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Improving Care Delivery and Nursing Workflow: A Clinician Usability Study of the Motion C5 Mobile Clinical Assistant

Alegent Health – Lakeside Hospital

Omaha, Nebraska



SIEMENS



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Executive Summary

After successfully implementing their new Siemens Medication Administration Check™ (MAK) system for bar code medication administration (BCMA) together with the Siemens Soarian® clinical suite, Alegent Health clinicians realized several workflow, usability, compliance, and ergonomic limitations specific to their existing workstation on wheels (WOWs) devices. To realize the full clinical benefits of BCMA and nursing documentation, nurses needed computer access at the patients' bedside, and, the automation of tasks previously performed manually revealed workflow areas that needed to be streamlined. Existing WOWs were cumbersome and difficult to push, causing nurses to complain of neck, back, and shoulder pains. Additionally, various WOW connectivity problems disrupted nursing workflow. Because of these issues, patient data could not be easily entered or accessed at the point of care.

Alegent Health leadership believed a more portable and ergonomic device would improve nursing efficiency and satisfaction, as well as improve care delivery. Alegent Health participated in the Motion Computing® Clinician Usability Study program, testing a Motion C5 mobile clinical assistant (MCA) in Alegent's Lakeside Hospital with Siemens MAK and Soarian Clinicals. Results from the study revealed:

- Significant increases in end-user satisfaction
- Care delivery improvements as a result of increased ability to document at the point of care
- Increased clinician productivity due to increased mobility, reduced device performance problems, and improved workflow
- Improved compliance with cleaning and disinfection control protocols due to unique Motion C5 design

Introduction: Improving ergonomics of bar coded medication administration while decreasing the total cost of ownership

Alegent Health is a faith-based health ministry sponsored by Catholic Health Initiatives and Immanuel Health Systems, formed in January 1996. Today, it is comprised of nine acute care hospitals with 1,829 licensed beds, 1,300 physicians and more than 8,600 employees. In 2007, Alegent Health ranked 13th in a survey of the Verispan's top 100 integrated health care networks (IHN) in the nation. Alegent Health has a 10 year strategic partnership with Siemens to use their software, imaging equipment and building technology. Alegent Health has also formulated an ongoing collaboration with Motion focused on improving real time point of care documentation and mobility for its clinicians across its hospitals and ambulatory care clinics.

Impetus for Change

Healthcare research literature indicates that over 770,000 people are injured or die annually as a result of harmful medication errors at an incremental cost of up to \$5.6 million per hospital, per year depending on size (Classen, Pestotnik, & Evans, 1997; Cullen, Sweitzer, & Bates, 1997; Cullen, Bates, & Small, 1995; Bates, Spell & Cullen, 1997; Bates, Cullen & Laird, 1995). In the 2001 Agency for Healthcare Research and Quality article entitled *Reducing and Preventing Adverse Drug Event to Decrease Hospital Cost*, the following key points were made about harmful medication errors:

- Patients experiencing harmful medication errors spent an average of 8-12 more days in the hospital than those who did not.
- Costs of increased hospitalization of patients who experienced harmful medication errors were between \$16,000-24,000.
- Between 28 – 95 percent of harmful medication errors can be prevented by preventing medications errors.

Although bar coding medication administration and point of care documentation have demonstrated quality of care improvements (Poon, et al., 2003) and cost savings, they also have presented workflow challenges in their implementation. In the report on the HIMSS 2005 survey *The Impact of Health Information Technology on the Role of Nursing and Interdisciplinary Communication*, poor process and workflow support was a leading dissatisfier among respondents. This dissatisfaction leads to decreased end-user adoption, increased costs and decreased return on investments

Alegent Health Lakeside Hospital Study Premises

Lakeside Hospital was opened in August of 2004 and was hailed as one of the world's most technologically integrated hospitals, with all nursing documentation completed in Siemens OAS Gold. In 2006, Lakeside Hospital went live with Siemens MAK. With the MAK implementation, workflow challenges began to appear as the nurses had to move the WOWs from room to room, and back and forth to the medication room, rather than a central location close to their patient care assignment. "We encountered a series of different challenges," said Michael Westcott, MD, Chief Medical Informatics Officer for Alegent Health. "They are difficult to push and difficult to adjust the height. Ergonomic issues were a problem."

Ergonomic issues

Key challenges for nursing staff included:

- The need to push the WOW device in and out of patient rooms up to 80 times per nurse, per shift.
- Difficulty pushing WOWs over thresholds between carpeted and non-carpeted floor.
- The WOWs were noisy.

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- The Bluetooth laser scanners often came uncoupled, requiring the nurses to go through a restore process that took up to two minutes.
- Increased complaints of back, neck, and shoulder pain.

The Lakeside Hospital nursing leadership requested ergonomic evaluations on the two types of WOWs in use at Lakeside. These evaluations were performed by a Board Certified Professional Ergonomist who examined push/pull implications and height adjustment issues. The force values were recorded using the Blankenship Omni 200 force gauge and varied depending on pushing speed. The faster the nurse pushed the WOW, the greater recorded force. The maximum push force and the average force varied between carpeted and vinyl floors. The push force increased to 50 pounds of pressure when nurses pushed a WOW over a threshold between carpeted and vinyl floors.

As a result of the ergonomist’s findings, larger wheels were put on WOWs, which provided some improvement to the force values. Table 1 illustrates the difference between the smaller and larger wheels.

| | Cart 1 | Cart 1– Carpet Casters | Cart 2 – Small Wheels | Cart 2 – Large Wheels |
|---------------|---|--|---|--|
| Carpet | Max Push Force: 19.5 lbs Average Force - Maintain Push: 5.5 lbs | Max Push Force: 16.00 Lbs Average Force - Maintain Push: 5.5 lbs | Max Push Force: 19.0 lbs Average Force Maintain Push: 6.0 lbs | Max Push Force: 13.5 lbs Average Force Maintain Push: 4.0 lbs |
| Vinyl | Max Push Force: 9.0 lbs Average Force - Maintain Push: 4.0 lbs | Max Push Force: 8.5 lbs Average Force - Maintain Push: 4.0 lbs | Max Push Force: 10.0 lbs Average Force Maintain Push: 2.0-4.0 lbs | Max Push Force: 6.0 lbs Average Force Maintain Push: 2.0-4.0 lbs |

Table 1: Report of ergonomist’s findings on push-pull force when moving Workstations on Wheels

The ergonomist also reported force measurements for adjusting the height of work areas. The knob release required 15 pounds of force with one thumb and the thumb release needed 2.5 pounds of force with the entire hand. As a result of this finding all WOWs were converted to lever.

The Fire Marshall also required an eight foot hallway egress and any device placed in the hallway needed to be moved every 20 minutes or it was considered a “stationary object”. Alegent Health’s interest in satisfying Fire Marshall and Joint Commission guidelines was another precipitating factor for the C5 study.

Power management and workflow issues

In addition to the ergonomic issues, power management had become an issue for nursing staff. The WOWs batteries would frequently lose charge without warning, causing loss of data. Alegent Health micro-analyst Allen Hager eventually determined that an older version of Bluetooth radio caused some of the power issues. (The problem with the Bluetooth radio version 1.1 was it was not hopping frequencies fast enough, thus causing problems with the MAK application.)The WOW power issues were resolved by replacing the batteries on the WOWs. However, when batteries failed, nurses had no immediate means to change them and mobility was suspended until the units were recharged. Also, when the scanner

would drop connectivity, it required the nurse to seek out another scanner and to sync it to the base on the device and ensure that it would scan the medication, patient wristband and the employee identification badge properly. This reconnection process meant it took the nurse longer to deliver medications properly as nurses would have to override the medication delivery system to chart without scanning the medications, patient's ID or their employee ID.

The need to log on and off workstations dozens of times each shift was inconvenient and time-consuming. Nurses locked workstations when stepping away from them, and then had to log in again when returning. Observations by Alegent Health nursing informatics staff showed an average of one to two logins per hour for an average of 12-24 logins per shift. A single login process could take up to two minutes, consuming up to 48 minutes of nursing time waiting for computer access. Alegent Health Lakeside Hospital leadership wanted to give nurses back this time each day so they could return to the patient bedside.

Access to data by other members of the healthcare team was impacted by data latency issues. Latency is defined as the time delay between the moment data is collected and the moment it is available in the EMR. Typically data latency is the result of batch charting by the clinical staff. Batch charting most frequently occurs because the clinician does not have time to log on and off between every patient encounter. The clinician waits until enough patient data has been collected to justify a workflow interruption. When collecting data, information is either documented on a "temporary" source, such as a piece of paper or memorized for later transcription or input. Data latency of vital signs by nurses was observed to be two hours and 48 minutes on average. Latency for shift assessment data was an average of one hour and 37 minutes.

In response to nursing concerns about the various medication administration workflow issues, Alegent Health's leaders decided a more mobile solution was required. "We just didn't believe WOW carts were the answer," explained Westcott. Alegent Health CIO Ken Lawonn added, "We just had a sense that something very portable would provide the nurses a much better solution than taking carts into the room."

At this point Alegent Health turned to Motion Computing, a firm with whom it had previously worked with and regarded positively. Their original encounter with Motion took place three years after implementing an older generation Motion device. "The units were bought from a reseller and no one really trained us how to use them," explained Westcott. When Motion made a routine satisfaction inquiry and learned of Alegent Health's challenges, they immediately provided training that helped improve clinicians' use of the technology. "The nice thing about Motion was that we already had the devices, had problems, and they didn't abandon us – they brought a team of clinicians, technical and workflow people in to help us," said Westcott.

Alegent Health then asked Motion if they could help with the medication administration workflow and ergonomic issues arising from use of the WOWs. At the time Motion Computing was in the process of designing the new Motion C5 mobile clinical assistant (MCA) as a mobile and purpose-built device

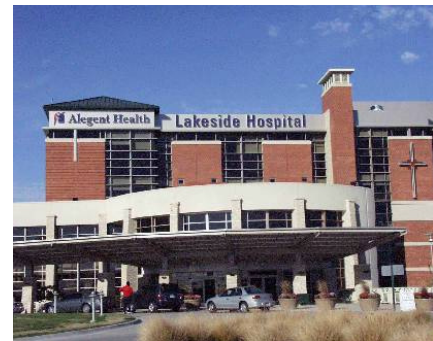
specifically for clinicians in the acute care environment. Alegent Health agreed to lead a Clinician Usability Study which utilized a formal methodology developed by Motion Computing. The clinician-centric methodology involved a structured approach to introducing new technologies within the workflow. Leaders representing Alegent Health nursing, operations, and IT formulated major project objectives and established specific performance improvement goals and metrics, as well as and specific hypotheses associated with each goal. Siemens also readily agreed to collaborate by incorporating valuable development changes into Soarian that took better advantage of the unique C5 functionality.

The major Alegent Health objectives for the study were to:

- Improve care delivery
- Enhance clinician productivity and workflow
- Increase clinician satisfaction
- Reduce delays in information availability within the EMR

The study was conducted at Alegent Health's Lakeside Hospital in West Omaha. A general medical-surgical unit was chosen for the study. This unit is divided into four pods and the study was focused on nurses. Prior to the study a team of clinicians from Alegent Health and Motion conducted ethnographic observational research at Lakeside to understand workflow and pain points. These teams documented:

- Clinician movement patterns (where clinicians walk, sit and stand by discipline) and task interruptions
- Common workflows for clinicians, patients and information
- Data access and input requirements by clinical discipline, location, modality, and data type
- Facility space constraints, Fire Marshall and Joint Commission requirements, i.e., NFPA 101 2006
- Infection control and prevention protocols for fomite disinfection, including requirements for isolation patients and the standard antimicrobial and germicidal agents used
- Staffing models and ratios by discipline, census, patient acuity and shift



Personnel from Alegent Health and Motion designed a series of study parameters to scientifically examine baseline, target and actual performance measures across multiple input variables. Baseline measures for time and motion data were captured. This included frequency and time required per login; time required to complete discreet tasks, including the collection of nursing assessment data; and, time documenting into the Soarian software application. Additional baseline measures of clinician satisfaction were measured using a formal Likert scale (nurses were asked to rate how strongly they agreed or disagreed with a series

of written statements.) This data, combined with nursing input and the Alegent Health objectives, helped clarify the study's scope and formulate performance improvement hypotheses.

Clinician Usability Study: Changing Technologies and Workflows

The Flexibility of a Personal, Mobile Device

For the study, Alegent Health modified its device provisioning model so each participating nurse received a Motion C5 MCA for his or her complete shift. Intel was instrumental in formulating the original MCA reference design based on its ethnographic research. The C5 benefited from Intel's research findings as well as similar research Motion had completed during the previous five years. The C5 was developed and commercially manufactured by Motion Computing as the Motion C5 mobile clinical assistant. Created to meet the demands of the acute care environment, the Motion C5 provides a sure-grip handle, a sealed



case for easy disinfecting, a lightweight design for portability, a 10 inch screen for easily viewing clinical information with minimal scrolling, rugged construction that minimizes the impact of dropping the device, and pen and stylus input so clinicians can enter text and navigate the software without being tied to a keyboard. The Motion C5 also includes features such as integrated barcode and RFID readers for patient identification and/or electronic medication administration, an integrated camera, and built-in Wi-Fi* and Bluetooth* for wireless connectivity. Alegent clinicians, infection control experts, IT administrators, and clinical care leaders were among many in the industry who provided input into the unique design and features

of the C5 platform. Siemens also actively contributed input to Motion that could enhance the clinician end-user experience and organizational value realization from using the Motion C5 with Siemens' software.

Using the Motion C5 changed the nurses' relationship with technology in several important ways:

- Nurses had a lightweight, portable device that was theirs to use for the entire shift. They gained unimpeded access to patient information, and no longer had to contend with other clinicians for access to a device. The time and consternation previously associated with searching for WOWs or desktops could be reallocated to patient care, and nurses could document and access information when and where their workflow called for it.
- Since the Motion C5 was a personal rather than a shared-access device, nurses remained logged into their MCA between patients as they made their rounds. Instead of having to log in to Soarian each time they approached a device, each nurse reduced his or her need to log in from the previous 12 to 24 times per shift to just two to four times per shift.

- The devices were truly mobile and easily portable. Nurses often carried them between rooms and used them in a variety of settings such as the break room, medication room, and nursing station. This additional agility and portability to access and input data from anywhere improved nursing productivity and satisfaction.

Methodology and Results

Baseline measurements of nursing activities were collected by Motion Computing staff with focus on data latency and number of data transcriptions. After staff training and implementation on the Motion C5, a trained observer collected a second set of observation data. Following a multi-week period of usage, participating nurses completed an online survey regarding their satisfaction levels with the Motion C5 mobile point-of-care solution compared to using the WOWs and desktop PCs at the nursing workstations.

Reduced Data Latency

Data latency is defined as time lapse between data collection and data recording into the EMR. If data is not in the EMR in a timely manner, there is an increased risk that other clinicians will make decisions based on data that are incomplete or no longer accurate. During the observation period, the majority of the time data was transcribed at the point of care to a nurse's paper note sheet, and transcribed at a later time into the EMR. Data latency for shift assessment data averaged one hour and 37 minutes when using the WOWs and just 17 minutes when using the Motion C5 (shown in Figure 1).

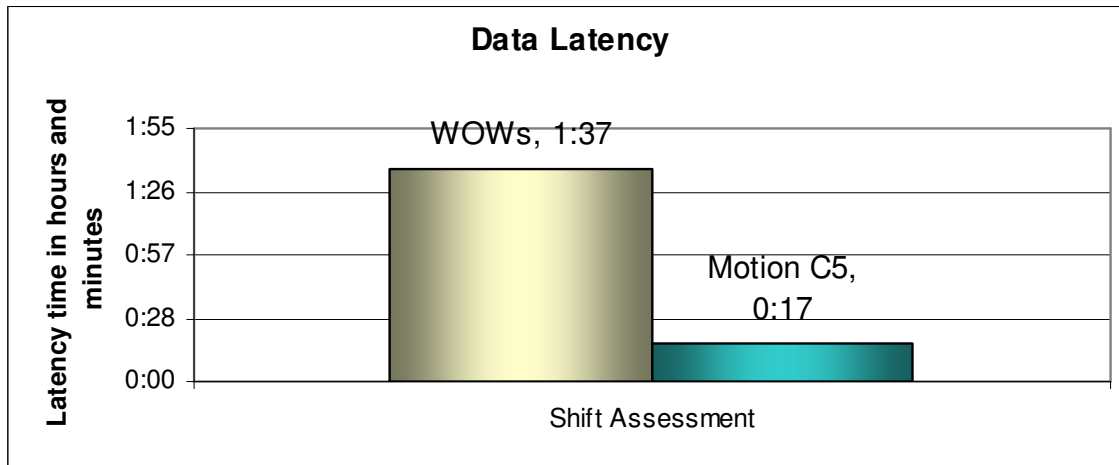


Figure 1: Data latency for nursing shift assessment data

For RN-acquired vital signs, data latency averaged two hours and 48 minutes, compared to less than one minute when using the Motion C5 for point of care documentation. This is illustrated in Figure 2.

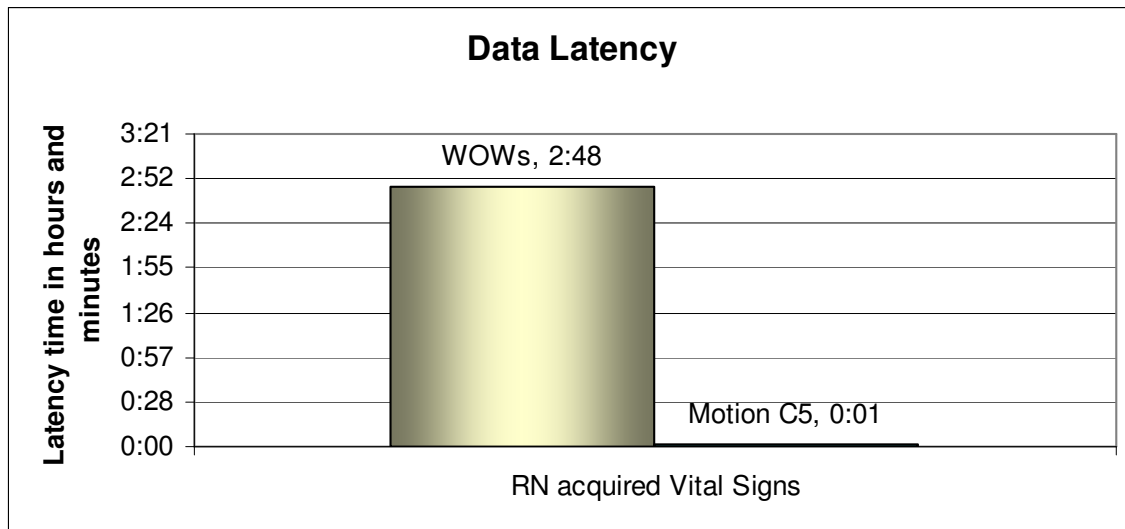


Figure 2: Data latency for RN acquired vital signs

“The use of the C5 demonstrated that when the nurses had the right types of tools to support them, they were more likely to collect at point of care, and that is critical,” said Lawonn. “The closer we get to providing real time documentation at the point of care, the better the overall quality of the record, and the better the care delivery.”

Improved Medication Administration

A review of previously published studies indicates that up to 34% of preventable medication errors occur at the point of administration (Bates, Cullen, & Laird, 2005.) During the C5 study, clinicians noted a total of 15 “near misses” out of a total of 1853 doses, indicating that the mobile devices were an effective tool with the medication administration management application.

Improved Data Transcription

In a recent study (Gearing, et al., 2007) researchers examined 1,463 sets of vital signs and found that between 14.9% and 25.6% of them contained one or more transcription errors. Figure 3 illustrates a typical workflow process for collection of patient vital signs information.

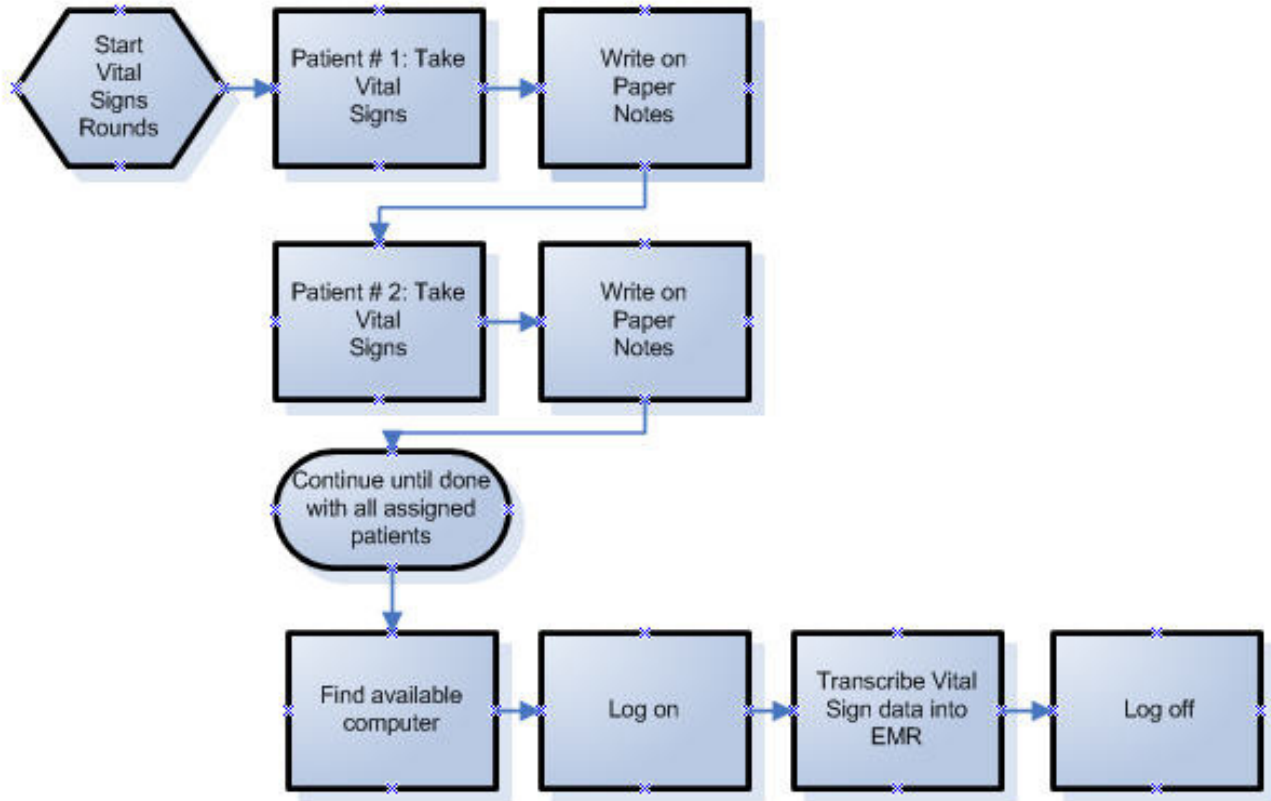


Figure 3: Workflow diagram of a typical vital signs collection process

Implementation of a mobile workflow reduced the number of data items transcribed, thereby reducing the potential for transcription errors. Figure 4 illustrates the vital sign workflow process using the Motion C5.

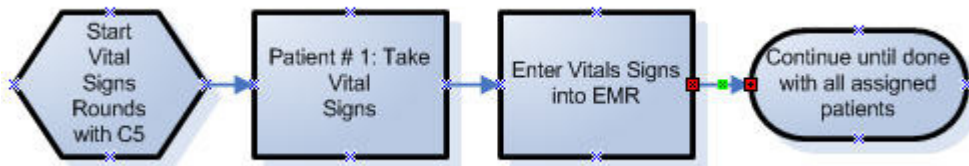


Figure 4: Workflow diagram of a typical vital signs collection process using the Motion C5

In addition, because clinicians had their own device, they were able to transcribe in real time closer to the point of care, increasing the likelihood for accurate and complete data.

Improved Nursing Satisfaction

The success of new technology implementations requires satisfied end-users. Without satisfied users, the prime benefits of any technology-enabled process may go unrealized, jeopardizing the desired benefits as well as contributing to staff unrest and turnover (HIMSS Report, 2005.) “Happy staff makes for happy patients,” said Westcott. Thus Alegent Health leaders knew nursing satisfaction was a critical study component. Following the study, an anonymous online survey of staff nurses revealed a 62% increase in overall satisfaction with the new C5 and mobile workflow process, as illustrated in Figure 5.

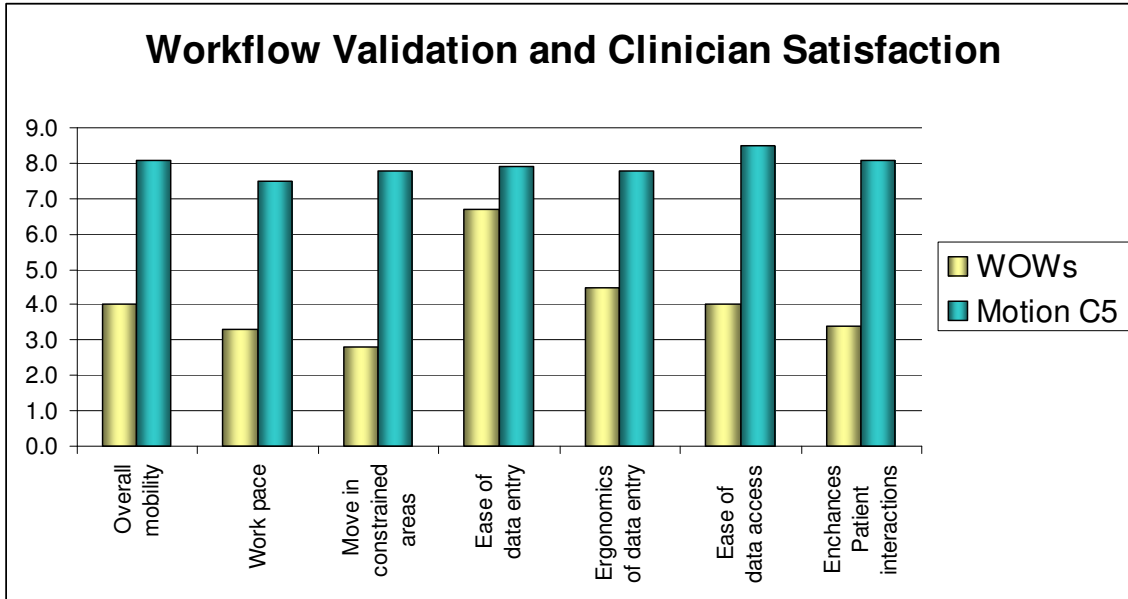


Figure 5: A 62% improved satisfaction with POC documentation process with C5 mobile clinical assistant device

Numerous factors contributed to the increase in clinician satisfaction. “The weight and accessibility were important,” claims Katie Baldwin, RN, a clinical informatics specialist. “Keep in mind that nurses are on their feet 12 hours a day. They felt it was easier to grab a C5 to give a medication than to lug a WOW down a hallway and push it into a room.”

Molly Foxhaven, a staff nurse who participated in the study, particularly enjoyed the C5’s mobility. “I liked that I could grab the handle of my computer and go around the whole floor. I could chart anywhere without having to stop and find a docking station.” Foxhaven also liked having complete chart access wherever she was. “It was nice to have the C5 with me between rooms because I had all the information if a doctor called or stopped me in the hall. I had one device to insert meds, look up labs, and get all my test results.”

Infection Control

One of the core design objectives of the C5 was to create a durable external chassis with smooth, sealed surfaces to reduce nooks, crannies, recesses and ports in which nosocomial pathogens or bacteria could adhere. A further design objective was to provide clinicians with a computing device that was easy to clean. Alegent Health staff members were pleased the C5 facilitated cleaning and disinfection. “With the WOWs, it is never clear who will clean it,” indicated Westcott. “Housekeeping doesn’t want anything to do with electronics and nurses don’t want to clean. But, cleaning a C5 unit is a breeze, so nurses are doing it.”

Cost Savings

Prior to engaging in the C5 Clinician Usability Study, Alegent Health had purchased and deployed hundreds of WOWs. Although it was not a primary focus of the clinician workflow study, one of Alegent Health’s objectives is to reduce the relative cost of acquiring, maintaining, and operationally supporting its end-user device computing infrastructure. Thus, a simple cost of ownership comparison was made analyzing upfront acquisition costs, annual operating expense, forecasted annual failure rates, and practical useful life of Motion C5s compared to the previously acquired WOWs. Extrapolated over a three year useful life, the Motion C5 was found to provide substantial savings compared to maintaining existing WOWs.

Additional impressions

Study participants noted a number of additional impressions regarding the Motion and their C5 device. “It doesn’t seem like a huge deal but the handle made a big difference to the nursing staff,” said Westcott. Westcott also noted HIPAA privacy was improved with the C5, compared to a WOW. “If necessary, you can easily turn the C5 upside down to prevent anyone from reading the screen.”

Lawonn was impressed by the overall Motion C5 design. “In general we found the design is favorable, having the handle is very helpful, and the overall size of the device is very good.” Lawonn expressed pleasure with the size of the screen, the touch screen capabilities, the battery life, and weight. “This design is very close to an ideal device for this workflow.”

From a nursing perspective, Foxhaven believed the units helped create credibility with patients. “It was easier for the patients to become confident in me because I had all their records with me. If they asked for information on an X-ray I didn’t have to go search and get back to them later.” Foxhaven believes patients looked favorably at the technology. “It spiked up a lot of conversations with patients. They took it as a good thing that we had technology and we were ahead of the curve. They felt it was another care improvement device doing all these cross checks and piqued people’s interests.”

“The C-5 devices made a tremendous difference in nursing workflow during our pilot project. Once the pilot was completed and the devices were removed, the nurses wanted them back. The entire nursing staff was excited when they learned the C5 devices had been purchased for all the medical and surgical beds at Lakeside Hospital. It has been so positive that the other hospital departments are requesting C5 pilots” said Karen Sweeney, RN, Chief Nurse Executive, Lakeside Hospital.

Alegent Health staff appreciated that Motion designers welcomed their feedback on how to make the C5s more functional. “We identified some opportunities for improvement that Motion is working on,” said Lawonn. “They take our comments to heart,” added Westcott. “You just don’t always find that with vendors.”

Collaborating for a Successful Study

Alegent Health collaborated with Motion Computing, Siemens and Intel to conduct its Clinician Workflow Study. Prior to the study, Alegent did extensive pre-work to observe and analyze existing workflow issues, identify study objectives, and develop relevant metrics. For more than a year prior to the commercial availability of the Motion C5, Siemens worked collaboratively with both Motion and Intel to determine how Siemens Soarian, MAK, INVISON[®], ID Center and other Siemens solutions could best integrate and exploit the unique, advanced feature set of the Motion C5 mobile clinical assistant to support the workflow requirements of Alegent Health and other clients. These organizations also worked closely with Alegent Health to conduct interactive design sessions. Staff from clinical, operations and IT collaborated to define the system performance thresholds and Quality of Service (QoS) metrics. Project resources were put in place to ensure consistent and sustainable service.

Alegent Health’s infrastructure teams worked closely with Motion’s infrastructure and mobility service team and other Alegent vendors to ensure Alegent’s wireless network was configured to meet the demands of wireless VoIP phones, tablet PCs, Wi-Fi enabled PDAs, and other ultra-mobile devices. Alegent Health and Motion provided on-the-job in-service training and reinforcement tools to ensure nurses were competent and confident using the Motion C5 with the Siemens Soarian and MAK applications.

Summary

Alegent Health conducted a Clinician Usability Study using the Motion C5 to assess improvements in clinician productivity, nurse satisfaction, data latency, and care delivery. The Motion C5 enabled nurses to increase documentation at the point of care and to reduce task duplications. Nurses were able to enter data more easily and faster, which improved the accuracy of clinical documentation available to other caregivers. In addition, nurses expressed increased satisfaction, were more productive, and spent more time with patients.

By thoughtfully applying technology to improve workflow, healthcare leaders at Alegent Health have demonstrated new ways to improve care delivery while optimizing clinician productivity. It is possible for healthcare institutions to achieve positive and sustainable process improvements utilizing advanced technological tools, such as the Motion C5 mobile clinical assistant, while collaborating with other technical partners.

Following the positive study results, Alegent Health ordered additional Motion C5 units for deployment across various floors and clinical departments of Lakeside Hospital and selected other hospitals. Alegent will deploy the Motion C5 and docking stations to satisfy its real-time point of care documentation objectives and improve the satisfaction of nurses and other clinicians. As Alegent Health evaluates future technology-change initiatives to improve clinical workflow and productivity, they intend to utilize Motion's Clinician Usability Study Methodology.

"The Motion C5 Study completed by Alegent Health demonstrated incredible promise for increasing both productivity and efficiency, allowing our clinicians to provide a greater level of care at the patient's bedside," said Wayne A. Sensor, CEO of Alegent Health. "We are committed to revolutionizing the quality of our health care through world-class leadership and innovations such as the C5, knowing that this is how we meaningfully enrich the lives of the families and communities we serve."

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