WHY REMOTE HEALTH MONITORING IS THE FUTURE OF HEALTH CARE

Hospitalists and physicians don’t need to be reminded that healthcare has radically changed over the past few decades. Healthcare administration and care today have become more onerous and complex with a host of new challenges that include cost containment, increased liability, digital (electronic) health record platform requirements, HIPAA regulations, and increased pressure from government regulators and insurance companies. These changes not only dictate cost but quality of care and overall patient outcomes. To make matters worse, traditional hospitals face increasing competition by specialty hospitals, outpatient surgery, and medical centers, as streamlined services are expanded to accommodate the growing needs of an aging population that is demanding more for less. It is a push for less expensive healthcare with more efficient specialization.

Many of these changes have come about so swiftly, they threaten to impact the very autonomy of medical decision-making, the quality of patient care, and the patient-physician relationship. Healthcare accountability is the new mandate. The biggest concern is accomplishing it without compromising quality of care. Remote monitoring technology offers the ideal solution, bringing the dramatic advances in semiconductor manufacturing to the medical world.

How We Got Here - An Historical Perspective

New federal regulations on spending limits, in-hospital stays, higher insurance copays, deductibles, and electronic filing requirements have placed additional demands on an already bloated and overburdened healthcare system that has spiraled out of control. In 2013, U.S. healthcare costs exceeded 17% of the Gross Domestic Product (GDP), according to the Organization for Economic Cooperation and Development. The Centers for Disease Control reported $2.9 trillion in total national healthcare spending in 2013.

Technological advances, intuitive medical devices, and insurance company mandates have significantly reduced in-hospital stays, ultimately improving the bottom line and patient outcomes. Today, 24-hour turnarounds and out-patient procedures are commonplace, as longer stays are penalized by insurance companies with tighter reimbursement schedules mandated by the Affordable Care Act and Centers for Medicare and Medicaid which sanction patient readmissions for the same condition.
The push for earlier discharges actually began in the 1980s, when hospital administrators were incentivized by increased profit margins under the traditional fee-for-service model. Shorter stays, it was determined, were better for the patient who could recuperate more effectively at home. In recent years, the healthcare system has begun to move from a fee-for-service to a fee-for-outcome (preventive) or pay-for-performance managed-care model in an attempt to reduce costs and bring U.S. hospitals in line with the more efficient European healthcare cost structure.

**Medical Accountability in the 21st Century**

As more emphasis is placed on performance models and patient outcomes, physicians must have a better way to track and control patient care - especially before and after hospital discharge. Superlative interaction is essential between doctors, staff, and patients, along with greater transparency, and responsiveness.

To reduce admissions and future doctor visits, hospitals must be able to accurately track patients’ status over longer periods of time without compromising the physician-patient relationship. Medical personnel must be able to:

+ Do pre- and post-operative monitoring
+ Ensure responsive medical care after discharge
+ Respond quickly to any changes in the patient’s condition
+ Manage chronic conditions effectively and preemptively
Effective at-home care requires secure, remote medical monitoring that is low-cost and low-touch to ensure the highest level of patient compliance. Patient engagement is critical for successful outcomes. Device ease of use is paramount. There must also be a low learning curve on the part of the patient as well as for medical personnel receiving and monitoring the data.

**Challenges for the New Health Paradigm and Growth of Telemedicine**

Cost efficiencies have been difficult within the old medical device paradigm. Until recently, traditional medical monitoring required multiple in-hospital or facility-based devices that relied on bulky technology, and distant monitoring stations which used telemetry. The devices were costly to purchase, deploy, and maintain. Devices had to be specialized for specific functions such as cardiac (EKGs), hemodynamic (blood pressure/blood flow), pulse oximetry (SpO2), capnographic (EtCO2/AWRR), neurological (ECG), and blood glucose monitoring.

Until recently, remote devices did not fit the bill. Not only was initial financial outlay untenable, but cost of operation was a problem with most devices requiring big batteries and lots of power. Insufficient security and networking technology also compromised patient privacy.

Today’s medical monitoring appliances have become a common sense alternative. They are small, robust, less intrusive and more energy efficient. They can provide comprehensive, medical-ready data capture for multiple medical specialties. They also have a high rate of acceptance among consumers who have become accustomed to consumer-grade monitoring devices and apps in the form of wearables, smart watches,
and smart bands that can be integrated with smartphones and tablets. With today’s medical-grade monitoring devices:

Demand is growing for wearing fitness monitoring devices that can offer versatile and specific health tracking.

- **Smart Contact Lenses**: Able to measure glucose levels in users
- **Electronic Sensor Tattoos**: Able to monitor skin hydration, temperature and any electronic signals from muscle and brain activity
- **Smart Fitness Bands**: Able to measure a range of activities, from steps walked to hours slept
- **Pain Relief Patch**: Able to manage and track pain
- **Smart Watches**: Able to monitor heart rate and calories burnt daily
- **Smart Socks**: Able to coach users on their running techniques in real time and monitor heart rate

+ Monitoring can be done at home to track patient status before, during, and after procedures.
+ Monitoring can be done over a secure network with patient authentication to confirm identity.
+ Preventive and preemptive monitoring can be done for high-risk patients with chronic conditions, significantly lowering hospital admissions.
Why Remote Healthcare Monitoring is Destined to Grow

With the heavy push toward cost containment, remotely quantified health has an extremely positive outlook with exponential growth expected over the next few years. Patients like the alternative that it provides. A 2012 eHealth patient survey by Ruder Finn reports that 33% of patients surveyed wanted their physicians to have access to remote monitoring technologies. The rate of acceptance was even higher with older survey respondents at 40%. The compound annual growth rate (CAGR) of remote health monitors from 2015 to 2019 is predicted to be 22%.

Long-term sustainability of remote patient monitoring is assured simply because it gives new healthcare models the stealth they need to compete. The advantages are many.

Telemedicine:
+ Improves access to care
+ Reduces costs
+ Allows healthcare administrators and physicians to do more with less

By 2018
Over 5 million wearables and mobile medical sensors will be purchased in the healthcare sector.
19 million patients will be monitored remotely.

The Growing Trend of Quantified Health

<table>
<thead>
<tr>
<th>Year</th>
<th>Health Monitors</th>
<th>Smart Phones</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>293</td>
<td>250</td>
</tr>
<tr>
<td>2016</td>
<td>323</td>
<td>255</td>
</tr>
<tr>
<td>2017</td>
<td>344</td>
<td>255</td>
</tr>
<tr>
<td>2018</td>
<td>368</td>
<td>258</td>
</tr>
<tr>
<td>2019</td>
<td>377</td>
<td>259</td>
</tr>
</tbody>
</table>

- Heart Rate Monitors
- Activity Monitors
- Pedometers
- Smart Bands
- Smart Watches
- Smart Glasses
- Smart Apparel

Forbes Insights

Millions of units
Remote monitoring assists the bottom line in a big way by delivering a huge ROI. A study by the Center for Technology and Aging at the University of California Center for Information Technology Research (CITRUS) reported substantial gains from reduced use of hospital and emergency services at five health systems. The return per-patient at Centura Health at Home in Colorado was $1,760 versus costs of $493. Study director David Lindeman, PhD cited “a strong evidence base for the effectiveness of remote patient monitoring, with benefits growing as state Medicaid programs move entire populations into a managed care environment.”

“There is a strong evidence base for the effectiveness of remote patient monitoring with benefits growing as state Medicaid programs move entire populations into a managed care environment.”

CITRUS Study Director David Lindeman, Ph.D.

- Remote devices are highly effective in treating chronic disease by capturing and analyzing data in real time.
- High-risk conditions can be quickly identified by alert algorithms and decisions made for emergency room or hospital admissions.
- Healthcare conditions can be trended and baselines established for more effective risk management.
- Improvements in health information exchanges that interface multiple providers are revolutionizing the monitoring landscape for cost containment.

**Finding Value in Health Data**

**Medical & Health**

Weight Management  
Stress Management  
Preventative Care  
Sleep Quality

Personal Training  
Workout Guidance  
Performance Optimization

Remote Consultation  
Post-Discharge Monitoring  
Chronic Disease Monitoring  
Clinical Trials

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Remote medical monitoring can offset ballooning costs in some of the most expensive healthcare treatment areas. For instance, a total of five to six million EKG procedures are done in-house in the United States each year. These procedures can be eliminated with one remote device fitted per patient. In addition, EKG monitoring typically accounts for 200 inpatient hospital admissions per hospital with an average stay of three days. That is an annual total of 20,000 device units per hospital. Remote monitoring devices would dramatically reduce these costs.

Remote patient monitoring through an Interactive Voice Response solution assisted the Geisinger Health Plan to lower 30-day all-cause readmissions of Medicare beneficiaries by 19.5 percent, in a study published in Medical Care.

Pharmacists who used telemonitoring were able to help 71.2% of patients achieve better blood pressure control than traditional office-based care, in a study published by HealthPartners Institute for Education and Research in the Journal of the American Medical Association.

A remote monitoring program of Medicaid patients with diabetes, conducted by the New York City Health and Hospitals Corporation, achieved a 1.8% reduction in hemoglobin A1c levels, in a study published in the Journal of Managed Care Medicine. This resulted in a 12% reduced risk for stroke, a 14% drop in heart attacks, a 16% reduction in heart failure and 21% decrease in mortality rates.
CONCLUSION:
THE BEST SOLUTION LIES IN SMART BIOPROCESSING

The Samsung Bio-Processor is an All-In-One quantified healthcare solution that will transform telemedicine and patient care as we know it. This low cost, energy-efficient solution securely and accurately captures multiple forms of bio-data in real-time from multiple monitoring devices. A separate DSP offers efficient processing of workloads that would normally be done by a high-power MCU. This reduces peak power consumption several times over. The small, single chip design allows manufacturers to produce low power devices without the need of a complex data interface. This is advantageous to patients and physicians alike.

**Bio-Processor**

Samsung Bio-Processor merges five different sensors in a single chip, empowering manufacturers to provide an in-depth monitoring of the human body.

*Providing a Variety of Fitness Data*

- **Body Fat**
  - Body Fat Percentage
  - BIA sensors can measure body fat, adjusting for normal or athletic users.

- **PPG**
  - Photoplethysmograph
  - PPG sensors can monitor heart rate and respiration.

- **ECG**
  - Electrocardiogram
  - Electrocardiogram readings measure heart rate and heart rhythm, testing general heart health.

- **Skin Temp.**
  - Skin Temperature
  - Temperature sensors measure skin temperature to obtain overall body temperature.

- **GSR (EDA)**
  - Galvanic Skin Response
  - Galvanic Skin Response (also called EDA) readings measure stress levels and emotional state.

The Bio-Processor implements five health functions, and secures sensitive sensor data using hardware-based encryption.

*Integrated Monolithic Solution for Superior Space Efficiency*

Samsung Bio-Processor saves board space by integrating all the core components including health functions and MCU into a single chip. When compared to discrete chips, the Bio-Processor saves over 80% in board space.

*Government-Level Security Technology*

Samsung Bio-Processor has a security module inside it to ensure secure encryption of sensitive health data. Instead of software encryption, the Bio-Processor uses hardware-based encryption which greatly improves the integrity and confidentiality of data.
Samsung Bio-Processor Features:

- Integrated MCU, DSP, AFE, PMIC and security blocks in the chip for efficient use of board space and power in monitoring devices. This enables continuous patient monitoring for days with a small battery, unlike competing devices.
- Robust monitoring that handles all types of health data with military grade security that ensures patient and physician authentication, secure data transfer and HIPAA compliance.
- Data is protected by True Random Number Generator + AES encryption.
- Five different AFEs in a single chip, for in-depth monitoring of data from five key sensors: Electrocardiogram (ECG), photoplethsymogram (PPG), bio-electrical impedance analysis (BIA), galvanic skin response (GSR), and skin temperature (SKT).
- Samsung-developed reference algorithms for easy implementation of heart rate, heart-rate variability, blood pressure, SpO2, and body fat calculations.
- Customizable SDK for hospitals and device makers to configure their own algorithms for specialized monitoring.
- Small form factor of 5.7x4.9mm, offering flexibility and discreet designs.
- Easy to deploy with a low learning curve for high patient compliance.
- Low cost makes it a viable option for disposable monitoring devices.

**Bio-Processor**

Use of a single optimized Bio-Processor reduces the power consumed by health functions, making it the ideal option for wearable devices.

Discrete chips have multiple components that need to be placed on a PCB. This results in complicated routing and an oversized PCB. The Bio-Processor avoids this problem by having an optimized PMIC.
## Bio-Processor

<table>
<thead>
<tr>
<th>Features</th>
<th>Bio-Processor (S3FBP5A)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Acquisition and Processing</strong></td>
<td></td>
</tr>
<tr>
<td>AFE</td>
<td>ECG, PPG, BIA, GSR</td>
</tr>
<tr>
<td></td>
<td>5x 12-bit SAR ADC</td>
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<tr>
<td></td>
<td>1x 24-bit ΣΔ ADC</td>
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<tr>
<td><strong>MCU</strong></td>
<td>Cortex-M4F (87MHz)</td>
</tr>
<tr>
<td></td>
<td>FLASH (512KB), SRAM (256KB)</td>
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<tr>
<td><strong>DSP</strong></td>
<td>Ultra-Low Power-SRP* (87MHz)</td>
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<tr>
<td></td>
<td>CMEM (10KB), IMEM, (128KB), DMEM (128KB)</td>
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<tr>
<td><strong>Security IP</strong></td>
<td>AES (Advanced Encryption Standard)</td>
</tr>
<tr>
<td></td>
<td>DTRNG (True Random Number Generator)</td>
</tr>
<tr>
<td><strong>Power Management</strong></td>
<td>DCDC, 4x LDO, POR, Keep Alive LDO</td>
</tr>
<tr>
<td><strong>Interfaces</strong></td>
<td>3x UART, 5x SPI, 5x I2C, 2x GPIO</td>
</tr>
<tr>
<td><strong>Power Supply</strong></td>
<td>Digital/AFE: 1.1V</td>
</tr>
<tr>
<td></td>
<td>LED Driver: 2.7 ~ 3.3V, 5V</td>
</tr>
<tr>
<td></td>
<td>IO Power: 1.8V</td>
</tr>
<tr>
<td><strong>Package</strong></td>
<td>FO-WFP, 5.7mm x 4.9mm</td>
</tr>
</tbody>
</table>

* = Samsung Reconfigurable Processor

**Demo Available:** An S-patch reference device has been built by Samsung for capturing ECG data. It features a 1-lead ECG patch that uses two wet electrodes. This is the second version of the S-Patch using the Bio-Processor. Samsung has also developed an Android app to capture and store data from this device.

**Be sure to request a trial of the S-patch or other reference devices**
Samsung Will Transform the Way You Quantify Health

Samsung has transformed mobile devices the world over. We are now revolutionizing medical diagnostics with the Bio-Processor – a secure, low-cost, low-power, and accurate monitoring solution. Our Bio-Processor offers efficient performance and packaging with top-notch security for maximum cost containment by hospitals and device makers. It can operate as a co-processor or as a standalone processor for added versatility. Its small footprint makes it ideal for compact monitoring devices.

Transform Your Medical Diagnostics with the Samsung Bio-Processor.

Versatile Configurations