ADVANTECH iHealthcare

AMiS-50E :

A multi-functional medical cart for HiMSS EMRAM applications

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Introduction

In hospitals, mobile medical workstations have a critical role in patient management. Beyond considerations dictating the ergonomic design of medical carts, another key factor influencing their design is the digital transformation of health services. The introduction of electronic medical record (EMR) systems has been at the center of this, linking key ancillary departments and giving healthcare workers access to accurate and complete patient information at the point of care. Because medical errors can have catastrophic outcomes, a major advantage of this is that it also gives hospitals a means to implement decision-support systems to minimize the risk of human error.

This not only overcomes many of the problems hospitals face with the use of paper-based records, but it can ultimately eliminate the need for paper charts, optimize quality of care, allow for health information exchange, and enable summary data continuity. The following sections examine the practical and technical considerations of mobile medical workstation design.

SECTION 1:

Effective Ergonomic Design

Ergonomics is aimed at maximizing physical capability and endurance while minimizing risk of injury. Regardless of whether a person is sitting or standing when using a workstation, it is imperative that they can perform their work while maintaining neutral posture. Although this is not always realistic, the basic premise is that the user should spend as little time as possible outside of their neutral posture in order to minimize the risk of injury [1].

The Cornell Healthcare Computer Cart Ergonomic Checklist [2] focuses specifically on the design of powered carts used in healthcare. Developed by Professor Alan Hedge and a team of specialists, the checklist is a tool for evaluating medical workstations along five dimensions: cart maneuvering, work surface/data input, screen/document reading, storage/accessories/power, and hygiene.

1. Cart Maneuvering

Workstations should have comfortable grips on both ends so that they can be easily pushed and pulled with minimal force. Adjusting the handles to a comfortable height should be easy, as should steering and maneuvering the cart in any direction. Of particular pertinence to hospitals, the base should be sufficiently narrow so that the cart can be maneuvered in tight spaces, such as between beds and around equipment.

2. Work Surfaces/Data Input

Obviously, a workstation must provide enough space and support for whatever computer unit is installed. The work surface needs to be stable for writing and preparing medication, but designed so that users can easily adjust the height for working while sitting (approximately 65 cm) or standing (approximately 120 cm). Like the main work surface, the keyboard/mouse platform also needs to provide sufficient stability for operation. Being able to stow the keyboard and mouse is ideal.

3. Screen/Document Reading

Ideally, the height of the screen from the floor should be within the range of approximately 80 cm (screen bottom) 180 cm (screen top) for comfortable reading when sitting or standing. The screen mount should be sufficiently stable for the user to swivel and tilt the screen as necessary.

4. Storage/Accessories/Power

Workstations need sufficient storage space to accommodate accessories for work tasks. They also need to provide security measures against equipment theft. For power, the battery should be easily replaceable and have enough lifetime to meet task demands. There should be a clear an intuitive battery power display with visual and audible warnings for when the power is running low. For recharging, the cart should have an easily accessible power plug as well as the required power outlets and electrical characteristics. Obviously, faster recharge times are obviously more ideal.

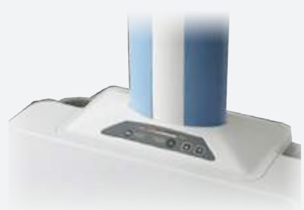
5. Hygiene

Hospital workstations need to be made from materials that are easy to clean and sterilize. It is important that cart surfaces be comfortable to touch (not too hot, not too cold) and they should be made from materials that will not chip or crack. Sharp edges should be avoided in preference for rounded or padded edges. Finally, the cart battery needs to be fanless so that contaminants are not blown around.

Widescreen Touch Computer

Easy Mounting

Reliable Battery



Battery Health Monitoring

SECTION 2:

Workflow Optimization

The digital transformation of health services begins with the linking of ancillary departments. Ultimately, the goal is to connect all hospital services to a central system to optimize workflow. Realizing this goal, however, requires a highly coordinated approach. For this, HIMSS Analytics developed the electronic medical record adoption model (EMRAM) to score hospitals according to their EMR capabilities. The EMRAM comprises eight stages indicating the extent of EMR adoption and utilization.

Stage 0

Systems for all three key ancillary department (laboratory, pharmacy, and radiology) have not yet been installed.

Stage 1

The three major ancillary clinical systems are installed with picture archive and communication systems (PACS) that provide medical imaging services via an intranet. Film-based images are displaced and patient-centric storage is available for images not in the Digital Imaging and Communications in Medicine (DICOM) standard format.

STAGE	HIMSS Analytics EMRAM EMR Adoption Model Cumulative Capabilities
7	Complete EMR; External HIE; Data Analytics, Governance, Disaster Recovery, Privacy and Security
6	Technology Enabled Medication, Blood Products, and Human Milk Administration; Risk Reporting; Full CDS
5	Physician documentation using structured templates; Intrusion/Device Protection
4	CPOE with CDS; Nursing and Allied Health Documentation; Basic Business Continuity
3	Nursing and Allied Health Documentation; eMAR; Role-Based Security
2	CDR; Internal Interoperability; Basic Security
1	Ancillaries - Laboratory, Pharmacy, and Radiology/Cardiology information systems; PACS; Digital non-DICOM image management
0	All three ancillaries not installed

Stage 2

Major ancillary system data is stored on a single clinical data repository (CDR) or data store, providing access to all orders, results, and radiology/cardiology images. Controlled medical vocabulary and order verification are supported by a clinical decision support (CDS) system for conflict checking. Document imaging systems may also be linked to the CDR. The system has basic security policies and capabilities.

Stage 3

Fifty percent of health professional documentation (e.g., vital signs, flowsheets, nursing notes, nursing tasks, care plans) is in place and integrated with the CDR. Documentation capability must be installed in the ED, although the ED is exempt from the 50% rule. Electronic medication administration record (eMAR) and role-based access control (RBAC) are implemented.

Stage 4

Fifty percent of medical orders are issued via computerized practitioner order entry (CPOE) by an appropriately licensed clinician. The CPOE is also supported by a CDS system for conflict checking. Orders are stored on the nursing and CDR environment. CPOE is in place in the ED, although the ED is again exempt from the 50% rule. Nursing/allied health professional documentation outside off the ED is at 90%. Where available, clinicians can access a national/regional patient database to further support decision-making. Even when the EMR system is down, access is still available to information on patient allergies, problem/diagnosis list, medications, and lab results. A network intrusion detection system is in place to detect possible network intrusions. A second level of CDS is in place to support nurses with evidence-based medicine protocols.

Stage 5

Full physician documentation is implemented for 50% of the hospital. Again, although this capability must be employed in the ED, the ED is exempt from the 50% rule. Nurse orders/tasks can be tracked and reported on. An intrusion prevention system is in place for detecting and preventing intrusions. Portable devices owned by the hospital can operate on the network and be wiped remotely.

Stage 6

The administration of medication, blood products, and human milk as well as the collection and tracking of blood specimens are performed using closed-loop process across 50% of the hospital. This also applies to the ED but without the 50% rule. Safe point-of-care processes and results are maximized using eMAR and technology integrated with the hospital's CPOE, pharmacy, and lab systems. To reduce medical errors, the CDS now accounts for the "rights" pertaining to administering medication, blood products, and human milk, and for collecting blood specimens. The CDS also provides some variance and compliance alerts triggered by physician documentation. Security policies are upgraded to allow for user-owned mobile/portable devices, and annual security risk assessments are conducted and reported to the governing authority.

Stage 7

Paper charts are no longer used for patient care. Discrete data, document images, and medical images are used in the EMR environment. With data warehousing, clinical data is analyzed to optimize quality of care, patient safety, and care delivery. Standardized electronic transactions can be employed to share clinical information with authorized entities or for health information exchange. Summary data continuity is demonstrated for all hospital services. Physician documentation and CPOE are at 90% and closed-loop processes are at 95% (the ED is exempt from these).

SECTION 3:

Preparing for the Cloud and AI

Worldwide, studies have shown that implementing IoT systems in healthcare environments can improve inventory management, asset utilization, staff productivity, care services, maintenance compliance, and information visibility [3]; enhance supply chain cost efficiency while reducing personnel costs and readmission rates [4]; minimize human error [5]; and reduce work pressure, improve medical diagnosis and quality of care, and promote national health infrastructure development [6]. Moreover, by collecting sufficient data, an effective IoT system can maximize asset ROI and turnaround.

Data Collection and Visualization

In hospitals, data are gathered through devices, including medical computers, healthcare information terminals, surgical video, tablets, handheld devices, and medical carts. To handle the high throughput, edge devices can be connected to gateways to segment data management. With edge devices programmed to downsample local data and generate alerts at the edge, data visualization and management can be performed in real time and locally at the front end. Meanwhile, data from all gateways at the edge can be aggregated in a time-series database at the back end for subsequent analysis.

Wireless Connectivity

Selecting the appropriate wireless technology involves a trade-off between coverage and throughput. Coverage can be up to 10 km for long-range standards, achieving a throughput of more than 100 Mbps at distances up to 5 km. At greater distances, some standards still perform reliably although at a substantially lower throughput (<10 Kbps). At shorter ranges (<100 m), the most commonly used standards are Wi-Fi and Bluetooth. Given that Wi-Fi is far superior for both throughput and coverage, it is generally the most popular choice for home and business applications.

Secondary to the coverage vs. throughput trade-off is device reliability. This is largely determined through device testing, with certifications and frameworks available to confirm a device's reliability. This includes RF and antenna component testing to ensure that devices can accurately record data, throughput testing for stable data transmission, EMI and frequency spectrum analysis to check that devices and environments are free from interference, TRP/TIS testing for antenna radiation efficiency, isolation testing to ensure that devices are electrically sound, and mobile station connection simulation to ensure operational performance.

AI and Decision Support

Decision support systems are intended to act as a human consultant in supporting decision-makers through evidence-based analysis. This includes identifying problems and their causes, proposing solutions, and then evaluating those solutions. Today, AI is often integrated into decision support systems so that computers can perform support tasks in a human-like manner.

In hospitals, research has shown that clinical-decision support systems can improve resource management [7]; practitioner performance (especially where users were automatically prompted by the system), and patient outcomes [8]. However, the success of such systems depends on both the implementation of appropriate rules and the quality of data during operation. Thus, systems that offer stability and reliability are critical.

SECTION 4:

Introducing the AMIS-50E Medical Computing Cart

The AMiS-50E is a fully customizable medical cart that can be configured for a range of medical applications (e.g., medication cart, vital sign cart, telemedicine cart). It features an intuitive dashboard design, ergonomically designed handles, a Panasonic Li-ion battery system for intelligent power management, Advantech point-of-sale all-in-one computer with an Intel Wi-Fi module, DIN rail mounts for accessory attachment, and electrical height adjustment functionality. Most importantly, the AMiS-50E supports the use of closed-loop processes for medication management, thus allowing for medication delivery to be tracked at the patient level.

Cart Maneuvering

The AMiS-50E has a large work area but can still be easily moved around hospital beds. With large casters and comfortable handles, the cart is easy to push and pull. Moreover, it will remain upright when rolling over small obstacles or when on a ramp at 10 degrees.

Work Surfaces/Data Input

The AMiS-50E can be easily adjusted to provide a comfortable working height for use while sitting or standing. It has an easy-to-access keyboard and mouse tray that allows the keyboard and mouse to be conveniently stowed. Furthermore, a mouse tray is located on the left and right side. It also has a reading light for night-time operation.

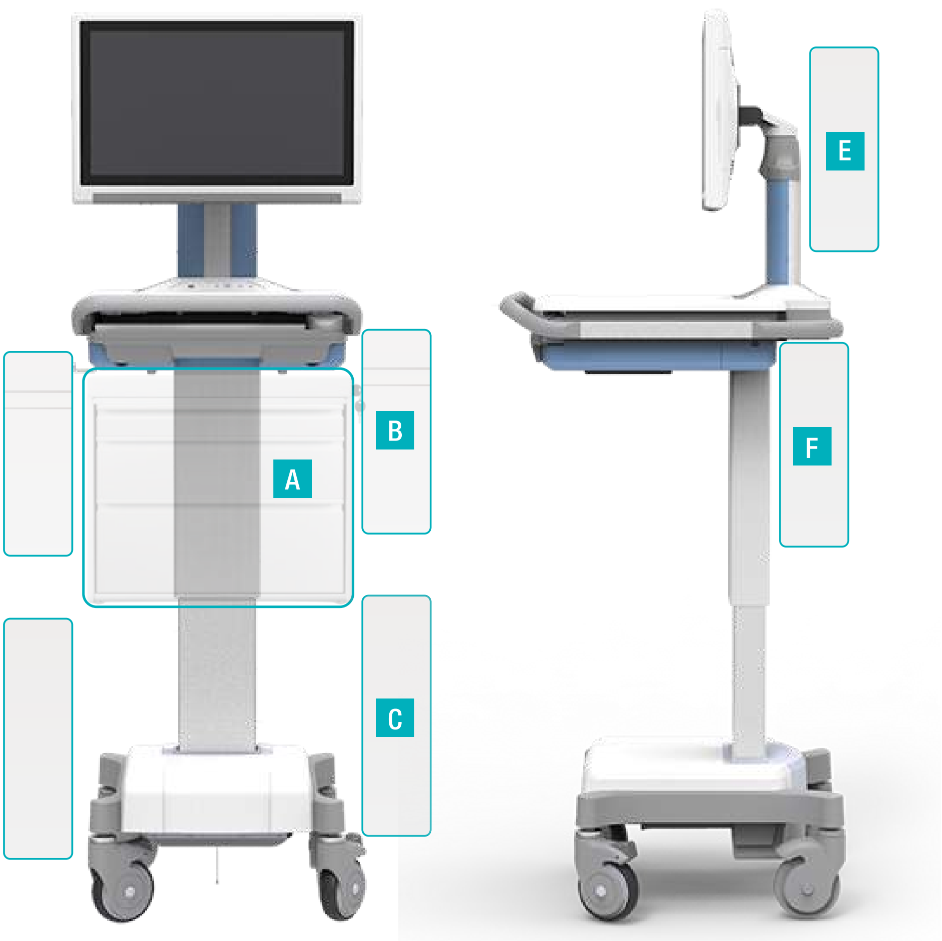
Screen/Document Reading

The AMiS-50E comes with a high-performance fanless all-in-one touchscreen computer designed for specifically healthcare applications. The arm neck design of the cart features a cable duct and a swivel range of 180 degrees and tilt range of 190 degrees, making it easy to maneuver the screen to a comfortable viewing position.

Storage/Accessories/Power

Key to the cart's flexible design is the utilization of DIN rails for accessory integration as well as the 4 x USB 3.0 ports and 1 x Ethernet port for connecting devices (e.g., barcode reader, camera), medical equipment (e.g., patient monitor), and software systems (e.g., HIS, PACS, GIS). These allow for a completely customizable medical workstation design according to task requirements. Furthermore, the AMiS-50E ensures mobile connectivity with its Intel Wi-Fi module, which has undergone extensive testing to ensure reliable performance. With Wireless-AC 2x2, the AMiS-50E outperforms previous designs based on the b/g/n 1x1 configuration.

The AMiS-50E features the world's first medical-grade mobile power system, offering a 3-hour rapid charge time for 10 hours of operational runtime. With a mean time between failure of almost 26,000 hours, the AMiS-50E is 2.5 times more durable than commercial systems. For tracking the battery level, the AMiS-50E has an intuitive dashboard with a battery power display and keys for adjusting the work surface height.



A Din-rail under table
Medication box or customization box

B R-L side din-rail

C Bottom base fixing
Trash can or container

D VESA stand
Monitor, all-in-one or teleconference camera

E Dovetail mounting
Vital sign devices

F Rear side din-rail
Storage box

Hygiene

The AMiS-50E is medically certified for safety, reliability, and infection control. It has a fanless power system to minimize the risk of viral contamination as well as IPX1 certification, meaning that it is protected against drips, leaks, and spills. Thus, the entire unit can be easily and safely cleaned in medical environments.

Other design features include a smooth design that prevents stubbed toes and crushed/pinched fingers. With only four screws needing be removed for motor replacement and a simple two-step procedure for battery replacement, the AMiS-50E is easy to maintain.

HiMSS EMRAM Applications

For HiMSS EMRAM Stage 1 applications, the AMiS-50E can be customized to operate as an ancillary clinical system or PACS system. With its connectivity options, it is ready for medical imaging applications over an intranet. This supersedes the need for film-based imaging and makes patient-centric storage of non-DICOM images available.

For HiMSS EMRAM Stage 3 applications, the AMiS-50E can be customized to operate as a health documentation workstation that can store, retrieve and visualize critical patient information (e.g., vital signs, flowsheets, nursing notes, nursing tasks, care plans) on a hospital's CDR. This also allows hospitals to implement eMAR systems and RBAC

For HiMSS EMRAM Stage 6 applications, the SDK can be utilized to customize the AMiS-50E for closed-loop processes necessary in the administration, collection, and tracking of medications and specimens. The AMiS-50E's connectivity options ensure easy integration with key systems to ensure safe point-of-care processes. CDS can be fully implemented to assist in reducing medical errors and detecting variance and compliance alerts. Other achievable results through the implementation of security policies include user-owned mobile/portable device connectivity, security risk assessments, and report generation..

HiMSS EMRAM Applications

HiSS EMRAM	AMiS-50E
Stage 1	The AMiS-50E can be customized to operate as an ancillary clinical system or PACS system.
Stage 3	The AMiS-50E can be customized to operate as a health documentation workstation that can store, retrieve and visualize critical patient information.
Stage 6	The SDK can be utilized to customize the AMiS-50E for closed-loop processes necessary in the administration, collection, and tracking of medications and specimens.

Introducing WISE-PaaS Command Centre

In environments where hundreds or even thousands of IoT medical devices are employed, it is critical for a control room-type system to be in place. For monitoring IoT devices and workflow in health environments, Advantech offers WISE-PaaS iHospital/CM Centre, a dashboard package that provides a customizable overview of health-related IoT operations. This allows for efficient data collection and datamining for CDS systems and for monitoring key metrics such as ROI and turnaround rate.

AMiS+/iMedication Offerings

Advantech's AMiS+/iMedication offerings integrate IoT medication devices (e.g., dispensing bins, medication boxes, smart power storage, smart gateways, and barcode readers) to create AMiS systems (AMiS carts, point-of-care terminals) that allow for closed-loop process customization with the AMiS+ SDK. This gives complete control over system settings related to status management, medication boxes, dispensing management, authorization, and operation records. This flexible iMedication SRP can be utilized in eMAR, pharmacy, nurse station, and patient ward applications.

AMiS Solution Architecture

The versatility of the AMiS solution derives from the variety of IoT sensing devices that can be fitted to the cart. As a simple example, an AMiS-50E could be fitted to operate as a mobile registration cart by connecting a card reader and a few other peripherals via USB. It could just as easily be fitted for use as a mobile medication cart or vital sign monitor.

At the heart of the AMiS solution are embedded platforms and edge intelligence services. The role of the AMiS-50E in a networked environment is ultimately realized with WebAccess and WISE-PaaS/EdgeSense, allowing users to co-create solution-ready platforms with domain-specific cloud services.

Medical Certification

Designed for safety/ reliability/ infection control

EMI IT & Medical, Safety – IT

c UL us LISTED FC CE CCC

Safety – Medical

IEC 60601-1 Compliance

Battery Pack

UN38.3 EN62133

Conclusion

The introduction of EMR systems and linking of key ancillary departments not only gives hospitals the ability to provide accurate and complete patient information at the point of care, but it also allows them to implement decision-support systems that facilitate risk management. The AMiS-50E is a fully customizable solution that can be adapted for various medical applications. It has been ergonomically designed in accordance with the Cornell Healthcare Computer Cart Ergonomic Checklist, and it conforms HiMSS EMRAM standards, thus ensuring long-term usability as EMR systems are expanded in the future.

For more information on how the AMiS-50E can be implemented to bring your EMR system up to standard, contact your local Advantech representative or visit www.advantech.com.

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