

AD _____

AWARD NUMBER: W81XWH-18-C-0156

TITLE: Smart Oxygenation System (SOS) Provides Early Warning of Lung Injury

PRINCIPAL INVESTIGATOR: Michael Kinsky

**RECIPIENT: The University of Texas Medical Branch at Galveston
Galveston, TX 77555**

REPORT DATE: Sept 2019

TYPE OF REPORT: Annual

**PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012**

DISTRIBUTION STATEMENT: Approved for Public Release; Distribution Unlimited

The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation.

REPORT DOCUMENTATION PAGE			<i>Form Approved</i> OMB No. 0704-0188		
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE Sept 2019		2. REPORT TYPE Annual		3. DATES COVERED 31 Aug 2018 - 30 Aug 2019	
4. TITLE AND SUBTITLE Smart Oxygenation System (SOS) Provides Early Warning of Lung Injury			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER W81XWH-18-C-0156		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) Michael Kinsky, M.D.			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) The University of Texas Medical Branch at Galveston Galveston, TX 77555			8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Medical Research and Materiel Command Fort Detrick, Maryland 21702-5012			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for Public Release; Distribution Unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT Background: Most pulmonary injuries are insidious and declare themselves over a period of hours or even days. Most recently, tactical military changes have resulted in increased time between casualty injury and definitive care e.g., prolonged field care, increased transport times and initial damage control surgery and resuscitation. The following types of injuries could increase due to longer time between injury and evacuation 1- smoke and chemical inhalation injury exposure 2- blast injuries resulting in concomitant pulmonary contusions [50% incidence of ARDS] 3- penetrating injuries to lung parenchyma 4- post resuscitation and acute lung injury 5-TBI induced lung dysfunction [neurogenic pulmonary edema] 6-atelectasis due to pain, over sedation and splinting after injury or initial surgery					
15. SUBJECT TERMS-					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON USAMRMC
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U			19b. TELEPHONE NUMBER (include area code)
			UU		

TABLE OF CONTENTS

	<u>Page No.</u>
1. Introduction	4
2. Keywords	5
3. Accomplishments	6 – 9
4. Impact	10 – 12
5. Changes/Problems	13 – 14
6. Products	15 – 17
7. Participants & Other Collaborating Organizations	18 – 20
8. Special Reporting Requirements	21
9. Appendices	22

- 1. INTRODUCTION:** Narrative that briefly (one paragraph) describes the subject, purpose and scope of the research.

Background: Most pulmonary injuries are insidious and declare themselves over a period of hours or even days. Most recently, tactical military changes have resulted in increased time between casualty injury and definitive care e.g., prolonged field care, increased transport times and initial damage control surgery and resuscitation. Prompt recognition and treatment of pulmonary dysfunction will be need to be addressed. Towards this end, we have shown that closed loop control [CLC]-oxygen [FiO₂] can better maintain target oxygen saturation [efficiency] while reducing oxygen utilization (improved efficiency with limited resources). Our group also demonstrated that CLC systems possess unique diagnostic utility. Specifically, activity of the CLC-FiO₂ algorithm identifies pulmonary (dys)function, especially using the SpO₂/CLC-FiO₂ ratio. We have incorporated this index into a decision support smart oxygenation system (SOS), which alerts pulmonary distress hours earlier than standard monitoring. Further, our experimental data using this decision support SOS shows that it initiates life-saving interventions [LSI] e.g., rescue ventilation, earlier, which improves overall lung function e.g., reduces severity of acute respiratory distress syndrome [ARDS]. While this provides an excellent diagnostic frame in intubated patients, it has limits. We therefore identified a CLC system called FreeO₂ [OxyNov] that works in spontaneously ventilated patients. Further, we identified a non-invasive monitor that measures tidal volume and minute ventilation called Exspiron [Respiratory Motion Inc.]

Objective and hypothesis: We hypothesize that seamless integration of CLC-FreeO₂ oxygen delivery system with Exspiron into our decision support SOS for at-risk casualties, will more rapidly assess and treat pulmonary injury. This approach will not only provide targeted therapeutic oxygen, but also, serve as a “watch dog” to rapidly and effectively assess and treat lung injuries in combat casualties. We will develop and perform proof of concept testing for the SOS prototype integrating FreeO₂ system and Exspiron. We have three **Specific Aims:**

Aim 1: Develop robust SOS prototype for use in spontaneous ventilation

Aim 2: Measure oxygenation and ventilatory indices during progressive hypoxemia in volunteers (n=10) without (visit 1) and with (visit 2) an extra-thoracic restriction device to simulate ARDS

Aim 3: Pilot clinical testing and SOS algorithm tuning

Study Design: We will first assemble hardware and software to link FreeO₂ and Exspiron system into SOS. The hardware assembly, driver development, connectivity and system architecture and simulation testing will be performed before human testing. We will then test the predictability of the SOS in volunteers undergoing hypoxia or hypoxia plus extrathoracic restriction. On each study visit one and two, each volunteer will receive different levels of oxygen; either – room air (RA), O₂ via nasal cannula (NC: 2 L/min) or FreeO₂ after hypoxia. The difference for study visit two is that volunteers will undergo hypoxia plus extra-thoracic restriction. Outcomes will test timing when the S_v/CLC_F ratio <250. Non-invasive ventilation indices from Exspiron will be also integrated into the SOS. Next, studies will be performed in selected patients undergoing extubation from the OR to post anesthesia recovery unit (PACU) [UTMB] and ICU [University of Cincinnati (UC)]. We envision PACU patients (n=40) will normalize (no LSI), a surrogate of reassuring pulmonary function. On the other hand, we will recruit at-risk patients that will likely fail extubation from the ICU (n=40) will require a LSI e.g., re-intubation, surrogate of pulmonary insufficiency. This will determine the impact of autonomous delivery of oxygen on timing of interventions (PACU efficiency vs ICU rescue ventilation). Other data will be integrated and analyzed similarly e.g., low minute ventilation by Exspiron, etc. Data generated from these studies will be incorporated into the decision support SOS prototype and used to develop future trials.

Relevance: Acute lung injury contributes to significant morbidity and mortality in military settings.

2. KEYWORDS: Provide a brief list of keywords (limit to 20 words).

Acute lung injury, closed loop oxygenation for therapy and diagnosis, smart oxygenation system (SOS), human testing, oxygen “watch dog”

3. **ACCOMPLISHMENTS:** The PI is reminded that the recipient organization is required to obtain prior written approval from the awarding agency Grants Officer whenever there are significant changes in the project or its direction.

What were the major goals of the project?

List the major goals of the project as stated in the approved SOW. If the application listed milestones/target dates for important activities or phases of the project, identify these dates and show actual completion dates or the percentage of completion.

Objective 1: Develop a robust SOS for spontaneous ventilation	Timeline (Months) estimate	QTR Period	Date/ Month actual
Major Task 1: SOS hardware assembly			
Subtask 1 User needs	1	1	2
Subtask 2 list hardware requirements	2	1	3
Major Task 2: Driver development, connectivity & architecture for SOS.			
Subtask 1 software requirements & spec	3	2	5
Subtask 2 Exspiron communication specs	4	2	4
Subtask 3 communication specifications for FreeO2 [* TSI flowmeter change]	4	*	10
Subtask 4 SOS assembly and programming complete.	6	3	10
Major Task 3: Simulation testing and study support			
Subtask 1 Risk Assessment	7	3	8
Subtask 2 Hazard analysis	7	3	8
Subtask 3 Draft user manual	8	4	9
Subtask 4 Decision support integration	10	4	11
Subtask 5 Engineering test report	11	4	11
Milestone: Prototype development integrating Exspiron and FreeO2 communication protocols complete.	11	4	11
Milestone: Prototype demonstration /IPR MTG	12	TBD	TBD

Objective 2: Implementing oxygenation and ventilatory indices after hypoxia ± CWR	Timeline (Months)	QTR period	Date/month actual
Major Task 1: Obtain Regulatory Approvals			
Subtask 1: Submit human use protocol for local IRB review	pre-award	-	0
Subtask 2: Submit human use protocol HRPO review	pre-award	-	0
Milestone: final Local IRB approval	3	1	2
Milestone(s): final HRPO approval	3	1	2

What was accomplished under these goals?

For this reporting period describe: 1) major activities; 2) specific objectives; 3) significant results or key outcomes, including major findings, developments, or conclusions (both positive and negative); and/or 4) other achievements. Include a discussion of stated goals not met. Description shall include pertinent data and graphs in sufficient detail to explain any significant results achieved. A succinct description of the methodology used shall be provided. As the project progresses to completion, the emphasis in reporting in this section should shift from reporting activities to reporting accomplishments.

Our accomplishments are structured based on fulfilling the primary objectives. Since we have just completed year one of the project, the bulk of the reporting will focus on Objective 1.

Objective 1: months 0-12. The PI and team will work with Arcos Inc., to develop connectivity and interoperability of two primary systems (OxyNov's FreeO2 system and Respiratory Motion's Exspiron system). Engineers from Arcos will provide hardware and software (table computer system with Java based communication drivers) that incorporates oxygenation/ventilation indices from these two systems to develop a graphical user Decision Support interface called Smart Oxygenation System (SOS). Towards this end, a user manual, risk analysis, driver connectivity and start-up instructions, simulation testing and implementation will be key milestones for year 1.

Objective 2: months 13-24. The SOS will be utilized in healthy volunteers. Specifically, oxygenation and ventilatory indices will be captured during progressive hypoxemia in volunteers (n=10) without (visit 1) and with (visit 2) an extra-thoracic restriction device to simulate ARDS. Tasks and key milestones in this objective will test the predictability and timing of the SOS to identify pulmonary distress in volunteers undergoing hypoxia or hypoxia plus extrathoracic restriction (when the SpO₂/CLC-FiO₂ ratio <250). A manuscript will be prepared and submitted.

Objective 3 [option]: months 25-36. Pilot clinical testing and SOS algorithm tuning will be performed in selected patients undergoing extubation from the OR to post anesthesia recovery unit (PACU) [UTMB] and ICU [University of Cincinnati (UC)]. Tasks in this objective will determine the impact of autonomous delivery of oxygen on timing of interventions (PACU efficiency vs ICU rescue ventilation). Other data will be integrated and analyzed similarly e.g., low minute ventilation by Exspiron, etc. Data generated from these studies will be incorporated into a manuscript(s) and the decision support SOS prototype for developing future trials.

Objective 1:

- The project kick-off meeting occurred mid-September 2018. The SO, COR and others were introduced.
- UTMB formalized a sub-contract with Arcos Inc (the contractual entity for developing the SOS prototype).
- The User Needs document was completed (sent QTR 1 Report), which included introduction, expected use (indications/contraindications), hardware requirements, calculations, functional needs (GUI screen), graphical display parameters, decision support alerts/alarms, compatibility and connectivity.
- Hardware requirements documentation was completed (QTR 2), which show core requirements, form factor display, durability, I/O ports, power supply as well as review criteria.
- There were some challenges for the PI to obtain a purchase order for FreeO2 from OxyNov due to vendor classification and procurement requirements (UTMB State Institution). After several months, the system was purchased and received in QTR 2.
- The Exspiron was purchased prior to this grant. Thus, focus was shifted –
- A driver was developed and connectivity to Exspiron was completed.
- Communication specification document was completed (sent QTR 2 report).
- Software requirement documentation was completed (sent QTR 3 report).
- Hazard analysis and risk assessment documentation was completed (sent QTR 3 report).
- All critical components, while available during QTR 2, there was an additional challenge in obtaining source coding from the FreeO2 system. This was recognized during QTR 3 as the PI visited OxyNov Quebec Canada. The in-person meeting was critical and also provided key information on hypoxia studies (objective 2). The critical problem with OxyNov FreeO2 system is that the ability to extract data from the FreeO2 system was locked. Thus, our team came up with an alternate approach that can be utilized on any oxygen tubing delivery system. Specifically, the FreeO2 system has the ability to provide therapeutic closed loop oxygenation. By integrating a flowmeter (clinical grade used to calibrate oxygen delivery systems) and pulse oximeter (Nonin) we thus have a means to provide SpO₂ and FiO₂ into the SOS prototype. In short, the therapeutic drive is not interrupted and diagnostic intel can be used for decision support from the SOS prototype. Connectivity to Nonin and TSI flowmeter systems were completed QTR 4 report.
- A final important aspect learned from OxyNov was that, while they have a CE Mark Approval, FDA clearance may be postponed as de Novo pathway was suggested versus 510K. The CLC O₂ predicate relied on low oxygen flows [less 3 L/min].

- This is relevant to Objective 3 [Option period – see below].
- The PI met with entire non UTMB team at MHSRS.
- Complete connectivity with all systems now [see pic]
- Final user manual complete (sent QTR 4)



Objective 2:

- All IRB and HRPO documentation to test the SOS prototype for YR 2 studies were completed in QTR 1.
- the PI was able to determine the set up for the hypoxia studies, which OxyNov's group perfected [Aim 2 studies]. While relevant to Aim 2 studies, this was important as their group provided a table of air + nitrogen flow rates to induce varying levels of hypoxia [21% -to – 5%].
- Pre-testing for thoracic restriction:
 - Qtr 3, Our team at UTMB (Ms Kahn) along with PI/team has made several attempts to develop the thoracic restriction device by measuring pre-and post forced vital capacity (FVC) before and after placing bound elastic banding; while we can reduce FVC by 20%, our material seems to have too much elasticity.
 - Qtr 4: After several iterations with Ms Kahn, we used two orthotic devices [used for pateints with scoliosis] placed around the mid abdomen and lower thoracic rib cage can reduce forced vital capacity by 1 L [Success].

Objective 3:

- In late QTR 4, The PI had two conversations with the Program Officer shortly after the MHSRS meeting to update him on this potential issue and another with the PO and Arcos director. Alternate ideas were discussed that would still be in line with the statement of work. Specifically, human testing on a smaller scale could be performed [originally ICU patients were proposed for objective 3, however, that would require FDA clearance or IND. A smaller scale study with direct clinician engagement is likely feasible with using the SOS connected to FreeO2 system in “black box” mode]. Additionally, further risk analysis and software programming were discussed to make the SOS more robust and to further increase its readiness level. Working towards these goals will continue as will a pre-meeting with the FDA regarding the SOS.

What opportunities for training and professional development has the project provided?

If the project was not intended to provide training and professional development opportunities or there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe opportunities for training and professional development provided to anyone who worked on the project or anyone who was involved in the activities supported by the project. "Training" activities are those in which individuals with advanced professional skills and experience assist others in attaining greater proficiency. Training activities may include, for example, courses or one-on-one work with a mentor. "Professional development" activities result in increased knowledge or skill in one's area of expertise and may include workshops, conferences, seminars, study groups, and individual study. Include participation in conferences, workshops, and seminars not listed under major activities.

Nothing to report

How were the results disseminated to communities of interest?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how the results were disseminated to communities of interest. Include any outreach activities that were undertaken to reach members of communities who are not usually aware of these project activities, for the purpose of enhancing public understanding and increasing interest in learning and careers in science, technology, and the humanities.

Nothing to report

Describe briefly what you plan to do during the next reporting period to accomplish the goals and objectives.

- Finalize documents for SOS
- Perform simulation testing of SOS
- Begin to recruit for healthy volunteer studies [all ready]
- Complete Volunteer studies
- Have Pre-FDA meeting with Arcos/FDA regarding SOS

4. **IMPACT:** Describe distinctive contributions, major accomplishments, innovations, successes, or any change in practice or behavior that has come about as a result of the project relative to:

What was the impact on the development of the principal discipline(s) of the project?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how findings, results, techniques that were developed or extended, or other products from the project made an impact or are likely to make an impact on the base of knowledge, theory, and research in the principal disciplinary field(s) of the project. Summarize using language that an intelligent lay audience can understand (Scientific American style).

The proposed will test a clinical prototype that is suitable for military and civilian clinical testing, in patients and volunteers in different patho-physiologic states. Our initial vision would be to incorporate other non-invasive ventilation indices e.g., Exspiron [non-invasive minute ventilation (MV)] into the SOS, which would increase diagnostic capabilities. Our long-term vision is to incorporate S_{CLCF} ratio, cardiopulmonary indices (MV and perfusion – production of carbon dioxide, or VCO_2) into a SOS monitoring algorithm such as automated decision-support those evolve for use in military and civilian trauma patients. We anticipate that the SOS algorithms will use threshold values or targets e.g., to define specific interventions such as need for rescue ventilation or other airway interventions. An advantage of this SOS is that it is non-invasive, seamless (coupled to supportive systems), easy to interpret by any skill level (as SpO_2 and oxygen are known entities) and usable at any echelon. While we have outlined how this proposal fits into current capability gaps, it closely aligns with combat casualty care research program, research and development of technologies to diagnose and reduce acute secondary organ damage and health technology.

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how the findings, results, or techniques that were developed or improved, or other products from the project made an impact or are likely to make an impact on other disciplines.

The technology and studies outlined in this proposal are highly relevant to hospital and ICU medicine, perioperative care and especially home health, pre-hospital and triage care.

What was the impact on technology transfer?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe ways in which the project made an impact, or is likely to make an impact, on commercial technology or public use, including:

- *transfer of results to entities in government or industry;*
- *instances where the research has led to the initiation of a start-up company; or*
- *adoption of new practices.*

Not at this time

What was the impact on society beyond science and technology?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how results from the project made an impact, or are likely to make an impact, beyond the bounds of science, engineering, and the academic world on areas such as:

- *improving public knowledge, attitudes, skills, and abilities;*
- *changing behavior, practices, decision making, policies (including regulatory policies), or social actions; or*
- *improving social, economic, civic, or environmental conditions.*

The impact here is potential change in behavior and decision making.

5. **CHANGES/PROBLEMS:** The Project Director/Principal Investigator (PD/PI) is reminded that the recipient organization is required to obtain prior written approval from the awarding agency Grants Officer whenever there are significant changes in the project or its direction. If not previously reported in writing, provide the following additional information or state, “Nothing to Report,” if applicable:

Changes in approach and reasons for change

Describe any changes in approach during the reporting period and reasons for these changes. Remember that significant changes in objectives and scope require prior approval of the agency.

All have been described – no change in SOW but the approach changes have been outlined.

Actual or anticipated problems or delays and actions or plans to resolve them

Describe problems or delays encountered during the reporting period and actions or plans to resolve them.

See report - problem and delays have been resolved.

Changes that had a significant impact on expenditures

Describe changes during the reporting period that may have had a significant impact on expenditures, for example, delays in hiring staff or favorable developments that enable meeting objectives at less cost than anticipated.

None

Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

Describe significant deviations, unexpected outcomes, or changes in approved protocols for the use or care of human subjects, vertebrate animals, biohazards, and/or select agents during the reporting period. If required, were these changes approved by the applicable institution committee (or equivalent) and reported to the agency? Also specify the applicable Institutional Review Board/Institutional Animal Care and Use Committee approval dates.

Significant changes in use or care of human subjects

None to report

Significant changes in use or care of vertebrate animals.

Not applicable

Significant changes in use of biohazards and/or select agents

None to report

6. **PRODUCTS:** List any products resulting from the project during the reporting period. If there is nothing to report under a particular item, state “Nothing to Report.”

- **Publications, conference papers, and presentations**

Report only the major publication(s) resulting from the work under this award.

Journal publications. *List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Identify for each publication: Author(s); title; journal; volume; year; page numbers; status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

Nothing to report

Books or other non-periodical, one-time publications. *Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like. Identify for each one-time publication: Author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (e.g., book, thesis or dissertation); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

Nothing to report

Other publications, conference papers, and presentations. *Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication as noted above. List presentations made during the last year (international, national, local societies, military meetings, etc.). Use an asterisk (*) if presentation produced a manuscript.*

Nothing to report

- **Website(s) or other Internet site(s)**

List the URL for any Internet site(s) that disseminates the results of the research activities. A short description of each site should be provided. It is not necessary to include the publications already specified above in this section.

Nothing to report

- **Technologies or techniques**

Identify technologies or techniques that resulted from the research activities. In addition to a description of the technologies or techniques, describe how they will be shared.

Nothing to report

- **Inventions, patent applications, and/or licenses**

Identify inventions, patent applications with date, and/or licenses that have resulted from the research. State whether an application is provisional or non-provisional and indicate the application number. Submission of this information as part of an interim research performance progress report is not a substitute for any other invention reporting required under the terms and conditions of an award.

We have a patent pending for the SOS

- **Other Products**

Identify any other reportable outcomes that were developed under this project.

Reportable outcomes are defined as a research result that is or relates to a product, scientific advance, or research tool that makes a meaningful contribution toward the understanding, prevention, diagnosis, prognosis, treatment, and/or rehabilitation of a disease, injury or condition, or to improve the quality of life. Examples include:

- *data or databases;*
- *biospecimen collections;*
- *audio or video products;*
- *software;*
- *models;*
- *educational aids or curricula;*
- *instruments or equipment;*
- *research material (e.g., Germplasm; cell lines, DNA probes, animal models);*
- *clinical interventions;*
- *new business creation; and*
- *other.*

Software and other analysis have been submitted in previous quarterly reports

7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

What individuals have worked on the project?

Provide the following information for: (1) PDs/PIs; and (2) each person who has worked at least one person month per year on the project during the reporting period, regardless of the source of compensation (a person month equals approximately 160 hours of effort). If information is unchanged from a previous submission, provide the name only and indicate “no change.”

Name:	Michael Kinsky, MD
Project Role:	PI
Researcher Identifier (e.g. ORCID ID):	0000-0002-2103-546X
Nearest person month worked:	1 mo/QTR
Contribution to Project:	The PI has directed the efforts for acquiring requisite components, working with Dr. Kramer and Mr. Branson and Ms. Khan to develop the technical requirements for all of Arcos work this quarter
Name:	George Kramer, PhD
Project Role:	CO-I
Researcher Identifier (e.g. ORCID ID):	0000-0003-0894-6768
Nearest person month worked:	<1 mo/QTR
Contribution to Project:	The Co-I has dedicated his efforts for coordinating the technical requirements for all of Arcos work this quarter
Name:	Rich Branson, MS RRT
Project Role:	CO-I
Researcher Identifier (e.g. ORCID ID):	0000-0002-0912-3360
Nearest person month worked:	<1 mo/QTR
Contribution to Project:	The Co-I has dedicated his efforts for coordinating the technical requirements for all of Arcos work this quarter
Name:	Muzna Khan, MS RRT
Project Role:	CO-I
Researcher Identifier (e.g. ORCID ID):	0000-0002-8096-981X
Nearest person month worked:	<1 mo/QTR
Contribution to Project:	The Co-I has dedicated her efforts for coordinating the technical requirements for all of Arcos work this quarter.
Name:	Michael Salter, MS
Project Role:	Research technician
Researcher Identifier (e.g. ORCID ID):	https://orcid.org/0000-0002-8096-981X
Nearest person month worked:	<1 mo/QTR
Contribution to Project:	The research associated has worked with the PI to assist in technical work, ordering parts, maintaining documentation and working with Arcos for initial instrument testing.
Name:	Roger Seeton, RN
Project Role:	Research Nurse
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	1 mo/QTR
Contribution to Project:	The research nurse has worked with the PI to help with all documentation for IRB/HRPP and human subject material. As well as recruitment material. He has also helped with Arcos to ensure human safety.

Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?

no

What other organizations were involved as partners?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe partner organizations – academic institutions, other nonprofits, industrial or commercial firms, state or local governments, schools or school systems, or other organizations (foreign or domestic) – that were involved with the project. Partner organizations may have provided financial or in-kind support, supplied facilities or equipment, collaborated in the research, exchanged personnel, or otherwise contributed.

Provide the following information for each partnership:

Organization Name:

Location of Organization: (if foreign location list country)

Partner’s contribution to the project (identify one or more)

- *Financial support;*
- *In-kind support (e.g., partner makes software, computers, equipment, etc., available to project staff);*
- *Facilities (e.g., project staff use the partner’s facilities for project activities);*
- *Collaboration (e.g., partner’s staff work with project staff on the project);*
- *Personnel exchanges (e.g., project staff and/or partner’s staff use each other’s facilities, work at each other’s site); and*
- *Other.*

University of Cincinnati

Arcos Inc.

8. SPECIAL REPORTING REQUIREMENTS

COLLABORATIVE AWARDS: For collaborative awards, independent reports are required from BOTH the Initiating PI and the Collaborating/Partnering PI. A duplicative report is acceptable; however, tasks shall be clearly marked with the responsible PI and research site. A report shall be submitted to <https://ers.amedd.army.mil> for each unique award.

QUAD CHARTS: If applicable, the Quad Chart (available on <https://www.usamraa.army.mil>) should be updated and submitted with attachments.

SMART OXYGENATION SYSTEM (SOS) PROVIDES EARLY WARNING OF LUNG INJURY
0011121518-0001/ USAMRAA
W81XWH18C0156



PI: Michael Kinsky, MD Org: University of Texas Medical Branch at Galveston Award Amount: \$718,879 [option not included]

Study/Product Aim(s)

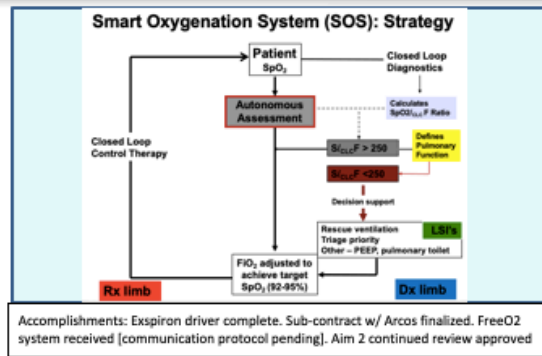
Hypothesis: At-risk casualties, suffering from lung injury, can more rapidly be assessed and treated using a smart oxygenation system (SOS) that connects to a stand-alone closed loop control (CLC) oxygen system and a non-invasive ventilation monitor

Specific Aims

- Aim 1: Develop robust SOS prototype for use in spontaneous ventilation
- Aim 2: Measure oxygenation and ventilatory indices during progressive hypoxemia in volunteers (n=10) without (visit 1) and with (visit 2) an extra-thoracic restriction device to simulate ARDS – months 13-24
- Aim 3: Pilot clinical testing and SOS algorithm tuning – months 25-36 [OPTION]

Approach

We will develop a user manual, connectivity to OxyNov's (closed loop control oxygen for spontaneous (sp.) ventilation) and Respiratory Motion's (non-invasive minute ventilation and tidal volume and respiratory rate) communication protocol to extract data packets e.g., SpO₂, estimated FiO₂ and S_{1/2}F ratio, minute ventilation and respiratory rate, which will then be graphically displayed in real time. SOS Prototype will be tested in human volunteers first [hypoxia ± chest wall restriction (CWR)] and then patients [option] to determine pulmonary dysfunction.



Accomplishments: Exspiron driver complete. Sub-contract w/ Arcos finalized. FreeO2 system received [communication protocol pending]. Aim 2 continued review approved

Timeline and Cost

Activities	CY	18	19	20	21
Develop robust SOS for sp. ventilation		█	█	█	
Implementing oxygenation and ventilatory indices after hypoxia ± CWR			█	█	
Pilot clinical testing [option]				█	
Estimated Budget (\$K)		\$360K	\$360K	(\$option 400K)	

Updated: (September 30 2019)

Goals/Milestones (Example)

CY18 Goal – SOS hardware assembly, driver development and support

- SOS hardware requirements and user need
- Driver development, connectivity and architecture for SOS
- Simulation testing and study support [Risks/ prototype demo]

CY19/20 Goals – Obtain regulatory approval, study enrollment

- Regulatory approval
- Complete prototype and experimental testing
- CY21 Goal** – Option [Pilot testing]
- Regulatory approval
- Data collection in PACU patients [SOS vs standard of care (SOC)]
- Data collection in ICU patients [SOS vs SOC]

Comments/Challenges/Issues/Concerns

- Decided to use OxyNov with adapter flowmeter and pulse ox. This allows for CLC O2 Rx [OxyNov] and independent Dx intel

Budget Expenditure to Date

Projected Expenditure: 360K
 Actual Expenditure: 290K pre-encumbered + subcontract

9. **APPENDICES:** Attach all appendices that contain information that supplements, clarifies or supports the text. Examples include original copies of journal articles, reprints of manuscripts and abstracts, a curriculum vitae, patent applications, study questionnaires, and surveys, etc.