THE REAL VALUE OF MEDICAL DEVICE INTEROPERABILITY IN HOSPITALS

Medical Device Interoperability (MDI) is one of the most relevant technology trends in the development of medical devices. As the result of a study conducted with more than 230 participants from the main areas of patient care in hospitals, we summarize which MDI use cases are valued most by both medical technology manufacturers and especially the previously neglected perspective of healthcare professionals. We also provide valuable recommendations for the future direction of MDI development.
EXECUTIVE SUMMARY

Medical Device Interoperability (MDI) is seen as a major determinant for smooth, efficient processes in healthcare. In general, it is expected that MDI simplifies the work done by physicians and nurses, improves productivity and performance, and may significantly improve the patient outcome and care. Often only the opinions of Medical Device Manufacturers (MDMs) and the administrative staff of Health Delivery Organizations (HDOs) are considered as these produce respectively buy the technology for MDI. However, little is known about the real perspective of those applying MDI in the HDOs regarding their perceived benefits.

In this survey, the value of MDI was explored by proposing 19 different use cases, which were ranked and associated with a set of 15 predetermined benefits. Moreover, the level of satisfaction with current MDI options were given alongside an expected time to market for each use case. From the data collected from 23 participants several main observations and trends were discovered:

- The top five use cases were Isolation Room, Digital Charting, Ward Round Pol, Quiet ICU Wards and Integrated UI.
- Of these, Isolation Room and Quiet ICU hold the most promise in MDI development.
- The top five overall benefits of MDI were increased patient safety, increased process efficiency, improvement of the job attractiveness, support of [digital] innovation, and improvements of existing products.
- MDMs tend to overestimate the benefit of and demand for MDI use cases.
- Reduced total cost of ownership (TCO) is not an essential benefit for HDOs. Instead, patient care is a priority.
- The results hold great potential in guiding further MDI development and showcase the need for more detailed studies in this area.

INTRODUCTION

The demand for connected, data-driven medical applications is growing along with the importance of interoperability between different devices is increasing. Digitization and technology are key in the development and expansion of HDOs and, in the future, will determine their success. In the hospital setting, many different medical devices and technological systems are used. The challenge healthcare providers face, is the ability to summarize the wealth of information from general practitioners, insurance companies, labs, medical devices, and wearables. Medical Device Interoperability (MDI) is crucial in the use and usefulness of medical technology. Often different systems and providers are unable or even refuse to exchange data in a structured way. This is not only desired by the users but also required by the patients. The ability of systems to effectively exchange information and interact with each other is therefore the key success factor.

Typically, when conducting studies on MDI development and implementation, the Medical Device Manufacturers (MDMs) and other vendors are the main drivers with an idea for new products, while others in mind fit to their perspective of the market. In contrast, this study takes another perspective: the perspective of the healthcare professionals and providers, i.e. Health Delivery Organizations (HDOs), to provide a more holistic and directly applicable insight into the potential and the expected benefit of MDI. This survey focuses on operating room (OR), intensive care unit (ICU), emergency room (ER) and general ward (GW) and aims to evaluate the value propositions of MDI use cases regarding clinical as well as non-clinical benefits.

At the beginning of the questionnaire, general characteristics of the participants were captured for later stratification of the results. The type of provider (MDM or HDO), knowledge level, hospital area, and technological maturity level were considered. Participants were asked to evaluate different use cases and associate benefits with each. There was an individual set of use cases for the different hospital areas to focus on relevant topics per participant group. The silent ICU use case was only integrated in the ICU use case. The study aims to predict the expected general direction and status of MDI in the hospital setting. This was done by assessing satisfaction with products currently available and the time each use case was estimated to be available on the market.

In total, 19 use cases were evaluated and ranked according to Net Promoter Score (NPS). The NPS is a customer loyalty and satisfaction measurement taken from the average of promoters and detractors of a product or service. Given the available -100 to +100 range, a score above 0 indicates that a product or service has more promoters than detractors. The applicable scale for answers is within a range from 0 to 10, where an answer is counted towards the detractors when it is in the range of “0 to 6” and towards the promoters when it is in the range “9 to 10”.

The satisfaction with existing solutions in the market was also evaluated for all 19 use cases. Within the given range from 1 to 5, 1 represents “not satisfied at all” and 5 represents “completely satisfied”. The time to market for each individual use case was evaluated in the range from 2021 to >2025

Overall, 231 participants completed the study. The majority (40%) were HDOs. MDMs made up 30% of the participants. The most relevant hospital area was the operating room, followed by the intensive care unit. More than 90% of the participants considered themselves to have an intermediate or expert knowledge in Medical Device Interoperability.

Since there is no standardized definition of MDI, different organizations define Medical Device Interoperability slightly differently. For this survey, we use the general definition of interoperability from HIMSS:

“The ability of different information systems, devices and applications (systems) to access, exchange, integrate and cooperatively use data in a coordinated manner, within and across organizational, regional and national boundaries, to provide timely and seamless portability of information and optimize the health of individuals and populations globally.”

1 www.himss.org/resources/interoperability-healthcare
2 www.himss.org/resources/interoperability-healthcare

Fig. 1: Visualization of the study participants and study design
TOP FIVE USE CASES

The top five use cases overall combining results from MDMs and HDOs were Isolation Room, Digital Charting, Ward Round Pol, Quiet ICU Ward, and Integrated UI with a NPS > 40%.

Overall, the top five benefits associated with the use cases were increased patient safety, increased process efficiency, improvement of the job attractiveness, support of (digital) innovation, and improvements on/to existing products, as well as compliance/legal reasons.

Use Case: Isolation Room

The ‘Isolation Room User Interface’ allows the infectious patient to be isolated while the devices are still accessible. One central display outside of the isolation room allows physicians and nurses to monitor the patient and change device settings without entering the isolation room itself. Regular checks of patient status on the patient monitoring as well as changes to therapies such as ventilators and infusion pumps can be managed remotely. This makes work protocols more efficient for the healthcare providers. More importantly, it drastically improves patient well-being by providing a healing environment and may save time in critical instances where rapid actions are necessary since the healthcare staff is not delayed by isolation room protocols. In addition, the remote isolation room management improves the safety of doctors and nurses since it reduced direct contact with the infectious patient.

Table 1: Ranking of the use cases for all study participants with the associated NPS score. Further stratification between groups (HDO, MDM) and areas (ICU, OR) changes the ranking.

Similar use cases rank highly even when the study cohort is stratified into different segments (HDO compared to MDM and ICU compared to OP). This shows that despite the variations observed, some use cases are valued the most across all groups. Similarly, some use cases are seen as less important and should therefore have a lower priority in their development. When taking into account the data from Fig. 5, Isolation Room and Integrated UI are the use cases that should be focused on the most.
**DETAILED ANALYSIS**

**NPS STRATIFICATION**
Overall, there is a substantial difference between the ranking of the use cases according to NPS between HDOs and MDMs. This is important since the HDO perspective was previously neglected. On average, there was a 19% difference in NPS for use cases given by MDMs compared to HDOs. MDMs tend to rank use cases higher than HDOs. This implies that the actual usefulness of MDI is overestimated by manufacturers. Only 4 use cases (Digital Charting, Spot-Check Monitoring, Central Patient Watch, and Intra-Hospital Transport Monitor) were ranked higher by HDOs than MDMs. Isolation Room, being ranked first overall and MDM was ranked second by HDOs in favor of Digital Charting. When differentiating by care area, ICU in comparison to OR, differences can also be observed. Here, both MDMs and HDOs relevant to each area were considered. Nonetheless, this clearly shows that there are differences in the priorities for MDI use cases in different care areas of the hospital.

**BENEFITS**
Identified benefits are increased patient safety and increased process efficiency. Reduced total cost of ownership (TCO) was ranked 14th out of the 15 benefits. Only reduced cybersecurity risks ranked lower as a benefit. Previously, TCO was thought to be an important factor in purchasing decisions regarding MDIs. In this cohort, TCO importance was shown to be a lesser concern. HDOs, in particular, would prioritize patient health, product efficiency, and MDI improvement. This could be due to the fact that the MDM perspective was primarily considered and not the HDO perspective. Additionally, in this study, HDO study participants were mostly ‘users’ and not ‘managers’ and, as such, have more direct patient contact. This may shift the prioritization from financial considerations to patient care.

**DEVELOPMENT AREAS**
When analyzing NPS in correlation with satisfaction with currently available products and services, use cases holding the most promising market potential in creating new products were identified. These include Isolation Room, Quiet ICU Ward, Automated OR Setup, Service – Predictive Maintenance, and Physiological Closed Loop Control. These use cases had a high NPS score and low satisfaction ratings with current products. This indicates that if a (better) product was available it would be welcomed and used and appreciated. Manufacturers may therefore have incentive to develop in these areas. Digital Charting, Ward Round Pol, Surgical Display, and Spot-check Monitoring also had high overall NPS scores within combination with high levels of satisfaction with available options also being high. This indicates that these MDIs use cases should therefore be maintained in their current state or a “me too” product should be developed. Again, a slightly different picture is seen when the cohort is stratified into MDMs and HDOs. MDMs assess Isolation Room, Quiet ICU Ward, Automated OR Setup, Service – Predictive Maintenance, Physiological Closed Loop Control, Service – Biomedical Notification, and Treatment Recommendations as use cases that have the highest market potential. In the case of HDOs, these use cases are Isolation Room, Digital Charting, Ward Round Pol, Quiet ICU Ward, Integrated UI, Surgical Display, and Spot-check Monitoring. Overall, analysis shows that HDOs have lower levels of satisfaction with currently available products & services for the use cases presented compared to MDMs. This indicates that there is an unmet customer need for HDOs.

From these use cases that are associated with the highest value, it can be summarized that the key aspects in MDI selection are those that give a holistic perspective and those that improve patient comfort and safety. The presentation of information from multiple medical devices in a summarized and readily available, intuitive way allow for more efficient work. This also increases the quality of healthcare. Additionally, the interest in alarms in the form of directed messages to the relevant healthcare professional, reduce anxiety in patients and help improve procedures. Interestingly, three out of the top five use cases rank ‘Increased Process Efficiency’ as the most important benefit. This shows that besides the importance of the patient perspective, improving the performance and productivity of clinical care with MDI is also crucial.

**Fig. 5:** Visual representation of the analysis of all use cases according to NPS and satisfaction with currently available options, without group stratification.

**Fig. 6:** Centre of gravity for the use cases, which were then analyzed according to NPS stratification to satisfaction with currently available options. Stratification according to groups (HDO, MDM) shows significant differences.
The interoperable medical device system consists of an Isolation Room User Interface in front of the infectious patient's isolation room that allows the display of current measurements, settings and alarms of the medical devices which are or will be connected to the patient. The Isolation Room User Interface allows the control of selected functions of the connected medical devices in the isolation room.

**Benefits:**
1. Addressed the need of staff safety
2. Increased patient safety
3. Increased process efficiency
4. Improved the attractiveness of the job
5. Reduced costs

**Area:** ICU

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**WARD ROUND POI**

“The interoperable medical device system consists of a stationary or mobile Ward Round POI software application that allows the display of values & trends of measurements and settings, as well as alarm settings and the history of medical devices that were previously or are currently connected to the patient. The Ward Round POI app provides access to patient demographic information as well as other clinical information such as laboratory data by visually integrating the respective web-based IT systems.”

**Benefits:**
1. Increased process efficiency
2. Increased patient safety
3. Improved the attractiveness of the job
4. Compliance/legal reasons
5. Support of (digital) product innovation

**Area:** ICU, General Ward

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**QUIET ICU**

“The interoperable medical device system comprises medical devices at the patient’s ICU bed and either mobile devices or central stations, or both. If an alarm occurs, the alarm is forwarded to the mobile device or central station and it is acoustically announced at the medical device. If, after a period of time, the central station or mobile device cannot be reached or the alarm is not confirmed, the alarm is set off locally.”

**Benefits:**
1. Increased process efficiency
2. Increased patient safety
3. Compliance/legal reasons
4. Improved long-term clinical outcome
5. Improved existing products

**Area:** ICU

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**INTEGRATED UI**

“The interoperable medical device system consists of an Integrated UI at the patient’s bed that allows the display of the current measurements, settings and alarms of the medical devices that are or are intended to be connected to the patient. The Integrated UI allows the control of the connected medical devices.”

**Benefits:**
1. Increased patient safety
2. Increased process efficiency
3. Improved the attractiveness of the job
4. Support of (digital) product innovation
5. Improved long-term clinical outcome

**Area:** ICU, OR, ER

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**SUMMARY AND CONCLUSIONS**

Having surveyed over 230 participants from both MDM and HDO backgrounds, with a resulting ~10,000 answer, this study is a major contribution to research on MDI. Interoperability of medical devices is more than a convenience; it is a technology that increases the safety of staff & patients while improves process efficiency. The results of this study give a clear direction in which development should continue to best fulfill the demand of healthcare providers.

**MAIN FINDINGS**

The analysis of this study led to several main findings. MDMs tend to overestimate the usefulness of and demand for MDI use cases. This can be seen by the fact that HDOs have lower levels of satisfaction with current MDI options than MDMs, while seeing a clear benefit of MDI (high NPS). Therefore, an unmet need exists which was previously not recognized by MDMs. Furthermore, TCO is not an essential benefit for HDOs. Instead, patient care is a priority over monetary considerations. Another finding is that Isolation Rooms and Quiet ICU use cases hold the most promise in MDI development across the board. Overall, MDI that increases the availability of holistic information and medical device connection is favored by study participants. As such, patient comfort and safety is key in the most highly ranked MDI use cases. Additionally, process efficiency is highly valued in MDI.

Having clear guidelines and standards for MDI is key for successful development and implementation. The use cases presented only represent a fraction of the full potential this technology may supply. New solutions in healthcare increase work efficiency for providers and improve the standard of care and living for patients. Innovation must be continually supported and guided by evidence. Therefore, further studies into trends in and demands of MDI are crucially important. Since some use cases are already available on the market and many others are expected to enter the market in the next 2-3 years, the following recommendations for manufacturers of medical devices and HDOs can be made:

**MEDICAL DEVICE MANUFACTURERS**

- Integrate interoperability in your portfolio strategy
- Define & prioritize most relevant use cases for your company
- Speed up use case realization by integrating customers and partners
- Enable employees and organizational structures to develop, maintain and sell interoperable systems

**HDOs**

- Define a vision for the use of interoperable systems within your organization
- Integrate interoperability as a must-have criteria in buying/tender processes
- Enable IT and medical staff to handle interoperable systems
- Refine SOPs by integrating optimization potentials based on interoperable devices/systems
Dr. Klaas Rackebrandt is a team leader at the Hamburg branch office and responsible for the MedTech industry. Since 2017, he has successfully set up Innovation and Digitalization programs in various industries, but mainly in MedTech. He has a strong focus on products, as well as regulatory strategies to shape innovative product portfolios combining medical and non-medical devices. Before he joined UNITY, Dr. Klaas Rackebrandt studied Mechanical Engineering and worked at Siemens developing x-ray tubes. He is also a TüV certified QM Auditor.

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UNITY is the management consultancy for innovation and digital transformation. Our customers become digitalization winners. With 280 employees worldwide, we are present at 15 locations and lead projects around the globe. Within the field connectivity of medical devices, we support our clients in realizing better patient outcomes through our competencies in validating interoperability use cases, developing MVPs in product systems, coaching on interface standards (SDC, HL7 FHIR, IHE), interface specification and IoT architecture, as well as establishing integrated governance structures.