasileiros De Cardiologia* 2014;103:530-537
2. Bills E. Risk management for IEC 60601-1 third edition. *Biomed Instrum Technol* 2006;40(5):390-392
3. van der Peijl J, Klein J, Grass C, Freudenthal A. Design for risk control: The role of usability engineering in the management of use-related risks. *Journal of Biomedical Informatics* 2012;45:795-812