IMPERIAL

MedTechONE
Knowledge Base

What are some common usability design problems with medical devices and specific considerations for AI-enabled medical devices?

1 User Interface (UI) Design Problems

2 Cognitive Load

3 Error Feedback and Error Recovery

4 Trust and Automation Bias

5 Human-AI Collaboration

1. User Interface (UI) Design Problems

Common Usability Design Problems:

- Overly Complex Interfaces: Traditional medical devices often have cluttered UIs that can overwhelm users, especially under high-pressure conditions. Unclear icons, inconsistent layouts, and difficult navigation can contribute to operational errors.
- Inconsistent UI Elements: Inconsistent design elements, such as varying icons or non-standard layouts, confuse users and increase cognitive load.
- Training-Heavy Devices: Devices that require extensive training may be less intuitive and more prone to misuse, especially by users who do not frequently use the device or by novice users.

AI-Enabled Device Considerations:

- Transparency in AI Outputs: AI systems must provide clear and understandable outputs, showing how the AI reached its conclusions to promote trust. Transparency in decision-making ensures users understand the basis for AI-generated recommendations or actions.
- Training Needs for AI Systems: AI systems often require specialized training, especially when interpreting complex data or understanding the AI's decision-making process. For example, AI-powered diagnostic tools may require users to understand how confidence levels and predictive algorithms work.

2. Cognitive Load

Common Usability Design Problems:

- High Cognitive Load: Devices that require users to perform multiple tasks or make complex decisions increase cognitive overload, leading to errors. Traditional devices that require users to input detailed information or navigate through several layers of the interface create mental strain.
- Training-Heavy Devices: Devices that are difficult to learn or operate under stress can burden users and reduce efficiency. Training-intensive devices can increase cognitive load, especially for users who don't use them regularly.

AI-Enabled Device Considerations:

- Reducing Cognitive Burden: AI systems can help by providing suggestions or streamlining decision-making, reducing cognitive load. However, if the AI system requires frequent manual oversight or validation, it can add to the user's mental workload.
- Workflow Integration of AI: AI-enabled devices should integrate seamlessly into existing workflows without causing additional steps or complexities. The AI should provide actionable insights that simplify, rather than complicate, the user's decision-making process.

3. Error Feedback and Error Recovery

Common Usability Design Problems:

- Inadequate Feedback: Devices that don't offer clear feedback after user actions can leave users unsure of whether they have completed tasks correctly or if an error has occurred.
- Poor Error Recovery: Devices that do not allow users to easily recover from errors can cause frustration or even safety issues. Without an "undo" feature or adequate prompts, users might make irreversible mistakes.

AI-Enabled Device Considerations:

- AI Confidence Indicators: AI systems must provide confidence levels and indicate uncertainty when generating recommendations. When the AI is unsure or when there is a significant risk of error, the system should alert users and offer options for corrective actions.
- Proactive Error Detection and Recovery: AI systems should detect errors in real-time and guide users to resolve them. For instance, if AI detects conflicting input data, it should flag the issue and provide suggestions for resolution.

4. Trust and Automation Bias

Common Usability Design Problems:

- Over-Reliance on Automation: Users can develop automation bias, where they trust the device without verifying its outputs. This can be dangerous, especially if the device makes an error or provides incomplete data.
- Skepticism Towards the Device: Alternatively, users may be reluctant to trust the device's suggestions if they don't understand how the system works, leading to workarounds or underutilization of the device's capabilities.

AI-Enabled Device Considerations:

- Explainability and Ethical Considerations: Users must understand how AI systems make decisions. Explainability in AI helps ensure transparency, especially in safety-critical environments like healthcare. In addition, ethical concerns, such as bias in AI algorithms, must be considered. AI models trained on biased data can lead to unfair outcomes or incorrect recommendations, especially for diverse patient populations.
- Avoiding Automation Bias: AI should encourage critical review by users and not allow them to blindly follow suggestions. There should be a mechanism for users to verify AI recommendations.

5. Human-AI Collaboration

Common Usability Design Problems:

- Lack of User Control: Traditional medical devices sometimes don't give users enough control or the flexibility to adjust key settings during critical moments.
- Device Not Suitable for the Environment: Devices that are not designed for the specific environment where they will be used can create usability challenges. For example, devices used in high-noise areas like emergency rooms must account for distractions and stress.

AI-Enabled Device Considerations:

- Shared Decision-Making: AI should function as a collaborative tool, supporting human decision-making rather than replacing it. Users must retain control over critical decisions, with the AI providing suggestions or alternatives.
- Environmental Adaptability: AI-enabled devices should adapt to the environment in which they are used, offering different levels of support based on the situation. For instance, in a high-stress setting, the AI should offer only the most crucial information to avoid overwhelming the user.

Concluding Remarks:

Medical devices, including AI-enabled ones, face numerous usability challenges. Traditional devices often struggle with overly complex UIs, high cognitive load, and inadequate feedback mechanisms. AI-enabled devices introduce additional concerns, such as ensuring transparency, trust, and human-AI collaboration. Addressing these issues through careful design, effective training, and clear feedback mechanisms ensures that medical devices are safe, user-friendly, and efficient in real-world settings.