Persistent Access to Tactical Casualty Health (PATCH)

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Background

- Nearly ***90%*** of combat casualty fatalities occur prior to reaching a properly equipped medical center
- Approximately ¼ of the 4,596 combat deaths in Iraq and Afghanistan between 2001 and 2011 classified as ***'potentially survivable'*** [1]
- Tactical Combat Casualty Care (TCCC) has saved countless military and civilian lives by normalizing priority driven care [2]
- Documentation of the care delivered via this approach, currently done on a paper TCCC Card, is imperative to not only communicating patient status, injury, and treatments to subsequent providers, but also allows those monitoring the TCCC approach to evaluate its efficacy in a quantitative manner
- Unfortunately, ***less than 10% of the 30,000*** casualties in Iraq and Afghanistan had any form of documentation of care in their medical records, substantially hindering the aforementioned processes, and leading to a staggering ***67% of sentinel*** events being attributed to an error in communication [3, 4]
- Identifying this hole in care coordination, the military has gone to great lengths to improve their electronic record keeping capabilities, resulting in an ***electronic version of TCCC card*** that can and is being implemented into end user devices (EUD) like the Army's NETT Warrior, the Air Forces BATDOK, and SOCOM's ATAK
- Inherent to their nature, these devices rely on clear lines of communication
- The Army has identified an existing gap in current patient record handoff capabilities during evacuation, when communications are down
- Vivonics has leveraged these electronic TCCC cards by developing a low-profile electronics package capable of receiving, storing (solid state), and transmitting TCCC information to and from an EUD using Near Field Communication (NFC) (Figure 1)
- Further, this capability is embedded in a wearable patch (Figure 5) that can be placed on the patient anywhere away from injury
- ***The fully integrated system is dubbed Persistent Access to Tactical Casualty Health (PATCH)***

Methods

- In developing PATCH, Vivonics focused on five (5) main criterion deemed imperative to efficacy in battlefield conditions:
    1. Working distance
    2. Transfer time
    3. Battery life
    4. Storage capacity
    5. PATCH/skin adhesion quality
- Working distance, transfer time, and power consumption were evaluated via one experimental setup wherein a Samsung Galaxy S5 was placed incremental distances from the NFC antenna and a file 56 kilobit in size was transferred to and from PATCH (Figure 2 & Figure 3)
- Files were stored for over 30 days with no power to demonstrate the non-volatile and persistent nature of the system
- Storage capacity was developed to hold 16 different patient information uploads of full eTCCC information payloads
- PATCH material was evaluated on the PI in various application conditions, including in ideal and non-ideal (post sweat inducing exercise) conditions (Figure 4)

Results

- A wearable patch sensor, capable of both transmitting and receiving bio-medical data stored and transferable up to 64 kilobits was developed
- The device was able to transmit data up to 5 cm away (Figure 2)
- Uncompressed eTCCC XML format packets were transmitted and received in under 5 seconds by the current DoD Nett Warrior Device
- Devices performed both using battery and using a non-battery option, harvesting power from the Nett Warrior Device (Figure 3 & Figure 5)
- Biocompatible patch material was worn for more than 72 hours (prolonged field care benchmark) with no adverse skin issues (test terminated after 20.2 days of wear – Figure 4)

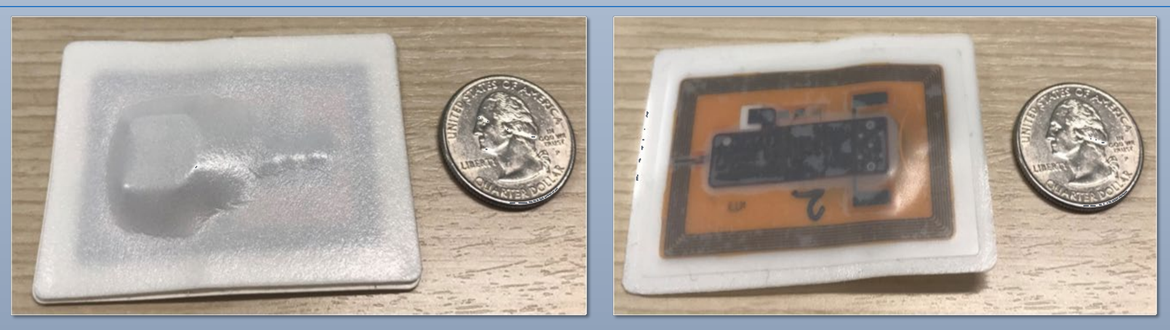

Figure 5*: PATCH prototype- flex circuit encased between two layers of adhesive. (Left) PATCH side exposed to environment; (Right) PATCH side in contact with skin*

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Military Application

The vast majority (67%) of the unanticipated events that resulted in death or serious injury not related to the natural course of the casualty's mechanism of injury are due to miscommunication between caregivers. The PATCH solution seeks to improve care communication and coordination to reduce the frequency of these events.

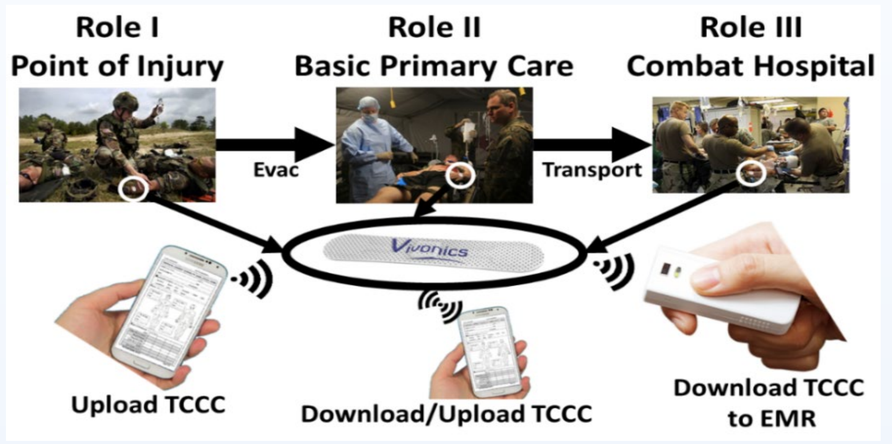

Figure 1*: A long lasting, biocompatible adhesive patch means that PATCH can be initially affixed by the Combat Medic moving with the patient through Roles 1, 2, and 3. The unique two way communication ability allows medics to download previously compiled care records, then update and store them.*

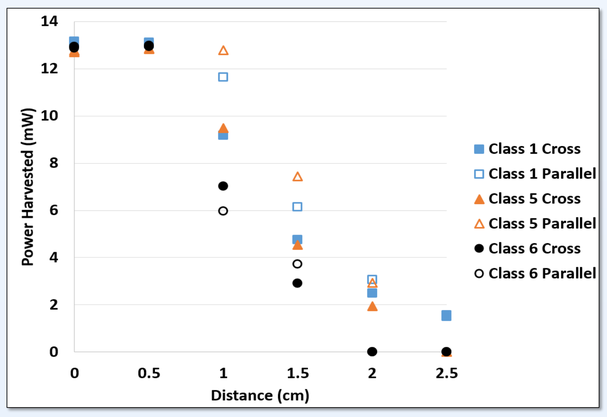

Figure 2*: Power harvesting output from an ST Microelectronics transceiver module evaluated through the ST mobile application in a like (parallel) and opposite (cross) orientation with respect to the listening antenna.*

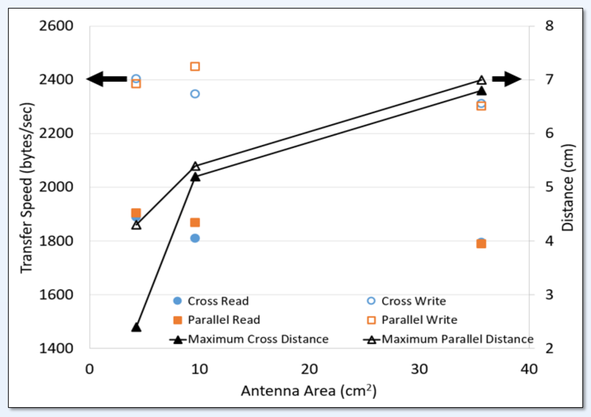

Figure 3*: Data transfer rate of an ST transceiver module (colored data with axis to the left) and the maximum communication distances (black lined data with axis to the right) for both parallel and cross orientation.*

Body Location	Attachment Time (hours)
Clavicle	77 (3.2 days)
Deltoid	85 (3.5 days)
Bicep	192 (8 days)
Forearm	485 (20.2 days)
Back of Hand	47 (1.95 days)
Average	177.2 (7.4 days)

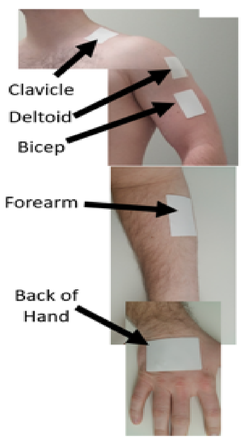

Figure 4*: PATCH material location and sample attachment time*

Conclusions

A long lasting, biocompatible, cyber-secure, patient medical information holding adhesive patch has been developed. PATCH can be initially affixed by the Combat Medic moving with the patient through Roles 1, 2, and 3. The unique two-way communication ability allows medics to download previously compiled TCCC data, amend it with new care, and upload the new information back onto PATCH for the subsequent Role. These above results demonstrate the feasibility of the proposed system and provide a path forward to improve data transfer times, working distance, and size through NFC optimization as well as introducing NFC initiated Bluetooth Low Energy (BLE) pairing for larger payloads (e.g. images, physiological waveforms, etc.). The authors believe that the reactionary nature of the PATCH process provides an effective yet intuitive solution to track accurate combat casualty medical information from point of injury through Role 3 care; a measure that could improve medical care communication and thereby reduce the unfortunate sentinel event rate and save military lives.

References

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