



Wearable Health Monitoring for Warfighter Readiness Estimation



Reid Honeycutt^{1,2}, Flore M. Hervé^{1,2}, Patrick Gibson^{1,2}, Eva Borrás^{1,2,3}, Dante E. Rojas^{1,2}, Yevgeniy Belous^{1,2}, Stephanie Fung¹, Mitchell M. McCartney^{1,2,3}, Nicholas J. Kenyon^{2,3,4}, and Cristina E. Davis^{1,2,3,*}

¹Mechanical & Aerospace Engineering UC Davis, ²UC Davis Lung Center, ³VA Northern California Health Care System, ⁴Division of Pulmonary, Critical Care and Sleep Medicine, University of California Davis, Sacramento, California 95816, United States

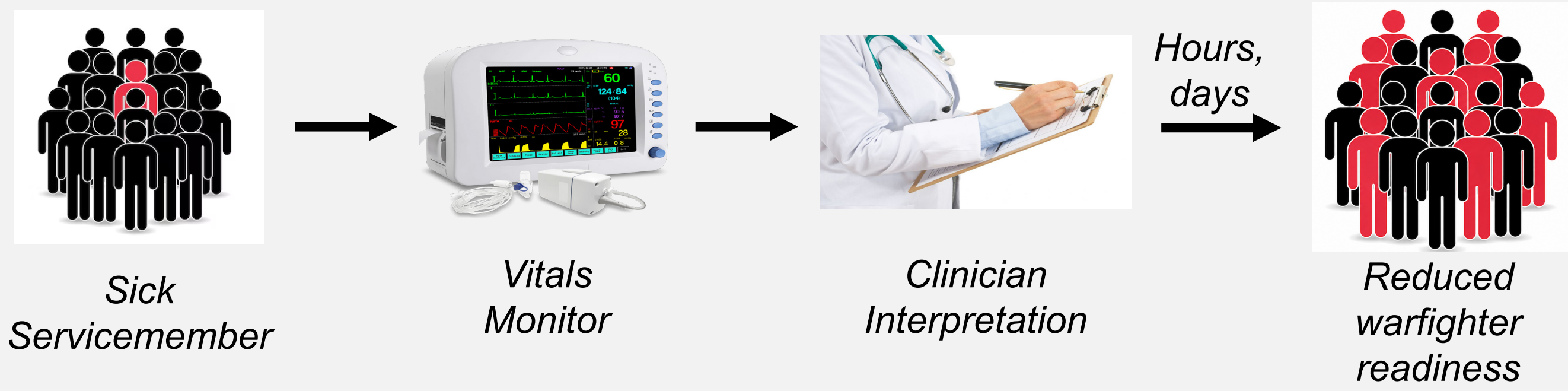
*correspondence: cedavis@ucdavis.edu

Current Challenges in Health Monitoring

Current health monitoring technology is limited by:

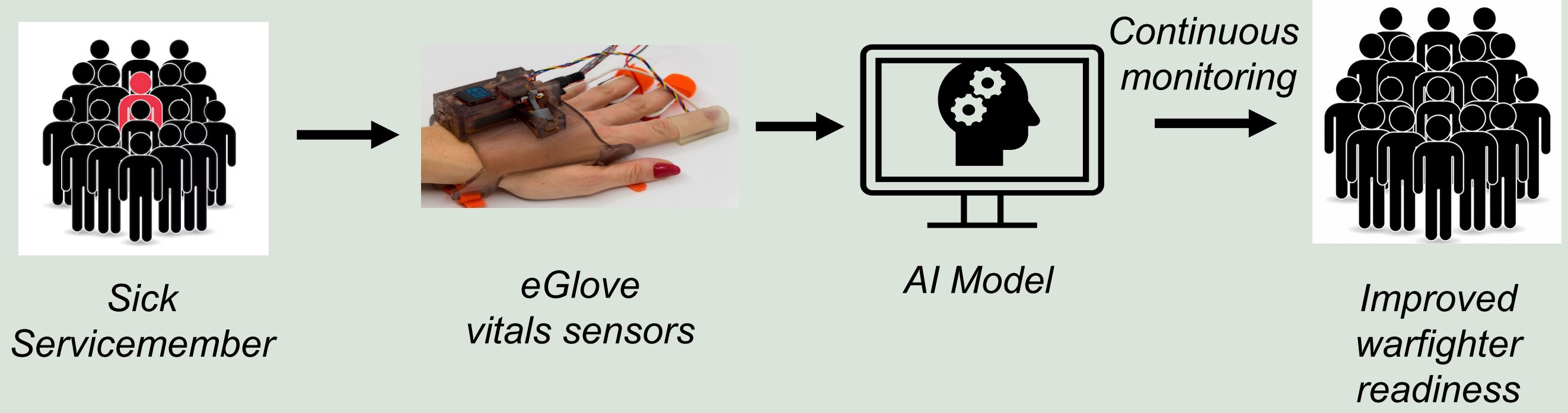
- Bulky form factor
- High manufacturing cost
- Significant power requirement
- Limited portability
- Analog data output

Current Health Monitoring Pipeline:



Solution

Wearable Health Monitoring Pipeline



- Wearable monitor enables continuous data collection
- Digital sensor data are streamed to automated analytics
- AI models identify early indicators of physiological distress
- Portable design supports field deployment
- Autonomous operation minimizes clinician burden

Data-driven health monitoring:

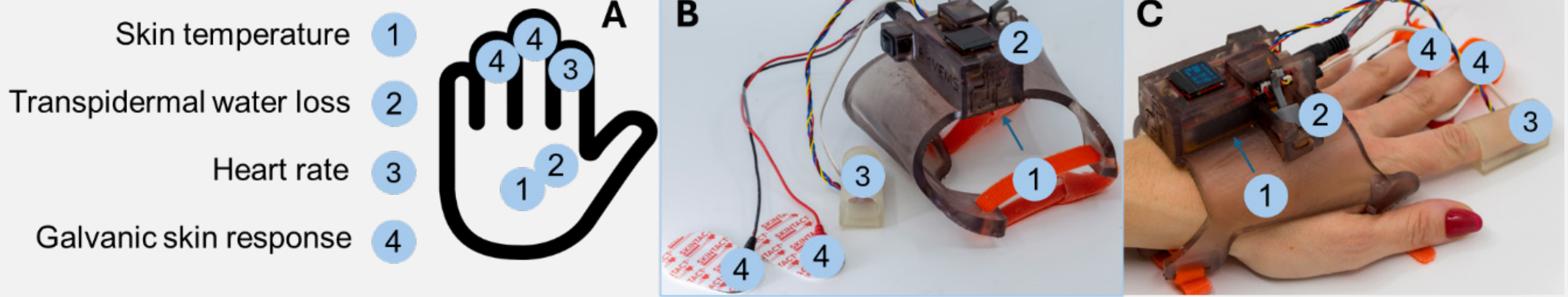
- Continuous physiological monitoring
- Early detection of health threats
- Reduced time to intervention
- Enhanced force health protection
- Improved mission readiness
- Continuous capability advancement

Conventional Health Monitor	Wearable Health Monitor
Clinician required	Autonomous
Bulky	Light & portable
Analog output	Digital records
Bound to clinical setting	Field-deployable
Limited time-frame	Continuous
Requires wall power	Battery operated

Disease Detection with The eGlove [1]

The eGlove collects several vital measurements:

- Skin temperature
- Heart rate
- Transepidermal water loss
- Galvanic skin response



Sensor placement on the eGlove. A. Positions of the four vital sensors on the hand. B, C. The flexible glove body adjusts to different hand sizes; all sensors mount directly on the glove.

These measurements are predictive of:

- Disease states
- Inflammatory conditions
- Psychological stress

Data Fusion with Other Clinical Measures Improves Prediction [1]

- **Data fusion** can combine vitals with other data
- Combining **vitals with VOCs** resulted in improved asthma classification accuracy

Prospective clinical study (n=39: 19 control, 20 asthmatic), found that combining eGlove vitals with exhaled breath VOC data improved classification of asthma than VOCs alone.

Dataset	# Measured Parameters	Sensitivity	Specificity	ROC AUC
Breath VOC metabolomics	135	0.68 (0.14)	0.63 (0.15)	0.72 (0.10)
Vitals	8	0.62 (0.20)	0.53 (0.18)	0.59 (0.12)
Combined (Low-Level Fusion)	143 (135 + 8)	0.78 (0.13)	0.70 (0.18)	0.80 (0.09)
Combined (Mid-Level Fusion)	4 (data reduction)	0.61 (0.16)	0.44 (0.17)	0.59 (0.10)

Future Directions

Completed:

- eGlove prototyped and validated against clinical gold standards for heart rate, skin temperature, and GSR
- Low-level data fusion of vitals with breath VOCs significantly improves asthma classification accuracy
- Automated data processing pipeline

Next:

- Expand use cases to new diseases
- Transition to field-deployable, real-time Warfighter monitoring

Stress Monitoring with The Vital Armband [2]

The Vital Armband collects:

- Skin temperature
- Heart rate
- Oxygen saturation
- Galvanic skin response
- Accelerometry

These measurements can monitor:

- Activity level
- Heat exhaustion
- Fatigue
- Dehydration

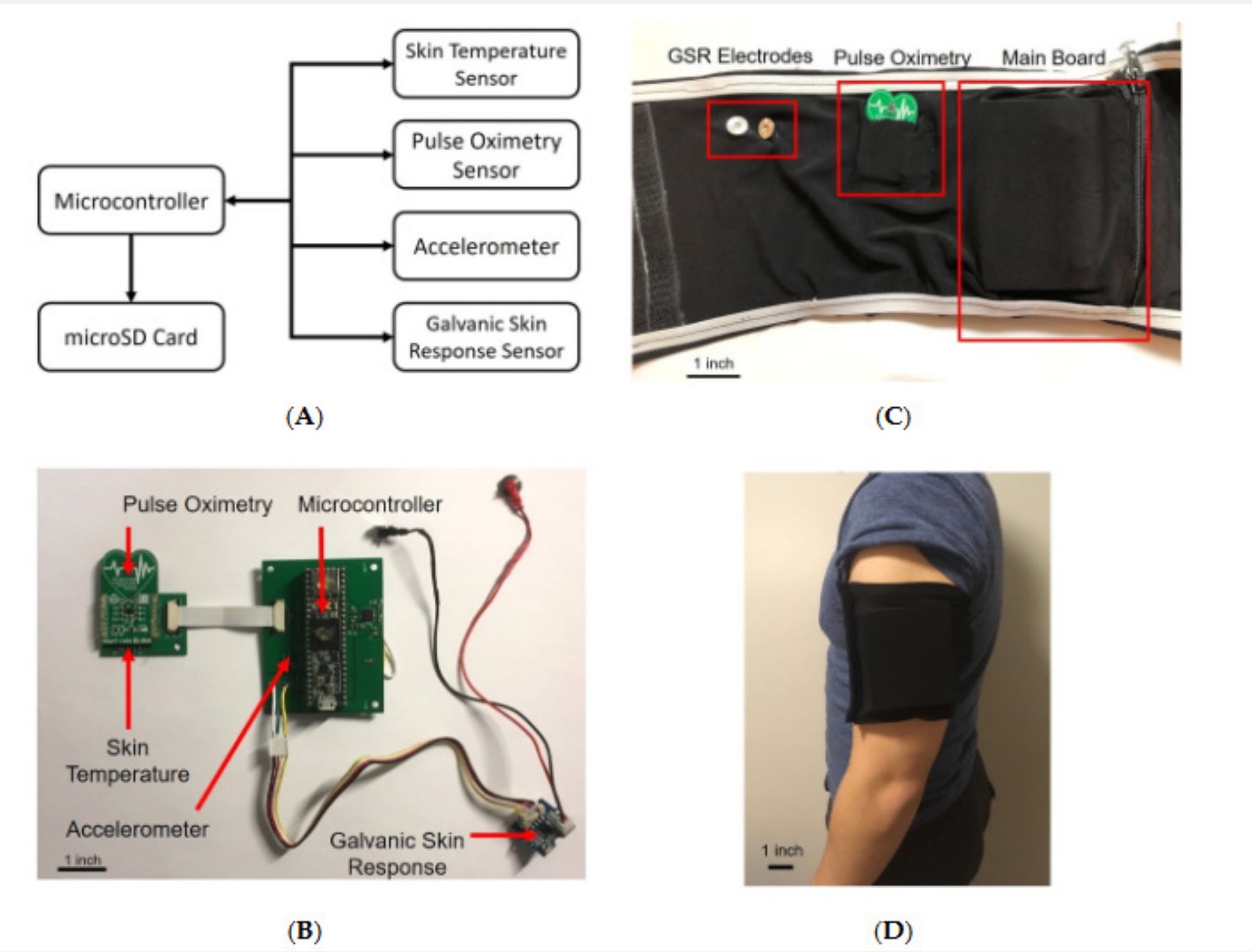


Figure 1. (A) The overall system diagram includes four commercial sensors integrated together using a commercial microcontroller; (B) The system components and PCBs are arranged prior to packaging; (C) The components are shown in the packaged armband; and (D) The final wearable device is shown.

Continuous Capability Development

- Continuous monitoring allows collection of large datasets
- Big data analytics provide new insight into warfighter health
- These analytics lay the bedrock for new technology development

Conclusions

- Wearable health monitors enable greater insights
- Better warfighter health protection
- Greater mission readiness
- Continuous capability development
- Reduced healthcare costs
- Faster disease detection
- Limit spread of illness

Acknowledgements

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Citations

1. Honeycutt R et al (submitted) *J. Breath Res.*
2. Pham S et al (2020) *Sensors*

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