

# Drivers and challenges of wireless solutions in future healthcare

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## **Abstract**

What do IT oriented healthcare people think to be most attractive and credible wireless applications in healthcare? What do they think about the challenges? These questions were presented to 70 participants randomly in HIMSS08 conference in February 2008, Orlando, USA. The questions were formulated in a one page query form with a two dimensional driver chart and one dimensional challenge chart. Proposed drivers and challenges were selected by the authors within a roadmapping project (Wirhe) where wireless future dimensions of healthcare are examined more deeply. The selected evaluators were motivated by a raffle of a Nokia's smartphone. The evaluators placed the proposed drivers and challenges on the charts by using a pen and answered on two background questions about their expertise area and country. The data was uploaded into ZEF-analysis tool ([www.zefsolutions.com](http://www.zefsolutions.com)) and the reports were processed both by direct calculation and applying z-scoring method. Results show that in average the most attractive application and credible application is wireless alarming and calling help. The second and third are mobile access to patient health record and vital signs (health) monitoring. The results show also that process change challenges are remarkably more difficult than technical challenges. Especially, the process change from the doctors' point of view is severe. Among technical challenges usability of the mobile user interface is seen the most difficult. Instead, the security of patient data is no more among the most severe challenges.

Key words: Wireless healthcare, mobile access, process change, drivers and challenges

## **Introduction**

Healthcare is a mammoth industry valued globally to worth USD 6 trillion. According to Kalorama's market study<sup>1</sup> alone in USA healthcare spending was in 2007 USD 2.3 trillion with 8 percent CAGR (Compound Annual Growth Rate). However, heedless of its stiffness it should be changed as fast as possible. Many global trends (aging of population, changes in environment and global climate warming) set major challenges to human health and healthcare.

Kalorama's market study promises also rapid growth of IT and especially wireless technologies risen from demand to enhance healthcare processes by technical products and services. Wireless technologies are seen to have huge potential. They can improve the patient care, reduce costs, streamline processes, help to obey regulations and give many other benefits. In decision making healthcare professionals need real-time access to data at the point of action for enhancing the process. Other useful applications of wireless technologies in healthcare are remote patient monitoring, e-prescription, asset management and tracking, etc.

According to above mentioned market study total market for wireless technologies in U.S. healthcare (2005) was USD 1.8 billion and is expected to grow annually 33 percent till 2010 to reach to USD 7.3 billion.

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Large information technology (IT) vendor companies like IBM, Intel, Microsoft, HP, Cisco and Google have started to concentrate their efforts on renewing healthcare by offering new technical solutions.

An IBM research team<sup>2</sup> concludes the huge challenges of world's healthcare systems: "Change must be made; the choices left to the stakeholders of today's healthcare systems are when and how. If they wait too long to act or do not act decisively enough, their systems could "hit the wall" – in other words, be unable to continue on the current path – and then, require immediate and major forced restructuring." They recommend healthcare providers to enhance management of chronic diseases and prevention of illness, consumers to take personal responsibility for their health and maximize the value they get from healthcare system, payers to help consumers remain healthy and care delivery organizations and clinicians to deliver higher value healthcare, suppliers to collaborate with care delivery organizations, societies to make better decisions regarding lifestyle expectations, governments to provide the leadership and political will power needed for innovative sustainable solutions. They also proposed three methods to improve healthcare systems: 1) transforming value, 2) transforming consumer responsibility and 3) transforming care delivery.

The same IBM research team has also written a paper of changes in healthplans<sup>3</sup> due to the changes in U.S. healthcare system. The major changes in a typical successful U.S. health plan in 2015 could be, among others, significantly different number of employees in different roles with some functions outsourced or performed collaboratively with business partners. Also the business processes should be greatly improved and enhanced with IT-related capabilities. They also recommend integrating health plans and wealth plans together with combined goals and health and financial planning tools and records.

Disease management is proposed by Intel's research team to be reconceived<sup>4</sup>. They emphasize development of IT solutions for chronic diseases. Patients with chronic conditions take 83 % of U.S. healthcare spending, 81 % of inpatient stays, 91 % of prescriptions, 76 % of physician visits and 98 % of home healthcare visits<sup>5</sup>. Technology is needed to strengthen patient long-term engagement on the care process. Healthcare providers can get accurate, relevant and timely information from their patients and the patients can have an intuitive, enjoyable and educational means of communication with their care team and their families. In addition to periodic mailings and phone calls communication can happen by e-mail, video conferences, SMS messages and other mobile services. Touch screen and other user friendly technologies may serve even people with little experience on IT.

Wireless Healthcare's (UK) report of wireless based disease management<sup>6</sup> argues that wireless technologies play a key role within disease monitoring and modelling applications. In developed countries AIDS, diabetes and influenza are diseases which play a major role with healthcare providers and pharmaceutical companies. They present examples of disease management systems for these three diseases: Voxiva's HealthNet<sup>7</sup> for managing major health programmes like HIV/AIDS, a mobile telemedicine system for Type 1 diabetes monitoring developed by the University of Oxford and Tplus Medical<sup>8</sup>, and a SAPPHIRE system for analyse, detect and respond to public health matters built by the University of Texas applying technology developed by Oracle and TopQuadrant. The system was used, for example, to analyse healthcare data in the repercussion of Hurricane Katrina in 2005.

California Healthcare Foundation<sup>9</sup> has collected the wireless applications of healthcare under two major categories: 1) Monitoring applications for cardiac, diabetic etc functions and 2) Patient communication and supporting applications. Monitoring applications can use portable, wearable or implantable sensors and work automatically. The latter applications provide patients with information and feedback directly and encourage them to take an active role in managing their health.

There are many applications available, for example, for cardiac monitoring<sup>10</sup> glucose monitoring<sup>11</sup> and multiple vital signs monitoring (portable and wearable) and even implantable monitoring integrated in pacemaker<sup>12</sup>. Other applications according to California

Healthcare Foundation are appointment reminders, health education and promotion applications, public health alerts, compliance reminders and other treatment support and engagement applications. BeWell's Asthma Assistant<sup>13</sup> is just one example.

California Healthcare Foundation defines a set of challenges as issues and implications. The health industry issues are uncertainty about reimbursement, unproven benefits, incompatibility of the health system for wireless applications, and privacy and security issues. The technical issues are potential information overload and lack of standards the market issues incomplete coverage, network fragmentation and mismatch between rapidly changing cell phone market and slow health care market.

Continua Health Alliance<sup>14</sup> shortly Continua is a giant cooperative effort to achieve continuum in care from the companies point of view<sup>15</sup>. There are already 133 companies who have joined together to develop architectures, create use cases and define standards for better integrated healthcare services. They focus on three target areas: 1) disease management for managing a chronic disease outside of a clinical setting, 2) aging independently for using technology and services to live in your own home longer, and 3) health and fitness for expanding personal health and wellness to where you live and play.

Continua's ecosystem contains sensor devices (like blood pressure and glucose meters, weight scale, pulse oximeter, spirometer, fitness equipments, implanted monitors etc.), RF connectivity means (like WLAN, Bluetooth, Zigbee, USB, etc.), aggregation and computation stations (PC, Cell phone, personal health system etc.) and health services (like healthcare provider, disease management, diet or fitness, personal health record and implant monitoring service).

Continua's End-to-End reference architecture contains PAN (Peripheral Area Network) devices and LAN devices, application hosting devices, WAN devices and Health record devices.

On the hospital side there are a lot of findings for improving outcomes. Solovy<sup>16</sup> lists ten lessons for hospitals and health systems to improve their outcome and quality: Improve patient flow, workflow and process, measure results and manage medication, use smart alerts and ubiquitous access to images, remember operation rooms and plan for the worst. Infrastructure investments are also important in addition to IT investments.

We can see that there are a lot of research and development work proceeding in the world for rescuing healthcare from global crisis by reengineering processes, finding new service solutions and developing new technologies. Wireless technologies give interesting new applications but face also challenges.

## ***Proposed drivers and challenges***

Information technology is generally seen as one of the means to solve many of the healthcare problems and, especially in our case, wireless technology with wide variety of mobile solutions is expected to help improving healthcare processes and increasing outcomes.

An important choice of us is that we handle with same priority both professional healthcare (mostly in hospitals and other institutional services) and private healthcare (mostly health promotion, monitoring and care at homes). We ask: Which wireless applications would be the best drivers? And what challenges are the most difficult drags?

We divide the potential wireless applications into three categories: 1) Applications for better access to patient and medical information, 2) Applications for untethered patient vital signs monitoring including home monitoring and 3) Applications for workflow management. All of these applications can be used both in hospitals and for outpatients. Some of the applications are planned for private health promotion and some are for professional healthcare only.

Mobile access to patient and medical information includes many different categories like access to patient health record, access to prescription system, access to inventory system

(CPOE - Clinical and pharmacy order entry and management systems), access to medical data bases etc. As well untethered patient monitoring could include many subcategories like ICU level, ward level and home level monitoring. Workflow management contains, for example, location and tracking solutions.

On the basis of a pre-study which we carried out two years ago and remembering that the choices should be known and easily understood we selected the following five applications for evaluation:

1. Mobile access to patient health record
2. Location and tracking for process enhancement
3. Vital signs (health) monitoring
4. Alarming and calling help
5. Comfortable home monitoring

We decided to use 2-dimensional chart with Attractiveness on horizontal axis and Credibility on vertical axis.

On challenges list we selected the following six problems:

1. Usability of the mobile user interface
2. Stability of connection
3. Usable but reliable authentication
4. Security of patient data
5. Process change from the nurses' point of view
6. Process change from the doctors' point of view

Here we decided to use 1-dimensional chart with Level of difficulty on horizontal axis. The first four are technical problems and last two process problems.

For classification we added two background questions: What are the answerer's primary responsibilities in his/her job? and Which country do they come from?

The query form can be seen in Appendix 1.

## ***Interviewees and interviews***

All 70 of the query answerers (interviewees) were attendees at HIMSS08 (2008) conference. 18 of the interviews happened on Sunday 24<sup>th</sup> of February during Opening Reception between 5 to 8 pm, 32 during Monday 25<sup>th</sup> of February and 20 at a breakfast panel meeting of ours on Tuesday 26<sup>th</sup> of February between 7.30 to 8.30 am. 47 of the answerers were participants of wireless oriented sessions since we tried to find people who are interested in wireless solutions. We arranged at the end of the panel meeting a raffle of Nokia N95 8GB smartphone to motivate people to participate our study.

According to background questions' answers 27 of the answerers represented USA, 26 Finland, 5 Canada and 11 other countries like France, Australia, India, Malaysia, Mexico and Sweden. The Finnish answerers represented more than half of all Finnish attendees at HIMSS08.

The primary work responsibilities of the answerers were Management (20), Technical (19), Marketing (10), Medical and nursing (5) and other (13).

The interviews (or filling the query form) took about 2 to 5 minutes per each, and less than ten of them asked focusing questions about the study objectives, organizations or answering methods. Half of the answering was effected by dealing the query forms out to participants of a session and collecting the fulfilled ones after the session.

All of the answers were moved to ZEF-service which is a two dimensional graphical query tool capable to z-score processing and is available in Internet.<sup>17</sup>

### **Driver analysis results**

The results of evaluating the drivers have been processed by calculating average and mean in horizontal and vertical direction. The position of the numbers 1 to 5 on the charts in Figure 1 tells averages and the height and width of the ellipses around the numbers are proportional to mean on the respective direction. In the left hand charts z-scoring have been applied to original answers before processing averages and means. The z-scored charts give better resolution and are also more accurate than raw processed charts since they give full resolution of the chart for each evaluator.

From the charts we can see that Alarming and calling help (4), was raised the most attractive and credible driver application in wireless healthcare. The US evaluators see the Vital signs (health) monitoring (3) even more attractive and credible and the Finnish evaluators raises Comfortable home monitoring (5) the most attractive. The Canadian evaluators see Mobile access to patient health record (1) the most attractive and credible application.

The largest difference is in the attractiveness of Comfortable home monitoring (5). The US evaluators place it far left from the other applications so that it is also on left in total evaluation (All) although the Finnish evaluators place it on most right.

According to expertise of the answerers big differences can be seen between groups. Mobile access to patient health record (1) is seen very attractive except in the Management group. Especially, the difference between Management and Marketing groups is clear.

Table 1. Primary (●) and secondary (O) drivers for each groups according to HIMSS attendees query

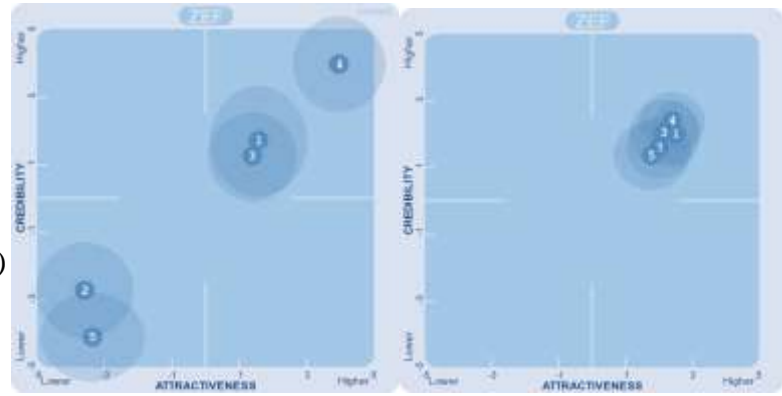
<b>Driver</b>	1	2	3	4	5
<b>Group</b>	Access	Location	Vital signs	Alarming	Home mon
USA			●	O	
Finland			O	●	
Canada	●			O	
Management			●	O	
Marketing	●			O	
Medical and nursing	O			●	
Technical	●			O	
<b>Altogether</b>	O		O	●	

## Wireless applications All

1. Mobile access to patient health record (70)

2. Location and tracking for process enhancement (70)

3. Vital signs (health) monitoring (70)



## USA

4. Alarming and calling help (70)

5. Comfortable home monitoring (70)



## Finland



## Canada



Figure 1. Attractiveness and credibility of wireless applications in future healthcare.

### **Challenge analysis results**

The results of evaluating difficulty of the challenges have been processed one-dimensionally by calculating average and mean in horizontal direction only. The position of the numbers 1

to 6 on the charts in Figure 2 tells averages and the width of the ellipses around the numbers are proportional to mean. In the left hand charts z-scoring have been applied to original answers before processing averages and means.

According to the charts the most difficult challenge is process change from the doctors' point of view (6) and the second is the same from the nurses' point of view (5). The technical challenges (1-4) are seen least difficult and, especially, Stability of connection (2) and Usable but reliable authentication (3) are seen easiest.

An interesting difference is that US evaluators see the Stability of connection (2) much more difficult than the Finnish evaluators. Another difference is that US evaluators see process change challenges as difficult from both nurses' and doctors' point of view when all other evaluators see the doctors' point of view remarkable more difficult.

According to expertise of the answerers big differences can be seen between groups. The evaluators from the Management group see Process change from doctors' point of view difficult but from the nurses' point of view not while marketing people see the it even more difficult from the nurses' point of view.

Medical and nursing evaluators see the authentication (3) the most difficult challenge. And technical people are worried of user interface (1) in addition to doctors' resisting of change. None of the groups are worried of the security of patient data.

Another interesting difference is that Medical and nursing evaluators see all challenges in average (right hand charts) remarkably easier than other groups.

The primary and secondary challenges of each group can be seen in Table 2.

Table 2. Primary (●) and secondary (O) challenges for each groups according to HIMSS attendees query.

<b>Challenge</b>	1	2	3	4	5	6
<b>Group</b>	User interface	Stability of connection	Authentic-ation	Security	Nurses resisting	Doctors resisting
USA					O	●
Finland	O				O	●
Canada			O		O	●
Management	O	O				●
Marketing	O				●	O
Medical and nursing			●		O	O
Technical	O				O	●
<b>Altogether</b>	O				O	●

## Challenges

●● 1. Usability of the mobile user interface (70)

●● 2. Stability of connection (70)

●● 3. Usable but reliable authentication (70)

●● 4. Security of patient data (70)

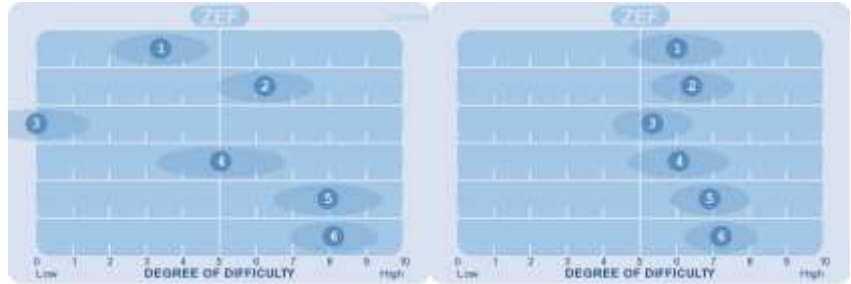
●● 5. Process change from the nurses' point of view (70)

●● 6. Process change from the doctors' point of view (70)

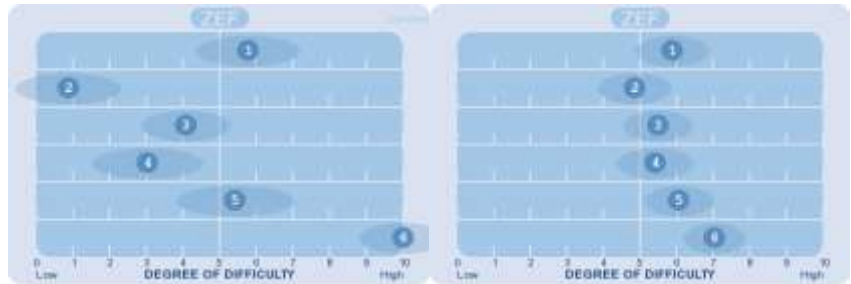
👤 All



👤 USA



👤 Finland



👤 Canada

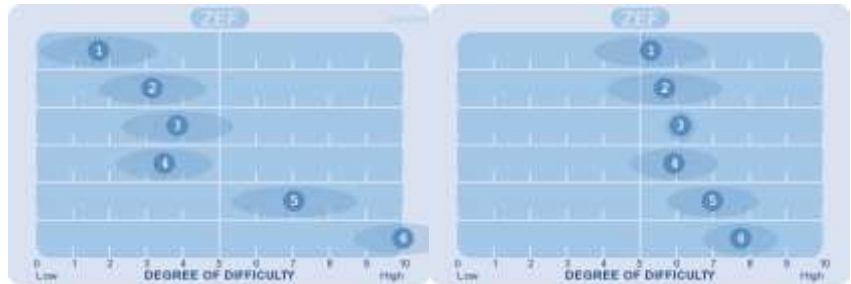


Figure 2. Difficulty of different challenges in development of wireless solutions for future healthcare

## Discussion

Comparison between countries ...

Comparison between expertise groups ...

Why home monitoring is not credible?

Comparison between process and technical challenges ...

Why security is not a severe challenge?

## **Conclusion**

Healthcare is ... industry ... changing ... IT technology ... wireless solutions. Drivers and challenges ... HIMSS08 ... Primary drivers ... Primary challenges ... Etc.

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