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Vocera Communications:

Vocera Benefits Study at The Children's Hospital at Westmead

Prepared by The NTF Group March 2007

The NTF Group

Executive Summary

This paper describes the *Vocera Benefits Study at The Children's Hospital at Westmead*—a trial of the Vocera® Communications System in the Emergency Department (ED) of The Children's Hospital Westmead in Sydney, Australia during 2006. This Vocera trial was part of a larger wireless study in The Children's Hospital at Westmead conducted by Cisco Systems and involving the deployment and evaluation of other wireless devices.

The Vocera Communications Badge is a wearable hands-free communications device that uses a hospital's wireless local area network (WLAN) to support instant mobile voice communications and messaging. Vocera leverages VoIP and speech recognition software to enable secure, two-way conversations without the use of phones or pagers.

The Children's Hospital at Westmead was considered an ideal location for the Vocera trial given its 'Connected Health' vision of becoming a digital hospital with medical grade wireless technology and network infrastructure. The need for some solid benefits data on which to build a business case for this vision was the catalyst for the broader Cisco trial, of which the Vocera solution was a major component.

Within The Children's Hospital at Westmead, the Emergency Department (ED) was chosen as the most appropriate department in which to base the trial for a number of reasons:

- The willingness of key personnel in the Department to participate in such a trial
- The recent focus within the Department on improving timely patient care, as evidenced by the development of the role of the Clinical Initiatives Nurses and the Paediatric Urgent Review Clinic
- The ready availability of historical admissions data against which to benchmark improvements

Benefits from the trial were expected to accrue in three main areas: benefits to the hospital arising from process and workflow improvements, benefits to staff arising from greater satisfaction in their roles and benefits to patients arising from better and faster care.

A combination of existing and newly collected data was used to measure the benefits from improved performance. The ED admissions database was used to assess the impact on patient waiting times while system and staff benefits were measured by a variety of observational and survey-based research techniques. Together these data sources provided a rich basis on which to understand and assess the many and varied effects of this trial.

One of the key benefits identified as a result of the broader wireless network trial conducted by Cisco were potential savings to The Children's Hospital at Westmead of 7,439 clinical hours in ED, amounting to $450,000 per annum in 2005/2006 prices (based on independent economic analysis conducted by Applied Economics). While this data came from time savings associated with the Vocera system, wireless access points and Computers on Wheels, from observation and staff response data, approximately 75% of these savings could be attributed to Vocera alone. A second benefit was the reduction in waiting times for patients in triage categories 3, 4, and 5.

These waiting times were reduced on average between 10 and 14 minutes per patient. Given an average of 119 patients per day in these categories this amounted to daily savings of over 22 hours in aggregate patient waiting time and over 46 hours in patient seen-to-exit time. Finally, significant improvements were noted in staff satisfaction levels as a result of less time being spent trying to locate the right person for a consult or conversation and more time being spent with patients.

Background

Vocera Communications System

The Vocera Communications System is a hands-free, voice-driven communication platform that runs over a hospital's wireless network. This solution consists of two key components: the Vocera System Software that controls and manages call activity, and the Vocera Communications Badge, a light-weight, wearable, voice-controlled communication device allowing hands-free conversation throughout a facility.

The Vocera System Software operates on a Windows server and houses the centralised system intelligence, including the user database, administration and user consoles, and speech recognition engine. By creating and maintaining a profile for each user on this system, Vocera enables badges to be shared between staff members working different shifts. To provide even more ways to reach important resources, Vocera also integrates with existing PBX and nurse call systems.

Weighing less than two ounces, the Vocera badge can be clipped to clothing or worn on a lanyard. It is a voice-driven device based on IP telephony. Within range of the wireless network hospital staff can communicate with each other by simply speaking the name of the person they are seeking to contact into the Vocera badge. This action triggers a call to that person's badge.

Vocera allows users to call one another by name, function, group, telephone number, or extension. Calling by name eliminates the need to remember phone numbers, while group calling allows staff to reach the relevant person in a particular department without having to refer to duty rosters or on-call charts. Calling by function involves linking a staff member to a particular role (e.g., Duty Nurse) so that a request for the role will be put through to the individual filling it at that point in time. Access to all staff logged onto the system eliminates the need to 'page and wait' reducing the time it takes to assist patients. Text messages and alerts can also be sent to the LCD screen on the back of the Vocera device.

Wireless voice communication of this type enables medical staff to contact each other wherever and whenever they need to. As was observed in The Children's Hospital at Westmead's Emergency Department this is particularly important in emergency situations or when information must be obtained quickly.

The Children's Hospital at Westmead

The Children's Hospital at Westmead is located in the rapidly-growing residential western suburbs of Sydney, about 30 kilometres (18 miles) from the Central Business District. It is a freestanding children's hospital dedicated to the care of children from all parts of Australia and from other countries. The hospital was purpose-built to meet the needs of children and their families, and has a bed capacity of 339, comprising 238 overnight beds and 31 for same-day treatment. The Children's Hospital at Westmead also functions as a teaching hospital for the University of Sydney and the University of Western Sydney and is a leading institution in children's clinical research.

The Children's Hospital at Westmead is transforming itself into a digital hospital through a "Connected Health" model that is based on wireless technology and network upgrades. This transformation involves a new business model for the design and delivery of healthcare based on three interdependent elements (1) new clinical services and applications (2) people and process reforms to improve workflow and underlying business process (3) information and communication technologies on a "medical grade" network. This made The Children's Hospital at Westmead an obvious choice for a Vocera trial.

Within The Children's Hospital at Westmead, the Emergency Department provides initial care for injured and ill children, including cases brought in by ambulance and helicopter. Some children are subsequently admitted to the hospital, while others are treated within ED and go home. In Australia in general, the number of patients coming into hospital emergency departments

Vocera Communications Badge

has increased year-on-year. In The Children's Hospital at Westmead, the increase is above the national average and growth has been around 10% each year.

In 2005/2006 43,300 patients were handled by the Emergency Department, an increase of just over 11% on the previous year, continuing a trend of year-on-year increases of approximately 10% per annum over the past five years. This phenomenon has placed the ED under significant pressure, heightening the need for better communication and workflow processes.

The Vocera Trial

The Vocera solution deployed in The Children's Hospital at Westmead trial involved the wireless voice-communications badge, which was worn around the neck by around 40 staff in the Emergency Department, including nurses, fellows, consultants, registrars and heads of department.

Training of ED staff commenced in mid-March of 2006, with the majority of staff fully trained by mid-April. At the time of writing, the Vocera solution is still in use at The Children's Hospital at Westmead however, for the purposes of analysis we have assumed that the trial ran from mid-April 2006 to end-October 2006.

On arrival at the Emergency Department, patients are triaged into one of five triage categories. Patients in categories 1 and 2 are those who require immediate treatment and who usually have arrived by ambulance. Patients in categories 3, 4 and 5 are cases that are urgent, semi-urgent and non-urgent respectively. Analysis has focused on patients in triage categories 3 through 5 because this represents the largest group of patients and because it is amongst this group that the time-saving benefits of Vocera are most likely to be evident. (As patients in categories 1 and 2 are seen almost immediately on arrival at the ED, there is little if any opportunity for a reduction in waiting-time to be observed.)

Observational research, conducted in the year *prior* to the trial, showed that clinical staff spent a great deal of time running from one part of the Emergency Department to the other. This was due to a variety of reasons, such as looking for other clinicians to assist with a patient, getting help with drug dispensing, providing information about a patient, contacting a consultant, and finding a porter.

The layout of ED contributes significantly to the difficulties that clinicians face in locating people. Corridors branch out like arms from the front desk making it impossible to see a clinician who is in a different 'arm'. It is also difficult to locate someone who is within the area known as the 'cubes' as visibility between cubes is very limited.

Prior to the Vocera trial clinicians sometimes used pagers to locate other staff, but because of the time it took to find a phone, wait for it to become free, and then wait for a return page, they mostly preferred running around to locate the person they needed to speak with. Clinicians who were unable to leave the bedside of a child with an acute condition found it particularly difficult and were forced to wait until an appropriate member of staff came by. Generally this was not a long wait, but with a critically ill child, any wait can have dire consequences.

Although all rooms have an emergency button, there is often the need to hold the child and Vocera was commended by clinicians as being of assistance under such circumstances because of its hands-free nature.

Research Design

A combination of existing hospital data sources and data specifically collected for the trial was used to measure the benefits from improved performance.

Patient benefits were measured using existing data sources (the Emergency Department admissions database). This was used to assess the impact on patient waiting times. The ED's Admissions database provided information regarding:

- Time and date at which each patient was admitted, seen and discharged
- Triage category into which the patient fell (with 1 being the most urgent cases and 5 the least urgent)
- Reason for the patient's visit to Emergency
- 'Outcome' of the visit

To establish benchmarks and estimate potential savings, every admission since 1 January 2002 was considered.

System and staff benefits were measured by observational and survey-based research techniques. Online staff surveys were conducted prior to the deployment of the Vocera solution and then again a few months after deployment. They were repeated again amongst committed Vocera users at the end of October 2006. Key personnel were observed pre-deployment as they went about their daily tasks and each action they took was monitored. Key personnel were then interviewed, in-depth, post-deployment. This took place in the early period of the trial (in June 2006). Finally in-depth interviews were conducted, using a standardised interview outline (and rating scales) with 13 of the most frequent or 'committed' users of Vocera.

The following table provides additional detail on the various research techniques used.

Data Sources	Key Aspects	Timeframe
Analysis of ED admissions data	• Modeling (ordered logit) and analysis of admissions data for patients within triages categories 3, 4 and 5 • For the purposes of analysis the data was split into three time periods – Pre-installation: 1 Jan '02 to 14 Mar '06 – Training: 15 Mar '06 to 14 Apr '06 – In-use: 15 Apr '06 to 31 Oct '06	November 2006
Observational Research	Observation of the day-to-day activities of 8 key personnel: • Clinical Nurse Specialist – Surgical Unit • Staff Specialist – Paediatric Intensive Care • Staff Specialist – Surgery • Clinical Coordinator – Surgical Unit • Medical Fellow • Medical Department Head of Emergency • Medical Registrar • Surgical Resident The following information was captured for each clinician: • Detailed information about the activities undertaken during a 'typical' day • Time taken to perform frequent activities and how often these were undertaken or attempted • Bottlenecks in process that could potentially be improved by devices (such as Vocera) dependent on wireless technology Detailed flowcharts were prepared depicting 'a day in the life' of each observed staff member. A review of these flowcharts helped to determine the potential areas for time savings once the Vocera Communications System had been deployed in addition to the areas that would benefit most from the deployment.	June 2005
Benchmark Staff Survey	Online survey of Fellows, Consultants, Registrars and Nurses in ED Sample size = 64. Surveys were designed to establish benchmarks for key measures, in particular: • Satisfaction levels with various aspects of the hospital environment, such as the time spent finding the right person for a consultation or conversation • Estimates of the actual average time spent waiting for a return page or trying to contact someone	December 2005 - January 2006
In-Use Staff Survey	Follow-up survey of Fellows, Consultants, Registrars and Nurses in ED Sample size = 41. Participants were asked the same questions as the first survey, with the addition of a specific question in relation to staff's own estimate of the time saved as a result of using the Vocera System	June 2006
Committed User Interviews	Smaller survey conducted in conjunction with in-depth interviews amongst heavy-users of the Vocera System Sample size = 13. This survey was designed to ascertain for this group: • Levels of satisfaction with various aspects of their role (such as the amount of time that they spend with patients) • The Vocera functionality that they use • Perceptions of the level of improvement in various activities (such as speed of communication) • Estimates of the time saved by using Vocera • Specific examples of how Vocera had helped with patient care and with staff and patient safety • Levels of agreement with various statements about the Vocera Communications System (such as "I would recommend Vocera to a colleague")	October - November 2006

Results & Discussion

'Waiting Time' Reductions in the ED

The ED admissions data included, for each admission, three time stamps: the time that the patient presented at ED, the time that the patient was first seen by a clinician, and the time that the patient was discharged (into hospital, home, alternate medical facility, etc.). The first phase of modeling focused on the interval between the first two time-stamps—that is, the interval between the patient presenting at ED and first being seen by a clinician. For simplicity, we call this the 'waiting time'.

The NTF Group compared data on waiting times for patients categorised as triage category 3, 4 or 5 patients over the period 1 January 2002 to 14 March 2006 with data on waiting times for the period 15 April 2006 to 31 October 2006 (commencing one month after the introduction of the pilot project to allow time for staff training and familiarisation with the Vocera System).

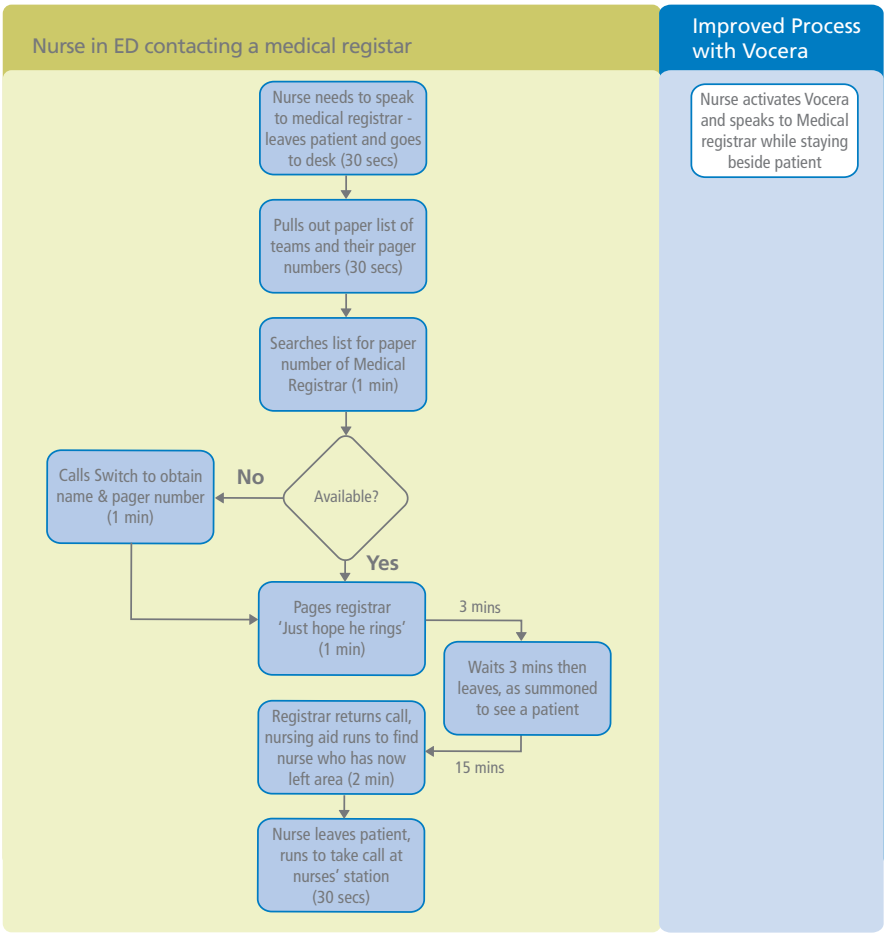
To ensure that the comparison across the two time periods was valid, statistical models were built that controlled for the effects of the variability in otherwise confounding variables such as illness type, patient load, seasonal influences (such as public holidays), time of day, day of the week, and month of the year. Obviously it was not possible to control for changes in staff or equipment, or for changes in operating practices in the Emergency Department. However, The Children's Hospital at Westmead confirms that there were no substantive changes in the resources or technology used in the Emergency Department during the trial period that are likely to have affected waiting times other than the introduction of wireless technology.

Table 1: Estimated daily savings in patient waiting time with Vocera System, 15 April – 31 October, 2006

Patient Category	Average No. of Patients per Day	Estimated Savings per Visit (Mins)	Daily Savings (Hours)
Triage 3	41.7	10.7	7.4
Triage 4	37.3	14.1	8.7
Triage 5	40.2	9.9	6.7
Totals	**119.2 (Sum)**	**11.5 (Average)**	**22.8 (Sum)**

Table 1 summarises the results of this modelling and shows, for example, that an average of 119.2 patients presented to ED each day and were categorised as triage 3, 4 or 5. The average reduction in the waiting time for each of these patients was 11.5 minutes, which represents a daily saving of 22.8 hours in aggregate patient waiting time.

Observational research before and after showed that there were many instances where because of speedier and more effective communication staff were able to save time and thereby ensure faster throughput of patients. The example below shows how the lines of communication have become simplified.



Estimate of Seen-to-Exit Time Reductions in ED

The second phase of modelling focused on the time interval between a patient being seen and exiting ED, either to be admitted to the hospital for ongoing care or to go home.

Table 2 summarises the results of this modelling and shows that the average reduction in the seen-to-exit time for each of the patients in triage categories 3, 4 and 5 was 23.2 minutes, which represents a daily saving of 46.1 hours in aggregate patient waiting time.

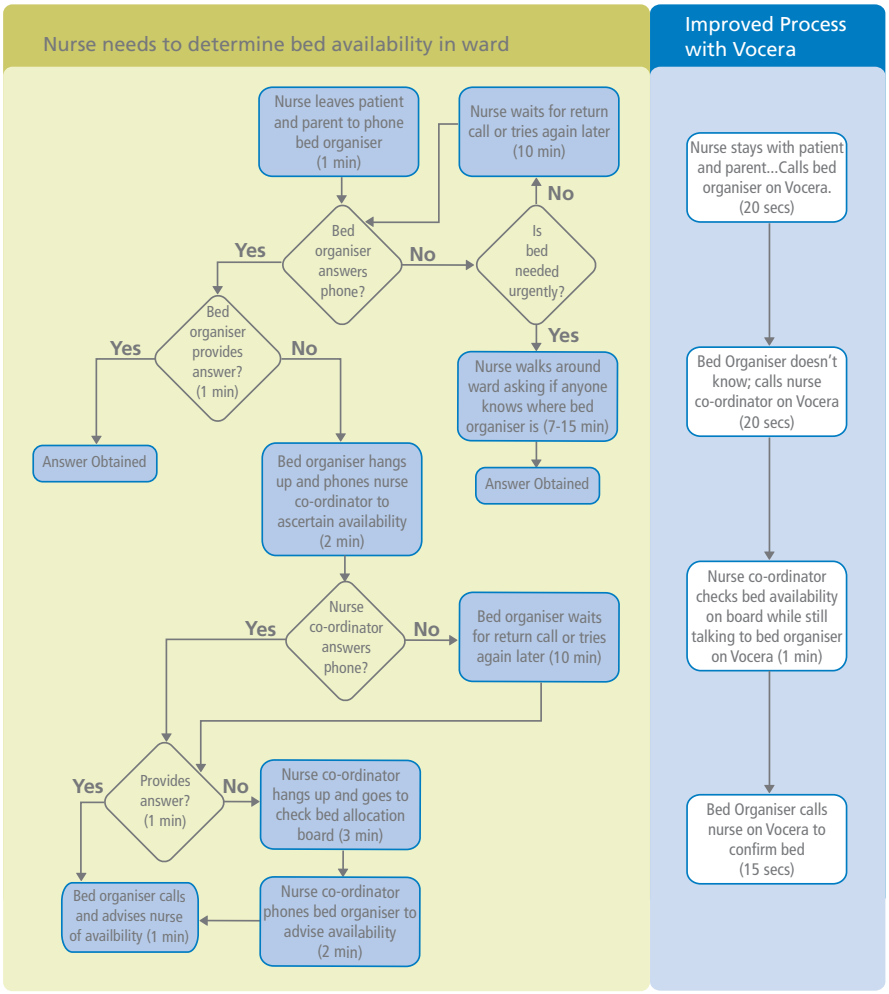
Some caution must be exercised in attributing the entirety of this time saving to the Vocera implementation as improvements in bed management practices also took place during the trial period.

The committed users believed that better communication via Vocera was largely responsible for the improvement and resulting reduction in patients' seen-to-exit times.

For instance, the improved bed management practice was greatly facilitated by Vocera as the following workflow shows:

Table 2: Estimated daily savings in patient seen-to-exit time with Vocera System, 5 April – 31 October, 2006

Patient Category	Average No. of Patients per Day	Estimated Savings per Visit (Mins)	Daily Savings (Hours)
Triage 3	41.7	44.4	30.9
Triage 4	37.3	17.3	10.8
Triage 5	40.2	6.7	4.5
Totals	**119.2 (Sum)**	**23.2 (Average)**	**46.1 (Sum)**



Financial Benefits

Two independent consultancies, Aegis Consulting Australia and Applied Economics were engaged to convert the NTF Group's estimates of waiting-time reductions into cost savings. To do so it was assumed that reductions in patient waiting times translated into staff time savings on a one-for-one basis.

These cost savings were calculated *before* the final reductions in patient waiting time had been determined so they were based on an earlier, slightly smaller reduction of 20 hours and 23 minutes per day (rather than the final figure of 22 hours and 48 minutes per day). This represented a saving of 7,439 hours per year, which, using the average hourly fully loaded cost per FTE clinician of $60.65 per hour, equates to a saving of over $450,000 per annum in ED alone.

While this data came from time savings associated with the Vocera System, wireless access points and Computers on Wheels, further observations and staff response data concluded that approximately 75% of these savings could be attributed to Vocera alone.

As a commonsense check on the time savings figures, approximately 20 hours saved per day across approximately 80 FTE staff (roughly the FTE in ED) equates to 15 minutes per FTE per day, which is broadly consistent with the self-reported time-savings estimated in the In-Use Staff survey.

By role type, the time savings estimated from that survey were:

- Consultants: 12 minutes
- Fellows: 17.5 minutes
- Registrars: 9.5 minutes
- Nurses: 24.8 minutes

Since nurses make up the overwhelming majority of Vocera users in ED, the weighted average saving comes out at 19 minutes per day per FTE, a little higher than the 15 minutes assumed in the calculation above.

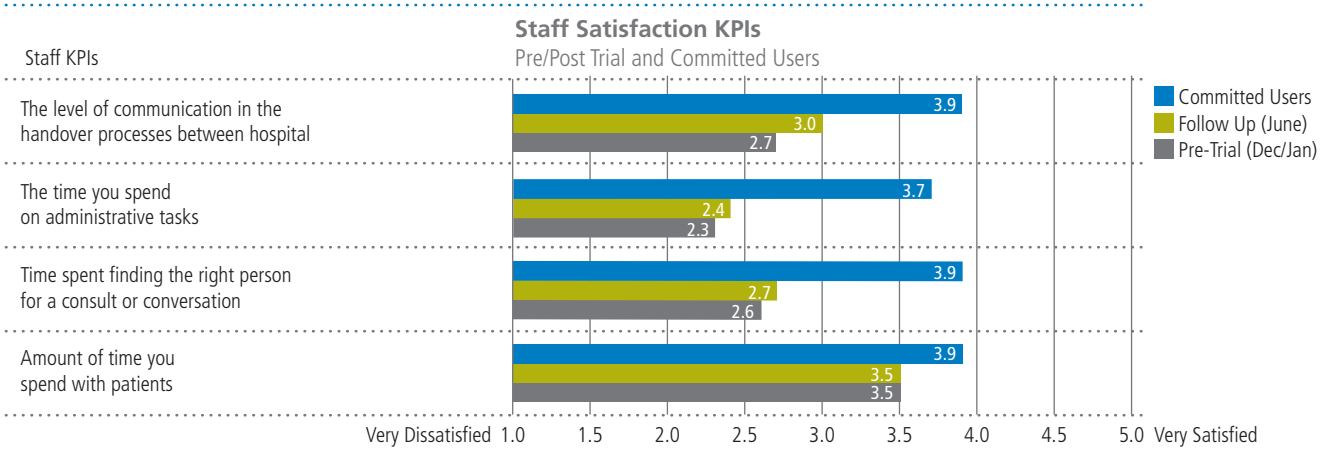
Note: Amongst committed users, an average time saving of 41 minutes was estimated, suggesting that committed use amongst a broader group of users could yield even larger savings

Staff Benefits—Benchmark Surveys

Staff satisfaction and perceived process efficiency improvements were quantified by comparing benchmarks established in the Benchmark Staff Survey, conducted over the period December 2005 to January 2006, with the results of the In-Use Survey, conducted in June 2006, and the Committed User Survey, conducted in November 2006.

These comparisons showed:

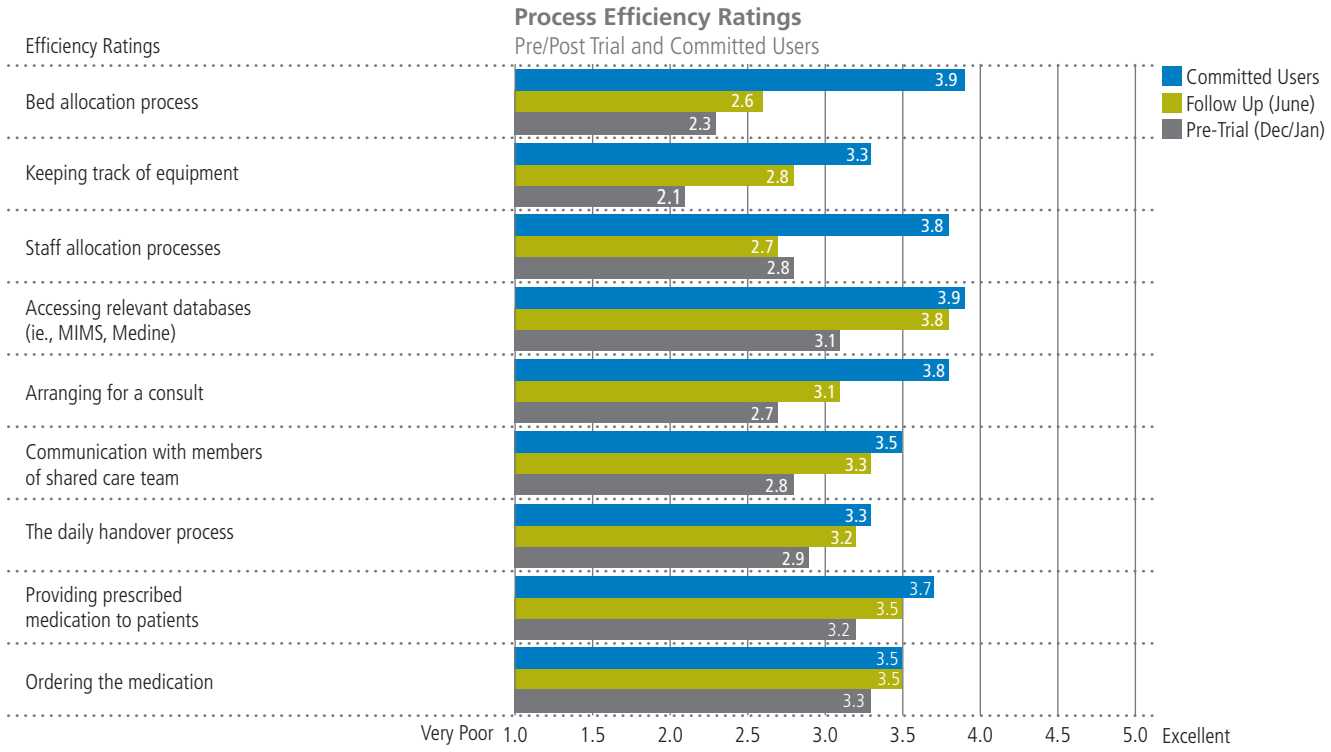
1. Significantly higher levels of satisfaction in relation to communications and time allocations.



The committed Vocera users had significantly higher satisfaction levels across the key areas of communication in the handover process—i.e., the time spent on administrative tasks and time spent finding the right person for a consult or conversation

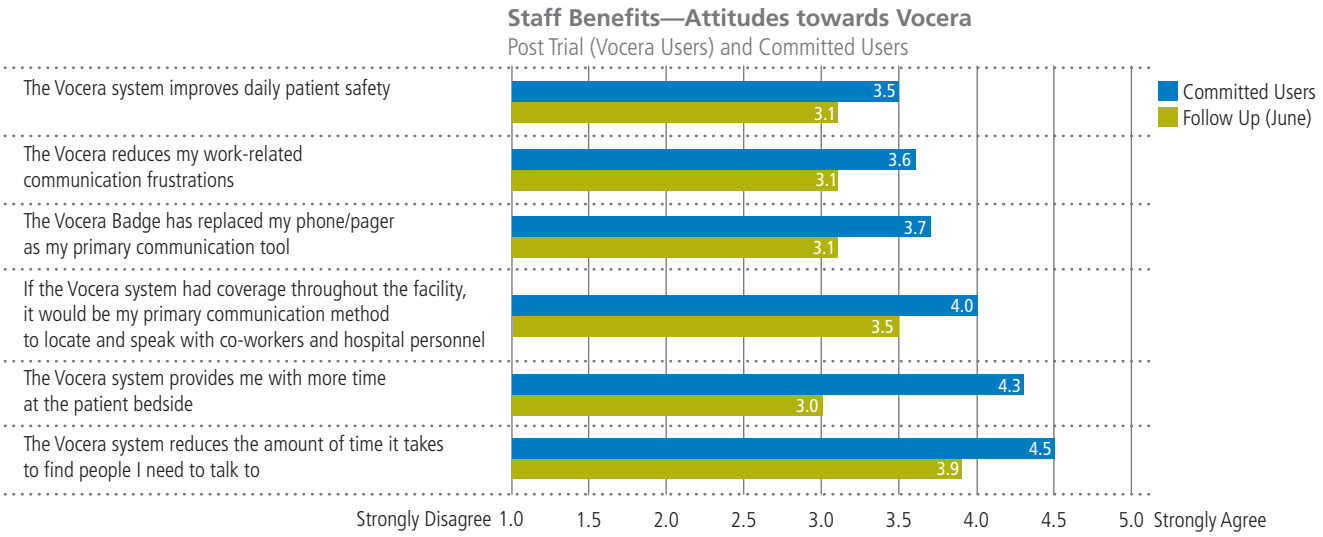
At the outset of the trial these areas were nominated for measurement as it was expected that improved staff satisfaction in them would show that bottlenecks had been overcome and staff would be freed up to concentrate on patient care. This graph clearly shows that to be the case highlighting improved staff satisfaction when it came to time spent with patients.

2. Significantly improved ratings for the efficiency of a range of processes.



For many of these processes—especially bed allocation, staff allocation, arranging for a consultation and keeping track of equipment—efficiencies are obtained largely through better person-to-person communication, an outcome that all users, committed users in particular, attribute to the Vocera solution.

3. Extremely positive attitudes towards the Vocera solution across a range of dimensions.



This chart shows that the committed users are even more positive in their attitude to Vocera than are Vocera users generally. Committed users agree very strongly with the statement that Vocera provides them with more time at the patient bedside.

Even higher levels of agreement were recorded in relation to the statement that Vocera reduces the amount of time it takes to find people they need to talk to. And they strongly endorse the view that if Vocera had coverage throughout the hospital it would be their primary communication method to locate and speak to people.

In the in-depth interviews committed users said their frustration level with the job was lower than before Vocera and this chart supports the role that Vocera has played in reducing communication frustrations.

Staff Benefits—Surveys and In-Depth Interviews

There were many quotes from staff illustrating the key points highlighted in the graphs. Some of these quotes are assembled below to show (in the authentic voice of the clinician) just how they felt about their experiences using the Vocera solution.

1. The ability to provide better patient care

Of critical importance to clinicians is the sense that patient care will benefit from their use of Vocera.

The committed users believed that Vocera enabled them to provide better patient care, which was immensely satisfying for them. They pointed out that they did not have to leave the patient or the parent. The head of the department noted that *"Anything that can improve staff communication has the ability to improve patient care."* To illustrate this point, one nurse found herself in the situation of having started a complicated dressing procedure on a child's leg. The child was stretched out on the bench in the procedure room, which is away from the main part of the ward and she had closed the door for privacy. Then she discovered that she had run out of dressing. Without Vocera she would have had to try to take the child with her (too large to carry) or resort to shouting out for assistance or just hoping that someone would look in.

"I had an instance where I was putting a dressing on a patient's leg. I was in the procedure room by myself and I ran out of dressings. I couldn't leave the patient; she could have fallen off the bed. It was so easy to get someone to come and bring me what I needed."

Additional points illustrating how Vocera helped improve patient care were supported by the following quotes:

"It improves efficiency of patient care — I can attend to them more quickly and make decisions."
Senior Emergency Specialist

"It helps with patient care — if people are doing procedures and they need help they don't have to stop and can get help."
Registered Nurse

"When in charge I can find staff and communicate with patients at the same time."
Registrar

"I can immediately call for doctors and extra nurses."
Registered Nurse

2. Ability to reassure parents on the spot

Improved information flow as a result of Vocera was also seen as being of value for parents, communication with whom, in a children's hospital, forms a large component of patient care.

This nurse emphasised the value to parents, contrasting the fact that she can give them an answer straight away rather than leaving them alone. She mentioned how good it felt to be able to reassure parents by staying with the child.

"It's the ability to give parents the instant answer instead of running around and leaving them there not knowing what is happening. You can give instant feedback to the parent."

3. Ability to assist with patient safety

Several staff members also provided clear examples of improved patient safety resulting from the use of the Vocera solution. One nurse described how she was still able to get assistance without leaving the patient's side:

"I had to hold a patient's head, I couldn't let go for its safety. I would have had to wait for someone to walk by, but was able to call for a nurse to come and assist me."
Registered Nurse

Others found that, because it was easy to call someone to get a second opinion, they were now doing this more often, resulting in improved decision making:

"In triage, rather than making a wrong decision I have made a quick call to confirm."
Triage Nurse

It was also felt that use of the Vocera device reduced the possibility of errors because staff tended to communicate directly rather than leaving notes that could be misinterpreted.

"It cuts down on errors in written communication because you can explain directly."
Registered Nurse

In an emergency, one clinician thought that he was out of range of the wireless network because he was out the back of the hospital, but he used Vocera anyway and in fact it did work, much to his relief. He gave this as a prime example of improving patient safety.

"I did use it out the back of the hospital—didn't know till then that it would work—just tried it on the off chance. I urgently needed a wheelchair—a child had had an arrest. I called on Vocera. It was great—I got the wheelchair straight away."
Nurse Co-ordinator

4. An overwhelming belief amongst staff that the Vocera solution will make jobs easier

All staff members felt that using Vocera made it easier to locate colleagues and reduced time spent running around. Some noted that Vocera benefited them by making it easier to book beds or summon people as needed without leaving the patient's side. Others commented that they had found Vocera so easy to use it had become "automatic".

The following quotes illustrate these points:

"It has improved my running around. It saves me an hour in running around trying to chase people."
Nurse Co-ordinator

"It streamlines what you do. You have fewer interruptions and you can call someone to do something for you."
Registered Nurse

"I'm able to quickly liaise with a team leader and it is much easier to book beds."
Nurse Co-ordinator

"I like it—it has become automatic—so much so that at home I've found myself going to use it to call my husband!"
Registered Nurse

Locating equipment was one of the bottlenecks identified in the observational study before the trial. One nurse was very grateful for Vocera making it easier to find some equipment she needed in the storeroom. This is how she described her novel use of Vocera:

"I found it very useful getting directions to find something I needed in the storeroom. The only one I knew who would know was at home, so I called her at home on Vocera. She gave me remote instructions, like 'now move to the shelf on your right, look up to the next level, in the far right corner,' incredibly useful. I was walking around the storeroom, telling her where I was and she was able to direct me."

Conclusion

The evaluation of the trial has shown that Vocera has contributed significantly in improvements across three key criteria: financial benefits, patient care and staff satisfaction.

Total savings to the hospital in terms of reduced patient waiting time have been independently audited and of the possible $450,000 annual savings in the emergency department, the trial has shown that Vocera contributes three quarters of these savings, that is $337,500 per annum.

Significant reductions in waiting times have been seen for patients in triages 3, 4, and 5. These waiting times have been reduced on average between 10 and 14 minutes per patient. Given a daily average of 119 patients in these categories, this amounted to daily savings of over 22 hours in aggregate patient waiting time and over 46 hours in patient seen-to-exit time.

Staff also believed that patient care was improved as they were able to spend more time with patients and their parents, they could respond more immediately and summon additional help as required without leaving the patient.

Finally Vocera contributed markedly to the increased satisfaction of staff, which was very evident amongst the highest users whose satisfaction scores across all key processes were even higher than those who were less frequent users.

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