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NCI Center for Global Health, Logistics, Data Analysis, and Technical Support

Final Report: Evaluation for the Affordable Cancer Technologies (ACTs) for Global Health Program

Submitted by: Synergy Enterprises, Inc. and Westat

SYNERGY ENTERPRISES, INC.

Westat

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Final Report: Evaluation for the Affordable Cancer Technologies (ACTs) for Global Health Program

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1. EXECUTIVE SUMMARY

At the behest of the National Cancer Institute (NCI) Center for Global Health (CGH), Synergy Enterprises, Inc., and Westat (Team Synergy) undertook an evaluation of the Affordable Cancer Technologies (ACTs) program to determine the extent to which the ACTs program (1) contributes to the oncology literature and the global research environment; (2) stimulates progress toward successful products or interventions for use in low- and middle-income countries (LMICs); and (3) creates long-lasting international, multidisciplinary partnerships around new and/or evolving cancer diagnosis, screening, or treatment technologies. This mixed-methods evaluation consisted of several components, including interviews with subject matter experts; analyses of NIH databases and data from publicly available search engines like Google and Web of Science to assess the productivity and reach of the ACTs grants; a survey of Principal Investigators (PIs) and other staff working for the ACTs grants; and case studies highlighting key areas of success, failure, and lessons learned. The results of this evaluation are summarized in the present report.

The evaluation examined the research space for the ACTs program and how the ACTs program grantees contributed to the state of the science. Specifically, it explored the process through which projects under the ACTs program have fostered new investigators; generated publications, especially by first-time authors; trained researchers/postdoctoral students and graduate students both domestically and in LMICs; and provided evidence of successful commercialization of products and/or treatment modalities. Some of the key questions the evaluation sought to answer included the following:

- What is the breadth of the ACTs program's international collaboration network?
- What are the tangible results from the program (e.g., publications, products, patents)?
- What are the intangible results from the program (e.g., international collaborations, training of new researchers)?
- What changes could be made to the program to improve workflow and outcomes?

The findings are summarized below.

1.1 Overall Impressions of the ACTs Program

Overall, Team Synergy found that the ACTs program was extremely well-received by grantees. While, at the time of the evaluation projects, they were at various points in their research and commercialization processes, program participants reported unwavering support from ACTs program staff as they conducted their studies, navigated different pathways toward commercialization, and continued the dissemination and publication of their findings. The present evaluation provided evidence that the ACTs program grantees exhibited the propensity to fill research gaps and/or impact the global oncology research space in the following ways:

- By allowing researchers to investigate what technologies could be provided to community healthcare workers in LMICs that could have a significant impact on patient survival/cancer mortality in LMIC communities. As one participant noted:

"Overall, the existence of the program in itself is a great asset and opportunity that is very welcomed and that greatly enhances chances of adequate technology development AND implementation."

- By providing funding for researchers to design diagnostic tests and devices that can allow more people to be screened and treated for cancers in LMIC countries as expressed by this participant:

  "The variety of products being developed and validated that if proven efficient may improve global health by preventing different cancers or offering accessible treatment."

- By allowing for the development of technologies tailored to the needs of LMICs (and other resource-constrained environments), which call for different types of technologies than would be developed for use in the US, thereby increasing the options for screening, detection, and treatment in LMIC settings. As a participant noted,

  "We have visited local communities in remote regions in LMICs and felt the strong needs of cancer screening in those regions. The local health workers are extremely interested in working with us and provided as much support as they could for the study. In addition to oral cancer screening, the local health workers are very interested in using similar technologies for cervical cancer screening as well."

- By training scientists in LMICs, thereby increasing local capacity for oncology research. As one participant noted:

  "While it is challenging to work across cultural and language barriers, as well as different time zones, it is a great learning opportunity that I can only recommend to anyone that wants to develop technologies & products for LMICs. There is no better way to learn about the challenges a technology or product will face in the environment where it will be deployed."

1.2 Need for the ACTs Program

- In each section of the evaluation, gratitude was expressed toward NCI and the ACTs program for filling a need in the global oncology research sphere that had previously gone unnoticed. As reported in the subject matter expert interviews, most interviewees felt that there were no other programs/initiatives that focus on technology innovations specifically designed with LMICs in mind, and an overall lack of funding for global cancer research was discussed.
- Additionally, from the perspective of the grantees, the overall absence of funding for oncology research within LMICs was largely due to the lack of adequate government, health, and financial systems infrastructure in the LMICs. As one ACTs program participant stated, "*You cannot think about diagnostics when there is no treatment system in place.*" While the ACTs program is not designed to help fill current LMIC health

systems gaps, it is instrumental in creating technologies that fit the often less robust health systems in place in LMICs.

1.3 Findings Related to Program Objective 1: How does the ACTs program contribute to the oncology literature and the global research environment?

The ACTs program participants and subject matter experts interviewed stated that the ACTs program and its grantees have helped draw attention to the fact that there is a community of global oncology researchers whose publications and presentations represent a growing body of evidence in the global oncology arena.

1.3.1 Contributions to the Oncology Literature

- To date, 61 journal articles have been published on ACTs program projects. ACTs program participants also reported an average of 4.1 journal publications per grant, and three participants reported more than eight publications from their ACTs program work. Of the 404 authors listed across the publications, 25 percent were from LMICs. Five publications had first authors who were both Early Stage Investigators (ESIs) and New Investigators (NIs), and four had first authors who were NIs.
- ACTs program participants reported an average of 11.4 conference presentations per ACTs program grant. The highest number of presentations reported was 30; three grantees reported no presentations as of yet.
- Of the first authors across all 61 publications, 47 had affiliations in the United States only, 12 had institutional affiliations in LMICs (seven in China, three in China and the United States, and one each in Peru and Brazil), one had affiliations in South Korea, and one had affiliations in Canada.
- Two ACTs program grants presented their data to the World Health Organization. In both instances, the data were considered and/or adopted for use in the creation of new clinical guidelines for cancer treatment.

1.3.2 Personnel with an International Scope

- Overall, 77 percent of all key personnel on ACTs program projects were US based, 17 percent were based in LMICs, and 6 percent were based in high income countries (HICs) including Canada and France. The majority of PIs were US based (80 percent, or 32 individuals), with 10 percent of the PIs being LMIC-based and HIC-based (four individuals for each).
- There were 30 students and post-docs listed by role in the personnel data across 12 ACTs program grants. Of these, 14 were listed as graduate students (47 percent), 14 were listed as post-doctoral students/staff scientists (47 percent), and two were undergraduates (6 percent). All students and post-docs had US affiliations.

1.3.3 Setting the Stage for Future Global Cancer Research

- Following their ACTs program awards, the PIs were further awarded — or had as pending — 71 additional grants involving an additional 43 PIs. Of these PIs, 9 percent were from LMICs, 12 percent were ESIs, and 33 percent were NIs.

1.4 Findings Related to Program Objective 2: How does the program stimulate progress toward successful products or interventions for use in low- and middle-income countries (LMICs)?

To be considered for an ACTs program award, PIs presented evidence of how they were going to develop the technology scientifically and commercially. ACTs projects have reported steps toward securing various intellectual properties, including patents and Food and Drug Administration (FDA) applications and/or assurances, as well as developing partnerships with commercial entities both in and outside of the US.

1.4.1 Interest from Commercial Entitles

- The majority of ACTs program participants reported in the survey having "some" to "extensive" interest in the ACTs program-funded technologies from commercial entities (55 percent). They also reported having "some" to "extensive" interest in the ACTs program-funded technologies, including respondents from the healthcare community in the test location (88 percent), respondents from the healthcare community in other locations (83 percent), and researchers based in the test country who were not on the test team (77 percent).
- Of those who began to market technology, two ACTs program participants reported licensing technology to other companies: one US-based company, and one company in an LMIC. The others said they planned to market to LMICs, without specifying a country. Four respondents also reported sales of technology.

1.4.2 Other Areas of Progress

- Eleven projects reported FDA Investigational New Drug/Investigational Device Exemption (IND/IDE) applications in their progress reports. Additionally, one grantee reported that both FDA approval and European Union CE mark registration have been awarded to his project.
- Another ACTs program project obtained a Small Business Innovation Research (SBIR) grant in partnership with AAS, Inc. (www.aasinc.co) to develop a new version of their technology. AAS's aim is to manufacture devices and reagents that make PCR (polymerase chain reaction) science affordable and accessible to everyone everywhere.

1.5 Findings Related to Program Objective 3: How does the ACTs program create long-lasting, international, multidisciplinary partnerships around new and/or evolving cancer diagnosis, screening, or treatment technologies?

The personnel involved in the ACTs programs are key to success in creating long-lasting, international, multidisciplinary partnerships. Of the 202 key personnel identified on the ACTs program grants, 25 percent had affiliations outside of the US. All of the personnel interviewed for the case studies commented enthusiastically on the significance of their work and its contribution to the global oncology field. Several interviewees also felt that the research conducted under the ACTs grant was a high point in their career that resulted in a very tangible benefit to the diagnosis and treatment of cancer in LMICs.

1.5.1 Personnel and Training

- Overall, of the 202 key personnel listed in the Query, View, Report (QVR) database, 14 key personnel were listed as ESIs (7 percent) and 51 key personnel were listed as NIs (25 percent). This includes three co-PIs who were listed as ESIs, and 10 co-PIs who were listed as NIs.
- All grants, without exception, involved a significant training component both in the US and the LMICs involved. Most grantees agreed that the ACTs grants also made a significant contribution to improving the training infrastructure in the LMIC sites involved.
- All ACTs program participants reported that their work on the ACTs program grant encouraged them to continue to work internationally. Additionally, from the survey of ACTs program personnel, over 90 percent of respondents reported "some" to "close" collaboration among personnel. This included collaboration among US-based personnel (94 percent), among LMIC-based personnel (97 percent); and between US-based and LMIC-based personnel (94 percent).

1.5.2 New Grants Awarded to ACTs Program Personnel

- Fifteen ACTs program personnel (45 percent) stated that while working on their ACTs program grant, they developed scientific collaborations with other ACTs program grantees. Of these, eight respondents (24 percent) reported working with some or all of the original ACTs grant personnel on an offshoot project of the same technological innovation. Three respondents (9 percent) reported multiple types of collaborations.
- There were 79 new grants awarded or pending awards to ACTs program PIs since the start of their ACTs program projects, and these new efforts incorporated 43 PIs who were not on the original ACTs program grants. Of these, 12 percent were from LMICs, 12 percent were ESIs, and 32 percent were NIs.

1.6 Suggested Improvements to the ACTs Program

In all aspects of the evaluation, responses indicated that the future prospects for the ACTs technology on the commercial market were positive. Grantees made the following overall suggestions for improvement:

1. Help program grantees improve their time to market by assisting them in navigating LMIC Institutional Review Board (IRB) submissions. The latter could happen by building in extra time for these time-consuming submissions, providing key local contacts, and potentially developing handbooks with guidance on navigating local LMIC IRB customs and regulations.
2. Provide guidance and/or funding to help ease the transition from the UH2 to UH3 phases of the grant. Alternatively, work toward introducing funding through alternate grant mechanisms. Some grantees also requested that "diversity supplements" be made available to help fund additional researchers or work within the LMIC.
3. Create more opportunities for ACTs grantees to collaborate with each other outside of the ACTs annual meetings. These meetings were highly regarded, and several interviewees requested more meetings and other opportunities to encourage collaboration between members of different teams.

Throughout this evaluation, the ACTs program emerged as a highly regarded and overall excellent support to the program grantees. As one grantee noted:

> *"Despite the challenges we encountered, the support from the ACTs management has simply been outstanding and the ability to network (and sometimes commiserate) with other ACTs recipients enabled us to learn from each other and in some cases collaborate to solve certain problems. Finally, the experience of developing and growing collaborations with international staff in focus countries feels very rewarding."*

Further discussion of the ACTs program evaluation findings can be found in the full report. The full listing of grants discussed can be found in table 1.1.

Table 1.1. Grant titles and PI by Cohort Year

Cohort Year	Base Project Number	Title	PI
2014	CA189910	Point-of-Care Diagnostic Tools to Improve Global Cervical Cancer Programs	Schmeler, Richards-Kortum
2014	CA189883	Cryopen: An Innovative Treatment for Cervical Precancer in Low-Resource Setting	Cremer
2014	CA189901	Low-Cost Enabling Technology for Image-Guided Photodynamic Therapy (PDT) of Oral	Hasan, Celli
2014	CA189923	Performance, Safety, and Efficacy of a New Cyrotherapy Device for Cervical Dysplasia	J. Anderson
2014	CA189965	CTIVE Viral Hepatitis Diagnostics to Support Prevention/treatment of HCC	Murphy
2014	EB019889, CA189966	Low Cost Automated Ultrasound for Breast Cancer Detection and Diagnosis	Love
2014	CA189908	Improving Specificity of HPV Screen-and-treat in South Africa	Kuhn
2016	CA202665	The Radiation Planning Assistant (RPA) for Radiation Therapy Planning in Low- and Middle-income Countries	Court, Beadle
2016	CA202637	Smartphone for Molecular Cancer Diagnostic in Africa	Weissleder, Chabner
2016	CA202663	Cytology-free POC Cervical Cancer Diagnostics for Global Health	Vinson, Smith
2016	CA202721	Development, Field Testing and Evaluation of the Efficacy of a Hand-held, Portable and Affordable Thermo-coagulator to Prevent Cervical Cancer in Low- and Middle-income Countries	Basu
2016	CA202730	Development and Clinical Validation of a Multi-type HPV E6/E7 Oncoprotein Test for Cervical Cancer Screening and Triage in Low- and Middle-income Countries	Herrero
2016	EB022623, CA239682	Low-cost Mobile Oral Cancer Screening for Low Resource Setting	Liang

Cohort Year	Base Project Number	Title	PI
2016	CA202723	Early Stage Diagnosis of Kaposi's Sarcoma in Limited Resource Settings Using KS-Detect	Erickson, Martin
2017	CA211310	A cost-effective radiation treatment delivery system for the low- and middle-income countries	Ford
2017	EB024965	Point of care, real-time urine metabolomics test to diagnose colorectal cancers and polyps in low- and middle-income countries	Kingham, Alatise, Wishart
2017	CA211415	Rapid Point of Care Detection of HPV-Associated Malignancies	K. Anderson, Brenner
2017	CA211457	Facile screening for esophageal cancer in LMICs	Meltzer, Wang
2017	CA211139	Digital PCR quantification of BCR-ABL for CML diagnosis and monitoring in a LMICs setting	Chiu
2017	CA211232	Smartphone Enabled Point-of-Care Detection of Serum Markers of Liver Cancer	Chilkoti, Chao
2017	CA211551	Field-deployable platform for prognostic hepatic cancer screening in low-resource settings	Porter, Scaife

2. INTRODUCTION

The Synergy Enterprises, Inc. and Westat (Team Synergy) evaluation of the National Cancer Institute (NCI) Center for Global Health (CGH) Affordable Cancer Technologies (ACTs) program aimed to show to what extent the ACTs program fulfilled the following objectives:

- Objective 1: Contribute to the oncology literature and the global research environment;
- Objective 2: Stimulate progress toward successful products or interventions for use in low- and middle-income countries (LMICs); and
- Objective 3: Create long-lasting, international, multidisciplinary partnerships around new and/or evolving cancer diagnosis, screening, or treatment technologies.

The evaluation examined the process through which investigators under the ACTs program have fostered new investigators; generated publications, especially by first-time authors; trained US- and LMIC-based researchers, and US-based post-doctoral students and graduate students; and provided evidence of successful commercialization of products and/or treatment modalities.[1]

As such, the evaluation sought to answer the following research questions:

- What defines the research space for the ACTs program?
- What is the breadth of the ACTs program's international collaboration network?
- What are the tangible results from the program (e.g., publications, products, patents)?
- What are the intangible results from the program (e.g., international collaborations, training of new researchers)?
- What changes could be made to the program to improve workflow and outcomes?

The evaluation team used a four-pronged, mixed methodology for the evaluation, which allowed for detailed and nuanced analysis and interpretation of the quantitative and qualitative data. Table 2.1 highlights the objectives, guiding questions, and evaluation tasks.

[1] LMICs or low and middle income countries are classified as such by the World Bank. Please see the following for a complete list:

World Bank Country and Lending Groups – World Bank Data Help Desk. (2019). Worldbank.Org; World Bank. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

Table 2.1. Objectives, Guiding Questions, and Associated Tasks for the ACTs Evaluation

Related Objective	Guiding Questions	Task 2—Subject Matter Expert Interviews	Subtask 3a—Analysis of Outputs	Subtask 3b—Principal Investigator Survey	Subtask 3c—Case Studies
Evaluate contributions to the research space (Objective 1)	• What are the contributions to the literature from ACTs program grantees? • How many early-stage researchers have been involved in ACTs program grants? • How many trainees have emerged from the ACTs program grants? • In what countries are the PIs located, and who are the collaborating research sites?	✓	✓	✓	✓
Quantify translational technology research from ACTs program grantees (Objectives 1 and 2)	• What new technologies or shared resources have emerged from the ACTs program? • What number and kind of intellectual properties have originated in the ACTs program grants? • How many journal articles or citations have emerged from the program?	✓	✓	✓	✓
Assess what additional improvements are needed to the program (Objective 3)	• What are the challenges to the program? • What additional activities are needed to enhance the program's effectiveness? • How has international collaboration aided program participants, and in what ways has it hindered the research?	✓		✓	✓

While each of these tasks and subtasks represents a distinct body of work, this report unifies the findings into a single document. Each of the subsequent chapters is a deliverable report that has been delivered to NCI, along with a final concluding chapter that brings everything together. Section 3 is a discussion of the subject matter expert interview findings (Task 2). Section 4 presents the analysis of output data for each of the ACTs grants (Subtask 3a). Section 5 contains the results of a survey distributed to ACTs PIs and other program participants (Subtask 3b), and section 6 presents four case studies of influential ACTs program grants (Subtask 3c). Section 7 concludes the report with a brief discussion of some of the limitations of the ACTs program overall and some desired changes for the future. The appendices for each report have been gathered and presented at the end of the document in a final section titled *Appendices for the ACTs Program Evaluation.*

3. SUBJECT MATTER EXPERT (SME) INTERVIEW FINDINGS BY QUESTION (TASK 2)

The following section presents findings from interviews with four subject matter experts (SMEs) interviewed by Team Synergy in October 2019. Team Synergy began the ACTs program evaluation with subject matter expert interviews to help inform the development of the survey and case study instruments. Many of the themes identified during these interviews are explored further in subsequent sections of this report. In addition, these interviews point to the unique nature and contribution of the ACTs program within the current cancer technologies funding environment.

SME interviewees included:

- Patricia Garcia, MD (pattyg@uw.edu), Affiliate Professor, Global Health, University of Washington; Dean of the School of Public Health, Cayetano Heredia University - Peru
- Catherine Klapperich, PhD (catherin@bu.edu), Associate Dean for Research and Technology Development, Professor, Dept. of Biomedical Engineering, Boston University
- Dan Milner, MD (Dan.Milner@ascp.org), Chief Medical Officer, American Society for Clinical Pathology Center for Global Health
- Lawrence Shulman, MD (lawrence.shulman@uphs.upenn.edu), Professor; Deputy Director for Clinical Services of the Abramson Cancer Center; Director of Center for Global Cancer Medicine; University of Pennsylvania

Interviews lasted about 45 minutes each and were recorded and transcribed. Prior to the interviews, interviewees received the ACTs Principal Investigators May 2019 Meeting Program, including investigator biosketches and grant abstracts. Interview findings are presented below by question.

3.1 INTRODUCTION

Q2. Please describe your current knowledge of and/or involvement with the ACTs Program.

- One interviewee was very familiar with the ACTs Program though not with individual awards. This grantee had applied for a grant prior. The other three interviewees had heard of the program but were not familiar with many program specifics, such as individual awards and investigators, publications and other products thus far, the ACTs funding mechanism, etc.

Q3. Can you describe your work/research as it relates to oncology research in LMICs?

- All four respondents have extensive experience relevant to the ACTs Program. All have conducted research in both cancer screening and cancer diagnosis in LMICs.

Q4. From your perspective, what are the major research gaps in global oncology research? What are the barriers to addressing these research gaps?

Gaps

- Gaps vary by country and location because social determinants or health vary by location. In addition, health systems and finances vary by location. You cannot think about diagnostics when there is no treatment system in place.
- More validation studies are needed to confirm the fact that clinical trial results are concordant with standard techniques.
- More research is needed that shows patient outcomes; it is critical to collect good data and evaluate how patients have done.
- More clinical trials are needed of drug and therapeutic interventions that might be attached to technology in various settings.
- There are many biological questions related to epidemiology, related to incidence of disease, and also related to treatment. If something works for young or pediatric, Caucasian patients in Europe, does it work for pediatric, African patients in Africa? And there is more research to be accomplished in pharmacogenetics, metabolomics and transcriptomics.
- Many non-biology issues, things like funding, access, systems-based approaches, infrastructure, exploration, etc. must be further explored as they affect disease incidence, diagnosis and treatment.
- There is a need for diagnostics that could allow us to reach more people, that could be affordable, sensitive, and maybe markers that can allow us to do better screening.
- There is a need for treatments that are feasible in non-western settings. We know more about pharmacologic and surgical treatments but in the case of chemotherapy, it is so often not available in many LMICs that patients often decide to die.

Barriers

- **Lack of funding** was mentioned by all as a key barrier to filling gaps in the current oncology research ecosystem**.** Funding for clinical collaborators who are not in the United States was mentioned as particularly challenging. Collaborators have financial administrators that have typically never written an NIH grant. It requires a lot of one-on-one mentoring at the investigator level to help LMIC staff successfully administer an NIH grant.
- **Lack of trust**. Investigators in LMICs do not want to feel like they are being taken advantage of in the research realm. They do not want to feel like they are being used or abused, and they want to ensure that projects are done not just for the benefit of the US investigators.
- **Environmental differences**. When technologies are tested in the US, for instance, it is possible to do a huge amount of safety testing around it. In many LMICs, the ability to do that level of monitoring is much more difficult, and it is sometimes harder to track patients to monitor their outcomes. Unless it is possible to show safety and effectiveness in the context of how care is delivered in LMICs, then these advances are not useful.

- **US developer lack of knowledge of what is needed in the field**. Developers are the people that could have the capabilities of designing a new diagnostic, but they do not necessarily know what is needed in the field. More point-of-care tests are needed. There is a need to better understand the conditions in different locales and the capabilities of the providers or healthcare workers.

3.2 Contribution and Impacts of ACTs Program

Q5. In what ways do you think that the ACTs Program, or other programs like the ACTs Program, fills existing gaps in the global oncology research environment? [discussed with Q6 below]

Q6. What do you see as the main impacts, contributions, and successes of the ACTs Program?

- Most respondents were not adequately familiar with the ACTs Program and its grantees to provide specific feedback on impacts of the program.
- Interviewees felt that the ACTs Program and its grantees have helped draw attention to the fact that there is a community of global oncology researchers. One interviewee mentioned a recent (within past 1-2 years) review article authored by several program grantees that presented new technologies in global oncology.
- Interviewees noted that the ACTs Program has the potential to fill research gaps and/or make impacts in the following ways:
    - By providing funding for researchers to design diagnostic tests that can allow more people to be screened for cancers.
    - By providing funding that increases access to cancer-related technologies (in screening, treatment, etc.).
    - By allowing for the development of technologies tailored to the needs of LMICs (and other resource-constrained environments), which are different from the types of technologies that would be developed for use in the US.
    - By allowing researchers to figure out what technologies could be given to community healthcare workers that could impact patient survival/cancer mortality.
    - By training scientists in LMICs and thereby increasing local capacity for oncology research.

Q7. In your opinion, what is the most appropriate way to measure the success of a program like ACTs?

- Interviewees felt that the ultimate measures of success should be related to the specific technology and its goals.
- Although interviewees noted that clinical outcomes would not be possible to measure during the life of the grant, they still enumerated clinical outcomes that would indicate success, because these were seen as the most important measures overall.
- Process measures suggested by interviewees included:
    - to what extent the product/technology was seen as acceptable to the local community/healthcare setting

    - how the grantee overcame anticipated and unanticipated challenges
    - how far down the translational pathway the technology was able to go
    - whether new investigators became aware of a global oncology-related problem
- Output measures suggested by interviewees included:
    - number of products/technologies developed
    - number of patents
    - number of licenses
    - number of startups
    - whether or not the product/technology made it to market
- Outcome measures suggested by interviewees included:
    - Whether and to what extent the product/technology was adopted
    - Percentage of local population screened
    - Percentage of local population with diagnosis of cancer who receive treatment
    - Treatment outcomes
    - Mortality rates

Q8. Do you feel that the work done as part of the ACTs Program is broadly applicable (e.g., from one LMIC to other LMICs; beyond the LMIC setting, such as within low income areas of the US)?

- Interviewees unanimously felt that work done by the ACTs Program had the potential for broad applicability. At least one interviewee, however, cautioned that stakeholders in different communities still needed to weigh in on the design parameters that would ensure success in their local areas.
- Although not part of the ACTs Program, interviewees provided several specific examples of work funded in one LMIC that was then used in another LMIC or in the US:
    - A rapid syphilis test developed in Peru that was successfully deployed in other countries in Africa, Latin America, and Asia.
    - A radiation machine designed for use in an LMIC with an unstable power grid that was seen as better than machines in the US and has started replacing machines at the University of Pennsylvania.
    - The Breast STRAT4, developed for use in Africa, designed to get a rapid reading on a small number of breast-cancer related markers traditionally done in the US through more costly and time-consuming immunohistochemistry methods.

Q9. Are there other programs or initiatives similar to the ACTs Program? How do they compare? [discussed with Q10 below]

Q10. Based on what you know of the ACTs Program, would the work being done through this program be possible under another existing grant mechanism or other type of funding?

- Most interviewees felt that there were no other programs/initiatives that focus on technology innovations within global oncology. An overall lack of funding for global cancer research (in general) was noted.
    - One interviewee mentioned that the US Department of Defense funded technologies related to cancer for use with deployed military.

- Other programs that interviewees noted as funding global healthcare technologies (but not specifically related to cancer) include the Bill & Melinda Gates Foundation, Grand Challenges Canada, National Institute of Biomedical Imaging and Bioengineering Point-of-Care Technologies Research Network, and USAID.
- When asked to weigh in on other funding mechanisms, interviewees were hesitant because they were uncertain about was allowable under different mechanisms. Specifically, they were not certain whether other funding mechanisms supported technology development or allowed funding to go to LMIC institutions.

Q11. From your expertise in the field and your knowledge of the ACTs Program, what do you think are likely to be the major challenges/barriers encountered by the program? [discussed with Q12 below]

Q12. What may be ways to counteract these challenges?

- Interviewees noted the following challenges and solutions:
    - Significant time is often required to develop new technologies, and grant cycles tend to be relatively short. Even five-year cycles were noted as being often insufficient.
    - There is a likelihood that a certain number of funded technologies will fail.
    - Meaningful US-LMIC collaborations are difficult to foster. NCI could give extra points or preference to collaborations that have been ongoing for some time. Also, the LMIC grant team could be brought to a workshop in the US (or a meeting could be held in an LMIC, such as in Africa or South America) to discuss the project and meet NCI staff, in order to increase LMIC ownership of the project and empower them as full partners.
    - It can be difficult for researchers to test technologies in environments that would lead to their eventual adoption.
    - Technologies are seen as too risky for traditional investors.
    - Administrative staff in LMICs need mentoring in working with NIH (e.g., creating biosketches, preparing budgets). It may help to offer virtual training to administrative staff in LMICs.
    - The goal of the technology needs to be well-considered, with significant input from the LMIC, before moving to development. The risk is that a technology could be developed too quickly and end up not meeting needs of local populations.
    - Government regulatory requirements in LMICs can make deployment difficult.
    - Diagnostic tests developed in specific ethnic populations may not be generalizable.
    - Idiosyncratic cultural factors can make technology adoption unlikely.
    - It may be helpful for researchers to create a specific plan for increasing local capacity so that the technology can continue to be used without the ongoing involvement of US researchers.
    - Resources from FINDdx can provide helpful guidance on how to develop products for LMICs.

3.3 COLLABORATION/PARTNERSHIPS

Q13. What do you see as the benefits of partnerships between US and LMIC institutions? Based on what you know of the ACTs Program, what benefits do these partnerships bring to the program?

- Increased training and career opportunities for staff in both the LMICs and the US; partnerships create unique educational experiences as participants interact with many different people in the healthcare space.
- A boost to LMIC clinical study programs: increased knowledge for the local team around whatever the disease, and the clinical approach.
- Opportunity to educate the greater public, healthcare workers, and the governments of LMICs about cancer and other diseases. Instigate cancer advocacy.
- Clinical diagnosis and treatment benefits for the trial catchment areas.
- Partnerships formed with LMICs allow the US the opportunity to study diseases that are much less common in the US.
- Innovative technologies developed in LMICs can often also benefit the US.

Partnership Barriers

- Lack of adequate funding.
- Lack of sufficient time: building meaningful relationships can be time-consuming and require face-to-face interaction, which may not be possible due to funding, or it may not be done due to a lack of cultural understanding about its necessity.
- Inadequate infrastructure – which often requires building relationships with governments and, if relevant, with the private sector.
- Administrative barriers: bureaucratic delays, difficulty moving funds, equipment, knowledge, etc.

Q14. What types of supports – from NCI and/or the US and LMIC institutions involved - are needed to promote the success of US/LMIC partnerships?

- Building human capacity: guidance and training for young researchers and especially LMIC staff.
- Removal of administrative barriers involved in moving human capital, technologies and funds across countries.
- Adequate funding for US grant staff but also for those on the ground in LMICs who have received training and feel ownership of the technologies developed.
- Investment in capacity building (mainly training) for transparent management of funding and real time monitoring of spending in US universities and on the ground at the LMIC for each grant.

3.4 Wrap-Up Questions to Close the Interview

Q15. What changes would you suggest for the ACTs Program moving forward?

- Evaluate grants to make sure that they start with at least a rough idea of what the road forward looks like all the way to market absorption of technologies.
- Longer rounds of funding.

Q16. What mechanisms are appropriate for funding this type of research? Are additional funding opportunities needed? Should these be within NIH or outside of NIH?

- One respondent commented that she was confused about whether both the UH2 and UH3 had to be completed and if that reduces chances of receiving the UH2. The others had no comments on this question, other than emphasizing again that there is a need for more grants in this area of research.
- Respondents thought there were some additional funding opportunities for technology research, but not specific to LMICs or oncology.
- One respondent said that what does not exist is an R21 level of money and time (2-3 years). The same respondent said that if the ACTs were written as an R21, the response would be that these technologies did not involve high risk. And if they were written as an RO1, the response would be that the mechanism is too long.
- Respondents were overall receptive to having private entities support the development of diagnostic technologies along with the NIH.

4. EVALUATION FOR THE AFFORDABLE CANCER TECHNOLOGIES (ACTS) FOR GLOBAL HEALTH PROGRAM DELIVERABLE 14: FINAL ARTIFACTS REPORT (TASK 3A)

4.1 Executive Summary

4.1.1 Introduction

This section focuses on *Subtask 3a: Analyzing NCI and Public Databases to Assess the Reach of the ACTs Grants with an LMIC Focus.* The results have been organized into thematic sections as determined by the program objectives. Section 4.3.1. reports on the contributions of the ACTs program grants to the research space (objectives 1 and 3) of the ACTs program. More specifically, this section details ACTs program grantees' contributions to the global research environment through publications of research outputs and describes the extent to which ACTs program grantees use LMIC staff in their projects, engage in multidisciplinary partnerships, and form collaborations with other project personnel. Section 4.3.2. presents ACTs program grantees' contributions to translational research technology, which relates to evaluation objective 2: how the ACTs program grants stimulates progress toward successful products or interventions for use in low- and middle-income countries (LMICs). This section reviews the extent of commercialization efforts undertaken thus far, including patents applied for and/or earned; clinical trials; IDE/INDs applied for and/or granted; and trainings and presentations conducted to interested scientists, ministry of health officials, and others. A full list of ACTs program grants appears in table 4.1.

Table 4.1. Grant titles and PI by Cohort Year

Cohort Year	Base Project Number	Title	PI
2014	CA189910	Point-of-Care Diagnostic Tools to Improve Global Cervical Cancer Programs	Schmeler, Richards-Kortum
2014	CA189883	Cryopen: An Innovative Treatment for Cervical Precancer in Low-Resource Setting	Cremer
2014	CA189901	Low-Cost Enabling Technology for Image-Guided Photodynamic Therapy (PDT) of Oral	Hasan, Celli
2014	CA189923	Performance, Safety, and Efficacy of a New Cyrotherapy Device for Cervical Dysplasia	J. Anderson
2014	CA189965	CTIVE Viral Hepatitis Diagnostics to Support Prevention/treatment of HCC	Murphy
2014	EB019889, CA189966	Low Cost Automated Ultrasound for Breast Cancer Detection and Diagnosis	Love
2014	CA189908	Improving Specificity of HPV Screen-and-treat in South Africa	Kuhn
2016	CA202665	The Radiation Planning Assistant (RPA) for Radiation Therapy Planning in Low- and Middle-income Countries	Court, Beadle
2016	CA202637	Smartphone for Molecular Cancer Diagnostic in Africa	Weissleder, Chabner

Cohort Year	Base Project Number	Title	PI
2016	CA202663	Cytology-free POC Cervical Cancer Diagnostics for Global Health	Vinson, Smith
2016	CA202721	Development, Field Testing and Evaluation of the Efficacy of a Hand-held, Portable and Affordable Thermo-coagulator to Prevent Cervical Cancer in Low- and Middle-income Countries	Basu
2016	CA202730	Development and Clinical Validation of a Multi-type HPV E6/E7 Oncoprotein Test for Cervical Cancer Screening and Triage in Low- and Middle-income Countries	Herrero
2016	EB022623, CA239682	Low-cost Mobile Oral Cancer Screening for Low Resource Setting	Liang
2016	CA202723	Early Stage Diagnosis of Kaposi's Sarcoma in Limited Resource Settings Using KS-Detect	Erickson, Martin
2017	CA211310	A cost-effective radiation treatment delivery system for the low- and middle-income countries	Ford
2017	EB024965	Point of care, real-time urine metabolomics test to diagnose colorectal cancers and polyps in low- and middle-income countries	Kingham, Alatise, Wishart
2017	CA211415	Rapid Point of Care Detection of HPV-Associated Malignancies	K. Anderson, Brenner
2017	CA211457	Facile screening for esophageal cancer in LMICs	Meltzer, Wang
2017	CA211139	Digital PCR quantification of BCR-ABL for CML diagnosis and monitoring in a LMICs setting	Chiu
2017	CA211232	Smartphone Enabled Point-of-Care Detection of Serum Markers of Liver Cancer	Chilkoti, Chao
2017	CA211551	Field-deployable platform for prognostic hepatic cancer screening in low-resource settings	Porter, Scaife

4.1.2 Key Findings

4.1.2.1 How the ACTs Program Grantees Contributed to the Research Space

Contributions to the Literature

Scientists broaden and deepen the research space through their publications and presentations. ACTs grantee publications spanned several disciplines, from clinical oncology to engineering and nanotechnology.

- There were 61 publications reported in the Scientific Publication Information Retrieval and Evaluation System (SPIRES) and Web of Science across 16 grants.
- Of the 404 authors listed across the publications, 25 percent were from LMICs. Compared to other studies with a focus on global health research, this is low. Studies on authorship show that when looking at research conducted in LMICs, greater than 50

percent of authors are typically from LMICs.[2,3] Possibly, this percentage is low because many of the publications so far have focused on the development of technologies which occurred primarily in the US rather than the implementation of these technologies in the LMICs. We thus recommend follow-up research in due time (see also discussion of study limitations at the end of this section).
- Five publications had first authors who were both early-stage investigators (ESIs) and new investigators (NIs), and four had first authors who were NIs.
- The grants with the greatest number of publications thus far were Meltzer, with 17 publications; Weissleder, with 10 publications; and Court, with 8 publications.

Dissemination of Research Findings Beyond Publications

- Two grants under the leadership of Basu and Cremer presented their data to the World Health Organization. In both instances, the data were considered and/or adopted for use in the creation of new clinical guidelines for cancer treatment.
- Seventeen conference presentations were reported across eight grants.

Utilization of Non-US-Based Personnel

- Overall, 77 percent of all key personnel on ACTs program projects were based in the US, 17 percent were based in LMICs, and 6 percent were based in HICs including Canada and France. The majority of PIs were US based (80 percent, 32 individuals), and 10 percent of the PIs were in LMICs and 10 percent were in HICs (4 individuals for each).
- There were 30 students and post-docs listed by role in the personnel data in 12 ACTs program grants. Of these, 14 were listed as graduate students (47 percent), 14 were listed as postdoctoral students/staff scientists (47 percent), and two were undergraduates (6 percent). All students and post-docs listed had US affiliations.

New Collaborations and Grant Awards

- Following their ACTs program awards, ACTs PIs have been awarded (or have pending) 71 additional NIH grants that involve an additional 43 PIs. Nine percent of these additional PIs are from LMICs, 12 percent are early-stage investigators, and 33 percent new investigators.
- In the Research Performance Progress Reports (RPPRs), Ford, Kuhn, and Hasan & Celli all discussed current collaborations between their projects and other ACTs program projects.
- Four key personnel worked on multiple ACTs program grants: Jose A. Jeronimo (CA202730, CA189883), Philip Castle (CA189883, CA189910, EB024965), Jose Fregnani (CA189910, CA202663), and Rebecca Richards-Kortum (CA189910, EB024965).

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[2] Kelaher, M., Ng, L., Knight, K., & Rahadi, A. (2016). Equity in global health research in the new millennium: trends in first-authorship for randomized controlled trials among low- and middle-income country researchers 1990-2013. *International Journal of Epidemiology, 45*(6), 2174–2183. https://doi.org/10.1093/ije/dyw313

[3] Hedt-Gauthier, B. L., Jeufack, H. M., Neufeld, N. H., Alem, A., Sauer, S., Odhiambo, J., … Volmink, J. (2019). Stuck in the middle: a systematic review of authorship in collaborative health research in Africa, 2014–2016. *BMJ Global Health, 4*(5), e001853. https://doi.org/10.1136/bmjgh-2019-001853

4.1.2.2 How the ACTs Program Projects Stimulate Progress Toward Successful Products or Interventions for Use in Low- and Middle-Income Countries

To be considered for an ACTs program award, PIs presented evidence of how they were going to develop the technology scientifically and commercially. Thus far, ACTs projects have reported steps toward various intellectual properties including patents and FDA applications and/or assurances, as well as developing partnerships with commercial entities both in and outside of the U.S.

- Eleven projects reported FDA applications in the RPPRs (see Appendix A.6 for more detail). Additionally, Basu reported that both FDA approval and European CE mark registration have been awarded to his project, The Liger Thermo-Coagulator.
- Erickson's project was the only project to report obtaining an SBIR grant in partnership with AAS, Inc. (www.aasinc.co) to develop an LED-based indoor version of the KS-Detect technology. AAS's aim is to manufacture devices and reagents that make PCR (polymerase chain reaction) science affordable and accessible to everyone everywhere.
- In all, 15 grants mentioned partnering or planning to partner with commercial entities in their transition reports. Many of the grantees reported either creating their own company or partnering with other commercial entities for manufacturing and/or additional testing.

4.2 Technical Approach

4.2.1 Data Collected

The data gathered for analysis under Subtask 3a came from internal NCI databases (QVR and impac II) and external searches on Google, Web of Science, and other sources. A crosswalk of the data with the objectives and central research questions is presented in table 4.2.

Table 4.2. Examples of Evidence and Associated Data Sources for the ACTs Evaluation Artifact Analysis Component

Related Objective	Guiding Questions	Evidence	Data Source
Evaluate contributions to the research space and evidence of multi-disciplinary and international partnerships (Objective 1 & 3).	• What are the contributions to the literature from ACTs program grantees?	• Number of articles published in peer review journals • Impact factors of journals • Disciplines of journals in which articles were published • Number of conference presentations/posters • Number of citations based on the ACTs program work • Number of news articles based on the ACTs program work	• SPIRES data containing a listing of publications associated with the grant numbers • Content analysis of the transition reports from UH2/UG3 to UH3 • iCite Search by PubMed ID Number (PMID) to obtain weighted RCR and number of citations • Web of Science search to obtain additional publications by grant number • Google news alert—news alert with keywords including ACTs program, PI name, Title of Award, & name of technology to quantify publications in news outlets

Related Objective	Guiding Questions	Evidence	Data Source
	• How many early-stage researchers have been involved in ACTs program grants?	• Number of early-stage investigators (ESIs), new investigators (NIs), LMIC investigators listed as key personnel • Number of graduate students, postdoctoral students, trainees supported • Number of ESIs and NIs as first/last authors on publications	• Analysis of the Research Program Progress Reports (RPPRs) • Content analysis of the transition reports from UH2/UG3 to UH3 • QVR person-level files and collaboration detail files associated with each project/grant and publication

	• How many trainees have emerged from the ACTs program grants?	• Number of graduate students, postdoctoral students, trainees supported
		• Influence on early-stage researchers, including numbers of the following:
		  ○ Trainee presentations
		  ○ ESIs and NIs
		  ○ Number of collaborations embodied in follow-on grant applications where ACTs participants are PIs or co-PIs (ESI/NI)
		  ○ Number of collaborations in publications
		  ○ Trainees who apply for new grants
		  ○ Early-stage research articles with acknowledgments for the funding
		• Subsequent funding for collaborators
			• Content analysis of the transition reports from UH2/UG3 to UH3
			• QVR person-level files for ACTs program grants for collaboration information and new awards.

	• In what countries are the PIs located, and who are the collaborating research sites?	• List of countries that researchers are working in • List of partnering institutions/organizations • Number of first/last authors who are from LMICs	• QVR project-level data, including performance sites • QVR person-level files and collaboration detail files associated with each project/grant and publication • Where no information was listed in QVR, individual person-level searches were conducted in various databases including Google and LinkedIn.

Related Objective	Guiding Questions	Evidence	Data Source
Quantify translational technology research from ACTs program grantees (Objectives 1 and 2).	• What new technologies or shared resources have emerged from the ACTs program?	• Number of new patents and shared resources • Number of new analytic techniques • New shared resources, e.g., datasets, tissue banks, registries • Regulatory successes/approvals • Evidence of commercialization	• Content analysis of the Research Program Progress Reports. • Content analysis of the transition reports from UH2/UG3 to UH3
	• What numbers and kinds of intellectual property have originated in the ACTs program grants?	• Number of new patents • New validated surveys/measurement tools • New shared resources (e.g., datasets, tissue banks, registries)	• Content analysis of the Research Program Progress Repots • Content analysis of the transition reports from UH2/UG3 to UH3

4.2.2 Methodology for Analysis

This section describes the evaluation team's approach to obtaining the data for the 21 grants that received initial UH2/UG3 grants under the ACTs program.

Step 1. Upon receiving the list of grants from the ACTs program lead, information on each grant family was downloaded from the QVR database housed at NIH. This dataset contained the following information about each grant: The Principal Investigators (PIs) and key staff, funding information, performance site countries, institutional information, links to the Foreign Award and Component Tracking System (FACTS), SPIRES, and iReport (the patent database).

Step 1a. Selected variables from NIH's QVR database were downloaded for a list of current ACTs grant recipients that was provided by Dr. Paul Pearlman. The QVR data were downloaded in long format and contained multiple rows for each grant recipient with information for individual support year, performance site, institute or center, etc. The data were then transformed into wide format with one row for each grant's base project number. Some variables were expanded into multiple columns to capture differences between support years, such as changes to or additions of PIs and having multiple performance sites.

Variables that had multiple values in a single column were reformatted into multiple columns for each response option and flagged to indicate if a response was present during the life of the grant (e.g., Type [UG3/UH2/UH3] or Foreign Grant Description [Domestic with Foreign Collaboration/Foreign Institution/Foreign Appl Flag Not Set]). Additionally, some variables in the wide format represented a count or total across support years or performance sites (e.g., number of new investigators, total dollars awarded to grant for all years awarded) and some variables showed the range of the grant years (e.g., first fiscal year, most recent fiscal year, first/last support year, or project start date).

Step 1b. Once the project-level QVR data were formatted, additional data were downloaded from QVR, including the person-level data for each PI and overall personnel information for the grant (Step 1c). The person-level data about each PI contains information about any committee memberships or service to NIH the PI has performed; a list of publications associated with the PI; any additional grants the PI has applied to and if they have been funded; and any collaborations the PI might have with other investigators, lab workers, post-docs, and others mentioned in the budget of a grant application or funded grant. Additional details about the collaborators were also downloaded from the collaboration details subsite in the QVR database.

Step 1c. The personnel information about each grant lists all the personnel associated and paid for out of the grant. These personnel are sorted into key personnel and not key personnel as determined by the PI. Additionally, students (undergraduate and graduate) and post-docs are also listed on these reports. Personnel affiliations and job titles on the grant are also listed. These were analyzed to determine the extent to which key personnel were from LMICs, and the number and location of the affiliations of students or post-docs. When an individual's affiliation was not listed in QVR, other databases such as Google and LinkedIn were searched to determine current affiliation.

Step 1d. Using the grant information from Step 1c with the list of key personnel and student level names, searches were conducted in QVR for Early Stage Investigator (ESI) and New Investigator (NI) Status. Names of ESIs and NIs were flagged, as were the locations of their institutional affiliations (US, other HIC, LMIC). Additional data were downloaded to determine when the ESI and NI statuses were confirmed and whether ESIs and NIs had been awarded grants. A full listing of key personnel and students with their affiliations and ESI and/or NI status can be found in Appendix A.3.

Step 1e. There were individuals named in grants as key personnel or students who had eRA Commons accounts but no mentions in QVR as having applied for a grant or served on a review committee. These individuals were then submitted into the T/K/R database function in QVR to assess whether they had been funded as trainees. None of the students flagged as not being in QVR were located in the T/K/R database.

Step 1f. To determine the number of new projects awarded or pending award to ACTs PIs or co-PIs, data was extracted from the PI/co-PIs' person files in QVR. The number of these awards or pending awards was then combined and is presented by ACTs program grant number. Additional descriptive information about subsequent collaborations is presented in section 5 and section 6.

Step 2. Using the embedded information about publications in QVR, SPIRES information was downloaded about each publication and amassed into a dataset (a listing of the variables can be found in Appendix A.2). The downloaded information included the PubMed Identification numbers (PMIDs), author names, full article citations, and funding sources.

Step 2a. The PMIDs generated by the ACTs program-related publications (55 in total) in SPIRES were combined into a database that included the publication journal name, impact factors, and funding sources.

Step 2b. As a second source for literature resulting from the ACTs program grants, the Web of Science database was searched and yielded eight additional citations that were not in the original SPIRES search. One of these was from a project that previously did not yield a publication.

Step 2c. The SPIRES and Web of Science citations were combined into a single database. The PMIDs generated by the ACTs grantee publications were entered into iCite to obtain information about the relative citation ratio (RCR) score for each publication, lists of publications where the article in question had been cited, the overall number of citations, and other bibliometric measures. The RCR metric examines the ratio between the actual number of citations and the expected number of citations given the authors and journal. Two articles in the list were from 2010 and 2013, prior to the start of the grant program, and those were eliminated for a final list of 61 publications.

Step 2d. The list of authors for all the publications was deduplicated and current affiliations were found for 100 percent of the authors.

Step 2e. Additional flags were added to the author list, consisting of position of the author (first, last) and if the author had an LMIC affiliation. A full list of authors, their affiliations, their PMIDs, and positions as first/last author can be found in Appendix A.2.

Step 2f. Appendix A.1 contains the list of publications from SPIRES and Web of Science by Base Project Number. This appendix includes the journal impact number where available, journal title, and area of interest for the journal.

Step 3. As the NIH databases did not contain some of the detail needed for the analysis, RPPRs and transition reports from the grantees were also analyzed. The RPPRs are submitted to the NIH by grantees to provide details about the funding spent, progress to date, key personnel, research outcomes such as publications, presentations and/or patent applications, and any trainings that occurred for the purpose of the research. The transition reports are additional reports submitted between the first phase of funding (UH2/UG3) and the second phase of funding (UH3). These reports provide more information about the progress of the research to date, including any necessary programmatic, personnel, or location changes. The reports also detail commercialization plans for the next stage of the grant — the validation stage (UH3).

Step 3a. The RPPRs were analyzed to determine the number of outputs as well as any collaborations mentioned between the grant team and other entities. Specifically, the reports were analyzed to determine the following items:

- the number of dissemination opportunities, including conference presentations;
- the number of articles published;
- the number of new analytic techniques reported;
- the number of clinical protocols reported;
- the number of patents reported;
- the number of resources reported;
- the number of FDA IND/IDE applications; and
- the number and type of trainings.

A table of the findings can be found in Appendix A.6.

Step 3b. The 21 transition reports that were submitted by the PIs when grants transitioned from the initial stage (UH2/UG3) to the next stage (UH3) were analyzed. These reports ranged from 26 to 350 pages in length. Some of the key areas examined included whether the technology had attracted any commercial interest thus far or whether any steps had been taken to advance the likelihood of future commercialization (e.g., partnering with manufacturers or obtaining patents); whether any post-docs or early stage investigators worked on the grant, particularly from LMICs; and any future plans pertaining to the research.

Step 4. As a final step, the evaluation team used the Google News search engine to search for "Affordable Cancer Technologies program," "ACTs Program" & "NCI," "ACTs Program" & "NIH," and "Affordable Cancer Technologies program" & "LMIC." Other searches used the PI name and "Affordable Cancer Technologies program" and the PI name with the specific project title and/or name of the new technology. A full list of the search terms and articles can be found in table 4.3 on page 15.

4.2.3 Data Limitations

Different Grant Cohorts: The 21 ACTs program grants were awarded in three different competitions (2014, 2016, 2017). As a result, the grants themselves are in different stages of development. Some are still in the initial development phase while others are nearly finished. The differing life spans of the grants limits the ability to compare grant to grant and limits the overall number of artifacts available for analysis.

QVR Analysis: Data presented in this section pertain to the 232 individuals listed in the grant as key personnel, students, or post-docs; of these, 202 were key personnel and 30 were listed as students (undergraduate and graduates) or post-docs. Additionally, individuals' locations were characterized as US, HIC, or LMIC depending on the location of their prime affiliation. An additional 101 individuals listed as key personnel or students on the grants were not found on the QVR. This is because they had neither applied for grants from NIH nor served on committees as of January 2020.

Whenever possible, the most recent affiliation is reflected in this evaluation report for each individual. However, it is possible that some individuals are listed as new investigators in QVR even though they have other major grants because they have not changed their QVR status (individuals are requested to update their own QVR records when their affiliations change and when their New Investigator status becomes obsolete).

Literature Analysis: The primary limitation with the literature analysis is the lack of key fields for many of the journal articles. Twenty-five articles did not have impact factors associated with their journals, and 38 of the articles did not have RCRs. In both instances, the latter is likely because the publications are too recent to earn these scores.

RPPR Analysis: A total of 42 RPPRs from 21 projects were analyzed for this report. RPPRs have the same headings and subheadings across projects but the content in each varies greatly by author and project. Some authors went into greater detail than others as to their research

progress, trainings, conference presentations, and other areas of dissemination of the research findings. It should be noted that while grantees mentioned FDA applications in the RPPRs, there was no access to the FDA IND/IDE database to verify their status.

Transition Report Analysis: While instructive in illustrating the depth and breadth of the scientific research, as well as any limitations that emerged related to the actual research, the content analysis of the transition reports did not fully address any activities undertaken by the PIs and their teams related to contributions to the research space. The content analysis produced few mentions of patents that emerged from the grants, presentations given at conferences pertaining to the devices and techniques funded by the grants, and any articles or publications related to the grants. LS

News Analysis: When using the Google News search engine and searching for "Affordable Cancer Technologies program", only one article was found regarding devices funded by the grant program. Searching by the PI name and the associated technology yielded more results as shown in section 4.3.1.3.

4.3 ACTs Program Artifact Analysis Results

4.3.1 How the ACTs Program Projects Contributed to the Global Research Environment

ACTs grantees have contributed to the global oncology research environment in various ways, including scientific journal publications, presentations at conferences and other scientific meetings, news articles, and the engagement and training of students and young scientists. The following section describes ACTs program grantee efforts in each of the above areas.

4.3.1.1 Contributions to the literature

The searches in SPIRES and Web of Science yielded 61 publications across 16 (out of 21) grants. Of the 16 grants that did produce publications, Meltzer produced 17 publications (28 percent); Weissleder produced 10 publications (16 percent); Court produced eight publications (13 percent); Erickson and Schmeler produced four publications each (6 percent each); Liang produced three publications (5 percent); K Anderson, Chilkoti, Cremer, Hasan, and Kuhn each produced two publications (3 percent each); and Chiu, Ford, Love, Kingham, and Murphy produced one publication each (2 percent each). Searches did not yield publications for the following grants: J Anderson, Vinson, Basu, Herrero, and Porter. Of the five PIs whose projects do not have any current publications, J Anderson is from the first cohort of grantees. Vinson, Basu, and Herrero are from the second cohort of grantees, however it is worth noting that Vinson and Basu both replaced the original PIs on their projects. Porter is from the last cohort of grantees. We are of course aware, through our qualitative interviews (Section 6) and our survey (Section 5), that most grants do have publications in the works as this report is being written.

The articles were published in a range of journals, which covered many different disciplines. Twelve articles were published in journals dedicated solely to oncology (20 percent), and an additional article was published in a joint oncology and endocrinology journal (2 percent). Six publications were published in interdisciplinary journals (10 percent); four were published in journals relating to physics and medicine (6 percent); and three publications each were published

in journals in the areas of biomedical engineering, gastroenterology, miniaturization, and natural science (5 percent each).

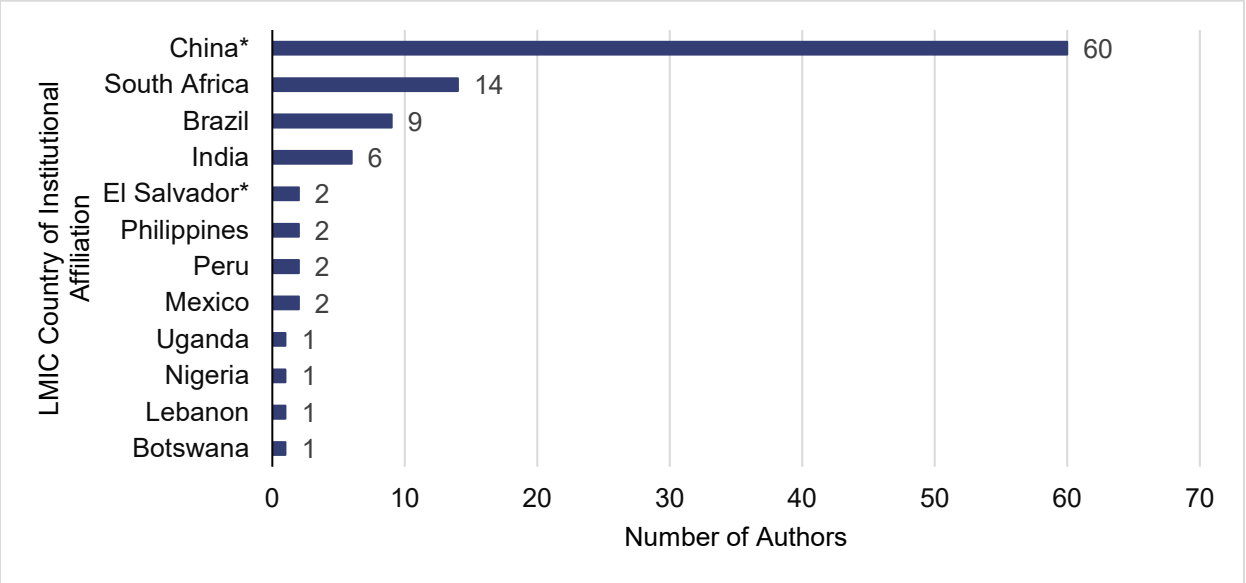
Of the 61 publications, 36 were published in journals that had impact factors. The journals with the highest impact factors were *Gastroenterology* (Meltzer), *Nature Reviews Disease Primers* (Erickson), *ACS Nano* (Weissleder), and *Clinical Cancer Research* (Meltzer). Each of these journals had impact factors greater than 10.

Of the 23 publications that had an RCR, 13 publications had an RCR score greater than 1 (56 percent). These were published by the following grants: Court, Weissleder, Meltzer, Cremer, Court, Chilkoti, Schmeler, Erickson, and K Anderson. A full listing of the articles published by each grant, along with the associated impact factors and RCR scores, can be found in Appendix A.1.

4.3.1.2 Authorship

Of the 61 publications, institutional affiliations were identified for all authors listed. In total, there were 404 authors across the 61 publications. There were 101 authors from institutions in LMIC countries represented on 36 publications (59 percent) as shown in figure 4.1. Publications that had at least one author from an institution in an LMIC came from 13 grants: Chiu, Court, Cremer, Erickson, Ford, Hasan, Kingham, Kuhn, Liang, Love, Meltzer, Schmeler, and Weissleder.

Figure 4.1. Number of Authors from LMIC-Based Institutions Across All Publications, by Country of Institution.



** Includes one author with joint El Salvadorian-US affiliation and eight authors with joint Chinese-US affiliations.*

The country most represented by author institutional affiliation overall was the United States, with 274 authors (68 percent) whose institutional affiliations were only in the United States, and 13 additional authors with affiliations in the United States and another country or countries (3 percent). Of the 13 authors with affiliations with institutions in the United States and elsewhere, eight had affiliations with Chinese institutions (61 percent), and one author each had affiliations with a US-based institution and an institution based in Canada, El Salvador, New Zealand,

Singapore, or France. One author had affiliations at institutions in three countries: Turkey, Singapore, and the United States (Aydin).

First and Last Authors

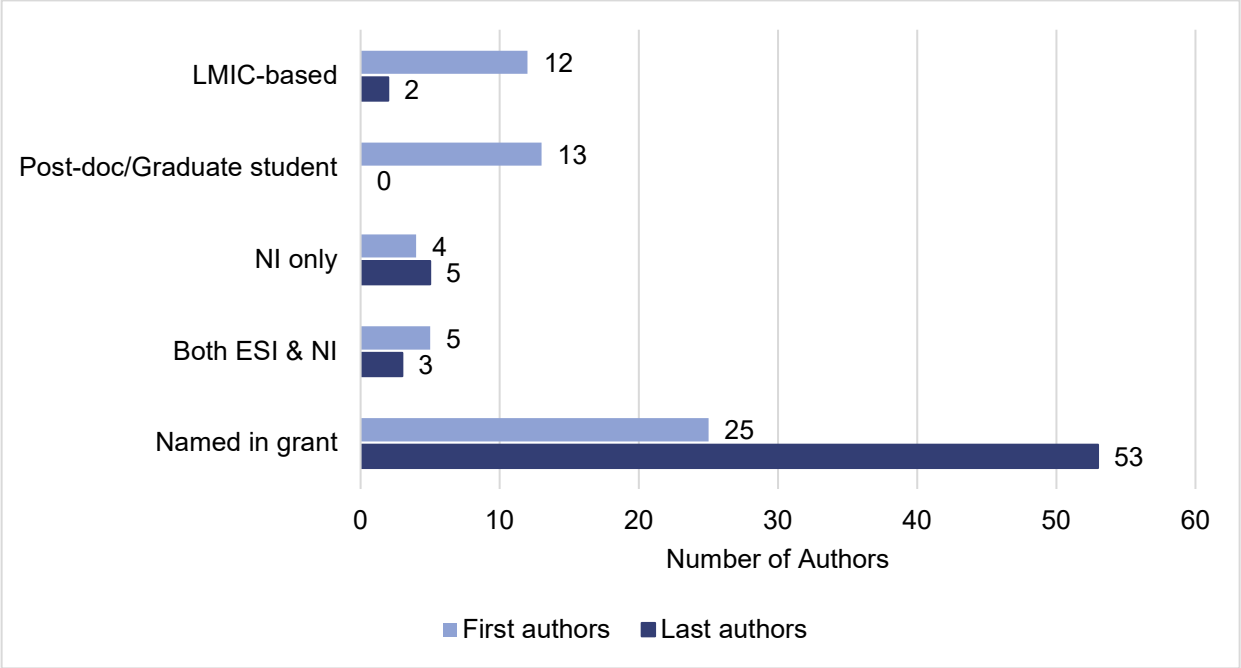
The position of first and last author holds significance within the scientific literature. First authors are typically seen as those who did the bulk of the work contained in the article while last authors are typically the owners of the laboratory or research project where the work occurred. It should be noted that one publication had only one author, Louise Kuhn. Dr. Kuhn was counted as a first author only. Therefore, there were 61 first authors and 60 last authors.

First Authors

Of the first authors across all 61 publications, 47 had affiliations in the United States only, 12 had institutional affiliations in LMICs (seven in China, three in China and the United States, and one each in Peru and Brazil), one had affiliations in South Korea, and one had affiliations in Canada. The 12 publications with first authors based in LMIC institutions were from five grants: Cremer, Hasan, Meltzer, Schmeler, Weissleder. Only five of the first authors were PIs on ACTs program projects. The percentage of first authors with institutional affiliations in LMIC countries is lower compared to the percentage of LMIC-based authors on other global health studies[2,3].

Of the 61 first authors, 25 were named on a grant in any role (key or other personnel) (41 percent) and 36 were not (59 percent). Of those listed, 10 were graduate students, five were co-investigators, five were PIs, three were post-docs, one was a Nurse Coordinator (not key personnel), and one was a Staff Scientist (not key personnel). Five of the 61 first authors were both an ESI and NI, while four were an NI, as shown in figure 4.2.

Figure 4.2. Key Characteristics of First and Last Authors of ACTs Program Affiliated Publications



Last Authors
Of the 60 last authors, two had institutional affiliations in an LMIC (South Africa and China), 57 had affiliations in the United States only (95 percent), and one had affiliations in the United States and Canada. The publications in which the last authors were from an LMIC-based institution came from Kuhn's grant (South Africa) and Meltzer's grant (China). Additionally, three of 60 last authors were both an ESI and an NI, and five were NIs.

Of the ESIs and NIs who were first or last authors, the last author on the Kuhn grant was the only one from an LMIC (South Africa, NI). Of the 60 last authors, seven were not listed as personnel on the grants. Of the 53 authors listed as personnel, 39 were PIs, 13 were co-investigators, and one was a consultant.

4.3.1.3 Additional Contributions to the Global Research Environment

This section focuses on contributions to the global research environment, other than publications, as evidenced in the RPPRs and the transition reports for each grantee. In all, 42 RPPRs and 21 transition reports were analyzed.

Presentations

Fifteen of the 21 ACTs program grantees listed conference presentations in their RPPRs. Some grantees noted that they presented at multiple conferences but did not name the conferences. Table 4.3 highlights some of the named conferences. Five additional presentations were found in the Web of Science entries as published in compendiums of conference presentations and are included in table 4.3.

Table 4.3. Selected Presentations by ACTs Program Personnel by Location of Conference from the RPPRs and Web of Science

US-Based Conferences/HIC-Based Conferences	LMIC-Based Conferences
The American Association of Physicists in Medicine (Court, CA202665);	South African Association of Physicists in Medicine and Biology (Court, CA202665)
Annual Symposium on Global Cancer Research (Erickson, CA202723)	University of Santo Tomas 6th Annual Cancer Conference (Court, CA202665)
The 22nd International Workshop on Kasposi's Sarcoma, Herpes Virus and Related Agents (Erickson, CA202723)	Association of Medical Physicists in India (Ford, CA211310)
International Conference on Advanced Vibrational Spectrocopy (Porter, CA211551)	West African College of Surgeons Conferences (Kuhn, CA189908)
Conference on Critical Issues and Best Practices Forum in Nanotechnology Education (Porter, CA211551)	21st International AIDS Conference (Kuhn, CA189908)
IEEE International Symposium on Circuits and Systems (K. Anderson, CA211415)	International Papillomavirus Conference (Kuhn, CA189908)
38th Annual Conference of the American-Society-for-Laser-Medicine-and-Surgery-Inc (Liang, CA239682)	
39th Annual Conference of the American-Society-for-Laser-Medicine-and-Surgery-Inc (Liang, CA239682)	

US-Based Conferences/HIC-Based Conferences	LMIC-Based Conferences
IEEE Life Sciences Conference (LSC) (K. Anderson, CA211415)	
2nd International Conference on Bio-engineering for Smart Technologies (BioSMART) (Celli, CA189901)	
NIH-IEEE Strategic Conference on Healthcare Innovations and Point-of-Care Technologies (HI-POCT) (K. Anderson, CA211415)	

In addition, two grants (Basu and Cremer) presented their data to the World Health Organization. In both instances, the data were considered and/or adopted for use in the creation of new clinical guidelines for cancer treatment.

Some ACTs program grantees also reported presenting to local health officials as part of their work in the LMICs. Dr. Erickson's project (CA202723) reported having *"discussions with leadership at various clinical care centers to alert them to the device development process and study procedures."* Dr. Love's project (CA189865) reported that the *"PI visited with the Dr Jose Mario Marquez Amezcua, Secretario de Salud in Puebla as well as Dr Jaime Agustin Gonzalez Alvarez, Secretario de Salud in Jalisco, Mexico, and presented the background and study plan which was enthusiastically received."* Dr. Weissleder's project (CA202637) reported visiting with local officials as well, mentioning *"Visits of rural health centers and Ministry, PMH, Gaborone Private Hospital (GPH), National Health Laboratory (NHL), BHP."*

Trainings

Including a training component is a requirement for institutions that receive NIH funding.[4] In particular, Individual Development Plans are required of those grantees that employ graduate students and postdoctoral students as project staff. Of the 21 ACTs program grantees, seven did not discuss any training programs in their RPPRs. Of those that did discuss training, 10 grantees reported having Individual Development Plans for the graduate students and postdoctoral workers in their labs. While many of the Individual Development Plans involved US-based students affiliated with US-based institutions, Dr. Erickson's Year 4 RPPR reported that *"Dr Martin from UCSF has provided close mentorship to Dr Semeere in Uganda in the conduct of the field work for this project."* None of the other RPPRs mentioned specific mentoring of LMIC clinical staff.

Two projects mentioned widescale training in their LMIC site locations. Dr. Cremer's Year 6 RPPR discussed how personnel in the study sites were trained on the technologies and how providers in El Salvador and Ohio were also trained on the technologies created under the ACTs program grant. Dr. Erikson's Year 4 RPPR discussed training personnel in Uganda (the LMIC site chosen for testing the technology). Members of the team met with staff at the Infectious Diseases Institute in Kampala and trained the biopsy technicians who will be using the device.

News Articles

News articles about research products are often the last form of contribution to the global literature due to privacy concerns about the technology still in a testing phase. A Google News

[4] https://grants.nih.gov/grants/guide/notice-files/not-od-14-113.html

search engine search found 16 articles, published from 2016 to 2020, about projects from nine ACTs program grantees. These articles appear in table 4.4.

Table 4.4. Google News Search Engine Results on ACTs Program Grantees

Base Project Number	PI	Keywords Used	Citations
CA189883	Cremer	PI Name, Grant Title, Cryopen, LMIC adapted Cryopen	Miranda J Jaime, Castro-Ávila Ana Cristina, Salicrup Luis Alejandro. "Advancing health through research partnerships in Latin America." *BMJ* 2018; 362 doi: https://doi.org/10.1136/bmj.k2690
CA202723	Erickson	PI Name, Grant Title, KS Detect, TINY	Cornell University. "TINY cancer detection device proves effective in Uganda testing." *ScienceDaily,* 20 September 2018. https://www.sciencedaily.com/releases/2018/09/180920161059.htm Cornell University. "Portable Cancer Detector Proves Effective in Uganda." *Technology Networks,* Sep. 21, 2018. https://www.technologynetworks.com/diagnostics/news/fire-sun-or-electricity-powers-hand-held-cancer-detection-device-309825
CA211310	Ford	PI Name, Grant Title, IMRT	Freeman, Tami. “Compensator expands global access to advanced radiotherapy”. *Physicsworld.* Radiotherapy. Jun. 2018. https://physicsworld.com/a/compensator-expands-global-access-to-advanced-radiotherapy/
CA188901	Hasan	PI Name, Grant Title, Smartphone	Saunders, Sarah. “Researchers evaluate comfort and stability of 3d printed applicators for oral cancer therapy.” *3DPrint.* December 27, 2019. https://3dprint.com/261104/researchers-evaluate-comfort-and-stability-of-3d-printed-applicators-for-oral-cancer-therapy/
			International Photodynamic Association. "Professor Tayyaba Hassan Receives IPA Aware for Significant Advancement of Photodynamic Therapy." *PR Newswire,* June 28, 2017. https://www.prnewswire.com/news-releases/professor-tayyaba-hasan-receives-ipa-award-for-significant-advancement-of-photodynamic-therapy-300481343.html
CA211415	K. Anderson	PI Name, Grant Title, HPV, blood sample, finger stick	Becker, Alexandra. "The rise of HPV related cancers in men". Texas Medical Center. June 6, 2018. https://www.tmc.edu/news/2018/06/the-rise-of-hpv-related-cancers-in-men/ Harth, Richard. "Escape from the lab! 6 promising biotech startup companies profiled at ASU symposium." Arizona State University. Biodesign Institute. October 2, 2018. https://asunow.asu.edu/20181002-escape-lab-6-promising-biotech-start-companies-profiled-asu-symposium

Base Project Number	PI	Keywords Used	Citations
CA189908	Kuhn	PI Name, Grant Title, HPV, Screen and Treat	Kuhn, L. , Saidu, R. , Boa, R., et al. "Clinical evaluation of modification to a human papillomavirus assay to optimize its utility for cervical cancer screening in low resource settings: A diagnostic accuracy study". *Lancet Global Health.* MDLinx. January 29, 2020. https://www.mdlinx.com/journal-summaries/human-papillomavirus-hpv-cervical-cancer/2020/01/29/7602291/
CA211457	Meltzer	PI Name, Grant Title, Biomarker, esophageal cancer	HemOnc. "Novel assay aims to detect esophageal cancer in its earliest stages." Healio. *Gastrointestinal Cancer.* May 6, 2019. https://www.healio.com/hematology-oncology/gastrointestinal-cancer/news/online/%7B9e8b0895-ffef-444d-938e-ceb56f442d04%7D/novel-assay-aims-to-detect-esophageal-cancer-in-its-earliest-stages Johns Hopkins Medicine. "Test for esophageal cancer could save millions of lives." *Science Daily.* Science News. January, 22, 2019. https://www.sciencedaily.com/releases/2019/01/190122114915.htm
CA211551	Porter	PI Name, Grant Title, Mongolia, Serum. HCC	eNews publication from the University of Utah summarizing the point-of-need detection of HCC: https://unews.utah.edu/putting-it-to-the-test/ Online article in *The Salt Lake Tribune* summarizing the point-of-need detection of HCC: https://www.sltrib.com/news/2017/08/31/u-researchers-develop-new-liver-cancer-test-just-take-a-tear-drop-results-in-two-minutes/
CA189910	Schmeler	PI Name, Grant Title, Brazil, Cervical Cancer, HRME	Hixenbaugh, Mike. "Houston doctors determined to reduce cervical cancer deaths in Rio Grande Valley." *Houston Chronicle.* Dec 1, 2016. https://www.houstonchronicle.com/news/houston-texas/houston/article/Houston-doctors-take-mobile-clinic-to-Rio-Grande-10636122.php Swartz, Mimi. "Out of Africa." *Texas Monthly.* November 23, 2016. https://www.texasmonthly.com/articles/interview-with-macarthur-genius-grant-winner-rebecca-richards-kortum/

While many of these articles were published in online scientific news services, a few projects had mentions in more mainstream publications such as the *Houston Chronicle* and the *Salt Lake Tribune*.

4.3.1.4 Description of Key Personnel Working on ACTs Program Grants

The ACTs program projects employ personnel affiliated with institutions all over the world, many of whom are new to NIH research projects and this type of research generally. The following section describes the personnel working on ACTs projects, their affiliations, and their roles.

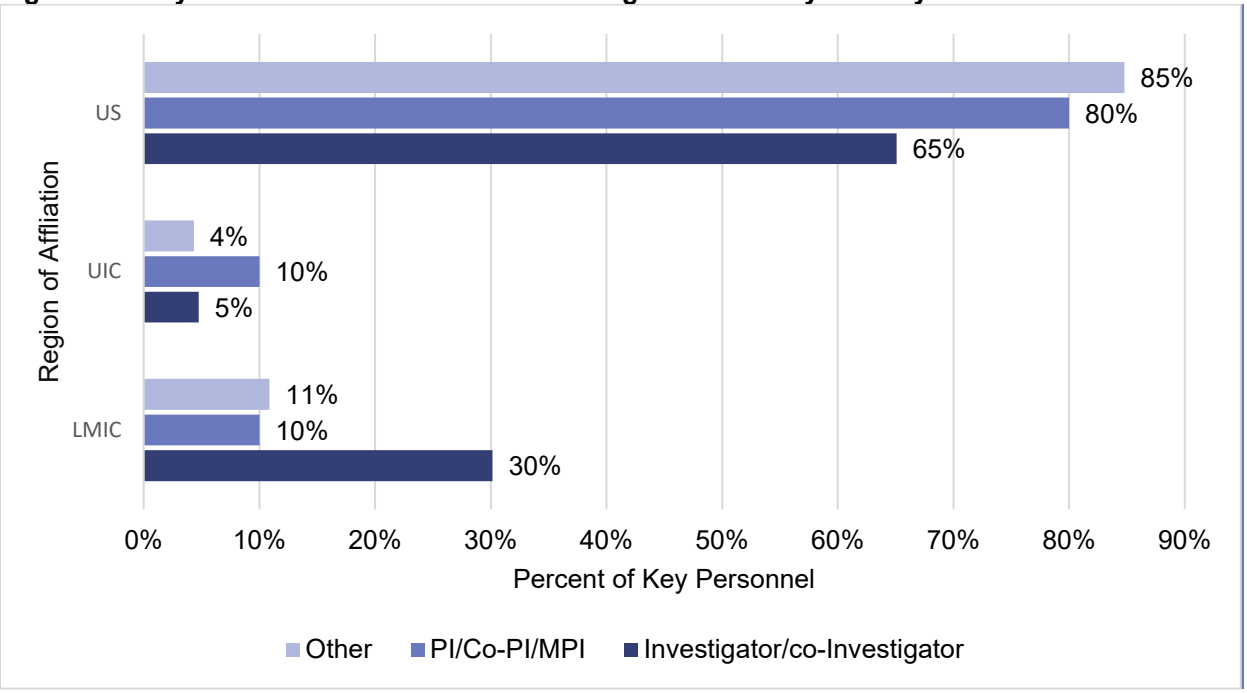
Role in Project

There were 202 key personnel reported by the 21 ACTs program grant projects listed in the QVR. Of the key personnel listed, 61 percent (123 individuals) were listed as investigators on the projects. This category includes co-investigators, site investigators, and principal investigators. Another 20 percent (40 individuals) were listed as PI, co-PI or MPI and 15 percent (31 individuals) were listed as "other." Some of the roles described under the other category included business development expert, global healthcare delivery expert, and Chief Technology Officer, each with one individual in that role.

Location of Affiliation

When examined by the location of an individual's affiliation, the majority of the key personnel were based in the US. Overall, 77 percent of all key personnel were US-based, 17 percent were based in LMICs, and 6 percent were based in HICs including Canada and France. The majority of PIs were US-based (80 percent, 32 individuals), with 10 percent of the PIs being LMIC-based and HIC-based (four individuals for each). Among co-investigators, the proportions shifted slightly, with 29 percent of the co-investigators being from LMICs (35 individuals) and 5 percent being from HICs (six individuals). The "other" key personnel also had more individuals who were US-based (86 percent, 26 individuals) than based in LMICs (11 percent, four individuals) or HICs (4 percent, two individuals). When examined by cohort year, there were no patterns between grants given in the 2014, 2016, or 2017 competitions and the affiliation locations of the PIs, Investigators, and other key personnel.

Figure 4.3. Key Personnel Roles on the ACTs Program Grants by Country



Early Investigator and/or New Investigator Status

Encouraging participation in projects from early stage and/or new investigators broadens the participation of scientists in the ACTs program research area. Early-stage investigators are those investigators within 10 years of their terminal degree (typically an MD or PhD), while new

investigators have not yet had a major grant from NIH. Overall, of the 125 key personnel listed in the QVR, 14 key personnel were listed as early stage investigators (11 percent) and 51 key personnel were listed as new investigators (41 percent). This includes three co-PIs who were listed as early stage investigators, and 10 co-PIs who were listed as new investigators.

4.3.1.5 Number of key personnel from LMICs – in country expertise

An important measure of the contribution to the global research environment is the number of scientists and clinicians working on the ground in the LMIC with the project. In an examination of the ACTs program grant key personnel, 16 grants listed as key personnel individuals with LMIC affiliations translating to 40 key personnel affiliated with LMIC-based institutions. A full listing of the grants, the individuals' roles on the project as stated in QVR, and the institutions can be found in table 4.5.

Table 4.5. ACTs Program Projects, Key Personnel from LMICs, and Institutional Affiliation

Base Project Number	Role on the Project	LMIC Institution Affiliation	Affiliated Institution's Country
CA189883	Co-Investigator	Instituto Nacional De Cancerologia	Mexico
CA189901	Co-Investigator	Aligarh Muslim University	India
	Other (Specify via text entry) Investigator		
	Other (Specify)-Subcontract PI		
CA189908	Co-Investigator	University of Cape Town	South Africa
	Other (Specify via text entry) PI -SubContract		
CA189910	Co-Investigator	Barretos Cancer Hospital	Brazil
	Other (Specify)-collaborator		
CA189965	Co-Investigator	Jos University Teaching Hospital	Nigeria
	Other (Specify)-Subcontract PI		
CA202637	Co-Investigator	Botswana Harvard AIDS Institute	Botswana
	Other (Specify via text entry) Sub PI		
	Other (Specify)-Co-Investigator on subcontract		
	Other (Specify)-Other Significant Contributor		
CA202663	Co-Investigator	Barretos Cancer Hospital	Brazil
		Chinese Academy of Medical Sci and Peking Union Med College	China
		Kenya Medical Research Institute	Kenya
		University of Nairobi	
CA202665	Co-Investigator	Stellenbosch University	South Africa
		University of Santo Tomas	Philippines
CA202721	Co-Investigator	African Centre of Excellence for Women's Cancer Control	Zambia

Base Project Number	Role on the Project	LMIC Institution Affiliation	Affiliated Institution's Country
CA202723	Co-Investigator	Makerere University/Infectious Diseases Institute	Uganda
CA202730	Co-Investigator	Autonomous National University	Mexico
		Costa Rican Department of Social Security	Costa Rica
		Honorary Commission of Fighting Against Cancer	Uruguay
		Hospital of Clinicas Jose de San Martin	Argentina
		Mayor, Real and Pontificial University of S. F. Xavier Chuquisaca	Bolivia
		National University of Paraguay	Paraguay
		Peruvian League Against Cancer	Peru
		University of Antioquia	
CA211232	Other Professional-Subcontractor PI	Zhejian Provincial People's Hospital	China
CA211310	Co-Investigator	Panacea Medical Technologies Pvt Ltd	India
	Consultant	PSG Hospital	
CA211415	Co-Investigator	All India Institute of Medical Sciences	India
EB024965	MPI	Obafemi Awolowo University	Nigeria
	Other (Specify)-Advisory Committee		
	PD/PI		
CA239682	Co-Investigator	K.L.E Society's Institute of Dental Sciences	India
		Mazumdar-Shaw Cancer Center	

Of the 40 key personnel from LMIC-based institutions, only nine could be found in the QVR as having applied for NIH funding or served on a committee (22 percent). Of these nine, two were listed as early stage investigators, having been within 10 years of their terminal degree (PhD or MD) at the time of the award (Maxwell Ankabi, Vikesh Sewram). Both have applied for NIH funding but have not received an award as of January 2020. Additionally, seven of the nine found in the QVR were listed as new investigators, meaning that they had not yet had major funding (e.g., R01) from NIH (77 percent). Of the two who were not new investigators, Dr. Alatise is a co-PI on an ACTs program grant, and Robert Lukande was listed as N/A in the QVR.

4.3.1.6 Students and Post-doctoral Workers on ACTs Program Grants

There were 30 student and postdoctoral workers listed by role in the personnel data in 12 ACTs program grants (10 percent). Of these, 14 were listed as graduate students (47 percent), 14 were listed as postdoctoral students/staff scientists (47 percent), and two were undergraduates (6 percent). All the students and post-docs listed had US affiliations. Of the 14 postdoctoral students, four were listed as both ESI and NI and had applied for grants but had no awards yet.

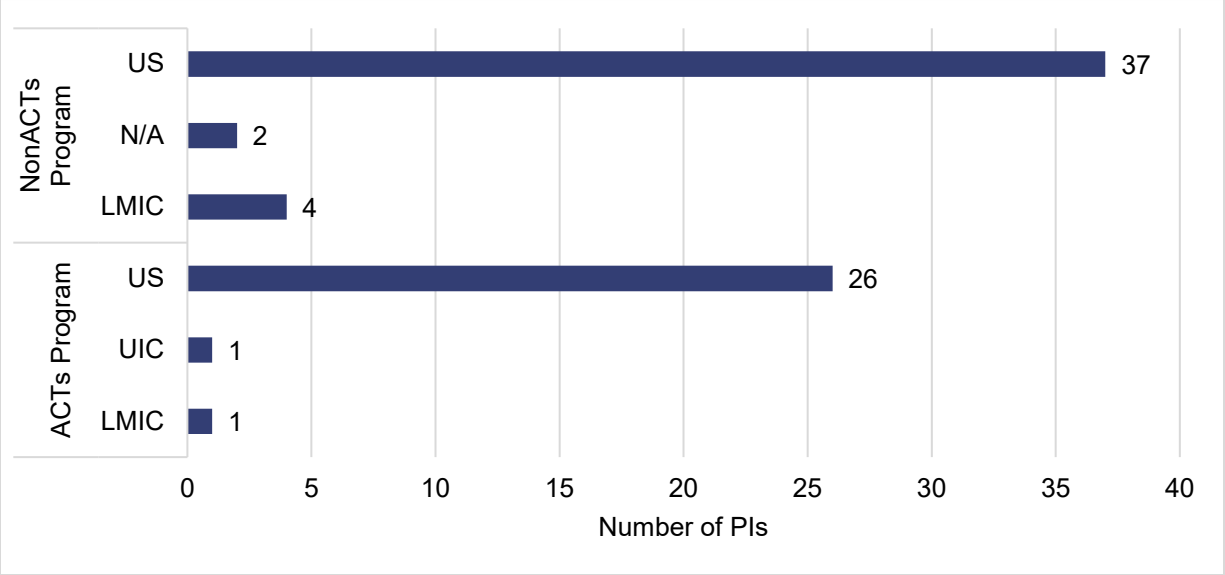
4.3.1.7 Collaborations Among ACTs Program PIs after the initiation of the ACTs program grant

While the bulk of the collaboration analysis is presented in sections 5 and 6, the analysis of the RPPRs, transition reports, and additional grant awards of the ACTs program PIs yielded additional evidence of collaboration among the ACTs program PIs, and among ACTs program PIs and other institutions and staff who were not on the original ACTs program grants.

One primary area to highlight is the additional grants that the ACTs program PIs were awarded following the ACTs program award. There were 79 new grants awarded or pending award to ACTs program PIs since the start of the ACTs program projects, and these new efforts incorporated 43 PIs who were not on the original ACTs program grants. A full listing of the new grants by ACTs program PIs can be found in Appendix A.3. From the titles of the new grants, eight were occurring in LMICs (10 percent). Not all projects had PIs that were awarded additional funding. Of the 21 ACTs program grants, six grant teams did obtain any additional awards since the start of the ACTs program funding (Love, Vinson et.al., Basu, Herrero, Ford, and Porter and Scaife.)

In these new collaborations, many ACTs program PIs reached out to other individuals at their schools or at additional universities, thereby further broadening the reach of the ACTs program grants, as shown in figure 4.4.

Figure 4.4. Number of PIs on Subsequent Awards by ACTs Program Status and Area of Affiliation



Many of the original ACTs program PIs branched out in their new awards to partner with PIs from different institutions thereby expanding the reach of the initial teams. Of the PIs on the new grants, five of the PIs were from LMICs, and 10 of the grants listed specifically call out LMICs in the titles, primarily in Africa. Additionally, five of the PIs were ESIs, and 14 were new investigators, as shown in table 4.6. A full listing of the affiliations of the PIs on subsequent awards can be found in Appendix A.5.

Table 4.6. PIs on Subsequent Grants with ACTs Program PIs by Characteristic

	Number of ACTs Program PIs	Number of NonACTs Program PIs	Total PIs on New Grants
Early Stage Investigator			
N/A		1	1
No	27	38	65
Yes	1	4	5
New Investigator			
N/A		2	2
No	24	31	55
Yes	4	10	14

During the analysis, the evaluation team found four key staff members who worked on multiple ACTs program grants:

- Jose A. Jeronimo (CA202730, CA189883)
- Philip Castle (CA189883, CA189910, EB024965)
- Jose Fregnani (CA189910, CA202663)
- Rebecca Richards-Kortum (CA189910, EB024965)

Drs. Jeronimo and Castle are key co-investigators and are considered experts in their respective fields of gynecological cancers; they are based in the United States. Dr. Fregnani is also an expert in gynecological health and was the key co-investigator on both grants. He is based at the Barretos Cancer Hospital in Brazil, where the two grants have performance sites. Dr. Richards-Kortum is the PI on the ACTs program grant number CA189910 along with Kathleen Schmeler. She is based at Rice University and served on the advisory committee for Drs. Kingham, Olusegun, and Wishart's grant (EB024965). She was not listed as key personnel. The evaluation team found evidence for additional collaborations between key personnel in the survey data (section 5).

From the RPPRs and transition report analysis, three projects reported collaborations with other ACTs program grants that did not involve new awards. Drs. Ford, Kuhn, and Hasan/Celli all discussed collaborations between their projects and other ACTs program projects. Dr. Ford reported partnering with Dr. Court and his project team, which will provide a remote radiation treatment planning system as a corollary to their work in designing a radiation treatment delivery system. Additionally, Dr. Kuhn reported that her project is pursuing using Dr. Cremer's Cryopen project in their work in South Africa. Drs. Hasan and Celli discussed upcoming collaborations between Dr. Liang and their project due to their interactions at the ACTs Program Meeting. It is these types of collaborations that the ACTs Program Meetings are intended to support.

> *"Through interactions, we have recently begun to work collaboratively with another UH2 PI, Prof. Ron Liang, who is developing low cost imaging technology for oral cancer screening. Although his imaging device has been developed for a different application it is likely adaptable for imaging PpIX fluorescence required for our project. Prof Liang has provided a device to our group and we are currently evaluating both approaches in parallel though testing and calibration*

with tissue phantom models following the same protocol that was used for preclinical development of the first generation smartphone imaging device which is currently in use."

4.3.2 Quantify the Commercial Progress of the Translational Technology Research from ACTs Program Grantees (Objective 2)

Objective 2 of the ACTs program relates to the extent that the program is able to stimulate progress toward the commercialization of products or interventions for use in LMICs. Before a product or intervention can become part of clinical practice in an LMIC, several steps must be taken to

- Secure the design of the project through patents and other means;
- Share data from the project; and
- Establish partnerships with other entities to produce and market the technologies.

4.3.2.1 Commercial Progress: Patents and other advances toward commercial success

A crucial stage in bringing products to the market is securing intellectual property rights through patents, trademarks, and registration with regulatory authorities such as the Food and Drug Administration in the US or the European Medicines Agency for countries in the European Union. This section presents results from an analysis of the transition reports as grants moved from the initial UH2/UG3 phase and the RPPRs submitted to NIH on a routine basis. While the information about this process differed by grant and reporting mechanism, many grants reported efforts in this area.

In the transition reports, three grants reported applying for patents (J. Anderson, Basu, Erickson). Erickson also reported his patent applications in the RPPR. No other project reported patents or patent applications in the RPPRs.

Eleven projects reported FDA applications in the RPPRs (see Appendix A.6 for more detail). Additionally, Basu reported that both FDA approval and European CE mark registration have been awarded to his project, The Liger Thermo-Coagulator. Also, Cremer's Cryopen has received FDA approval for certain treatment uses. No other project mentioned FDA approval in the RPPRs or the transition reports.

For this evaluation we had no access to the FDA IND/IDE application database and thus we relied on investigator self-reported data.

4.3.2.2 Commercial Progress: Data Sharing /New Analytic Techniques

Nine projects mentioned in their RPPRs the development of new analytic techniques, including software development and potential new protocols. While the results of the research have been shared through articles and presentations, two grants, Basu and Cremer, presented their data from the project to the World Health Organization. Basu reported that their data were incorporated into the World Health Organization's new practice guidelines on thermal ablation. Additionally, Cremer and Maza presented their work to the World Health Organization Committee on the Treatment of Cervical Intraepithelial Neoplasia (precancerous lesion on the cervix), where the data were used for consideration by the committee. Additional evidence of data sharing and new analytic techniques is provided in the discussion of Subtask 3b results.

4.3.2.3 Commercial Progress: Partnerships

The Subtask 3a analysis examined both the RPPRs and the transition reports for evidence of partnerships. Additional discussion of partnerships is presented under Subtasks 3b and 3c.

Industrial and Commercial Partnerships

As part of the ACTs program, grantees were required to partner with an industrial entity to assist in the commercialization of newly developed technologies. The industrial and commercial partnerships mentioned in the reports were typically contained in the business plan section of the transition reports. In all, 15 grantees mentioned partnering or planning to partner with commercial entities (71 percent). Many of the grantees reported either creating their own company or partnering with another commercial entity for manufacturing and/or additional testing. For example, Basu partnered with Liger Medical (http://medphysinc.com/index.html) to develop his device; Liang partnered with Carestream Health (www.carestream.com) to produce and distribute his technology throughout LMICs; and; Herrero partnered with Arbor Vita, which developed the previous iteration of his technology (www.arborvita.com). Other PIs, including Ford and Hasan, partnered with companies based in LMICs. However, Erickson's project was the only project that reported obtaining an SBIR grant in partnership with AAS, Inc. to develop an LED-based indoor version of the KS-Detect technology.

LMIC Governmental and Non-Governmental Organizations Partners

While much of the information about individual projects' partnerships with LMICs' ministries of health other governmental organizations, and non-governmental organizations (NGOs) is discussed in Sections 5 and 6, some of the transition reports did discuss partnerships with LMIC governmental organizations. Liang discussed partnering with the Government of Uganda, the Ugandan Ministry of Health, and the Common Market for Eastern and Southern Africa for participation and sponsorship of his project. Porter discussed partnering with both the Mongolian Ministry of Health and the Flagstaff International Relief Effort, which has an outpost in Mongolia where the research was under way. Additionally, Chiu reported working with both the MAX Foundation and the CML Foundation, which are non-profit organizations with extensive experience working with LMICs (Nigeria, Malawi, Uganda).

4.4 Conclusion

The analysis presented in this report on Subtask 3a highlighted the contributions made by ACTs program grantees in three key areas: the scientific literature, the global research environment, and the commercialization of new technologies. The ACTs program projects are in various stages, with some reporting only on the first two years of funding and some reporting on the entire X-year grant. While one grant was abandoned at the UH2 grant phase, the remaining 20 grants have forged forward and are in varying stages of development. Results from an online survey of the 20 active projects are presented in section 5, and case studies of four projects are presented in section 6.

5. EVALUATION FOR THE AFFORDABLE CANCER TECHNOLOGIES (ACTS) FOR GLOBAL HEALTH PROGRAM FINAL SURVEY REPORT (TASK 3B)

5.1 Executive Summary

5.1.1 Introduction

Team Synergy (Synergy Enterprises, Inc. and Westat) conducted a web survey of ACTs Principal Investigators (PIs) and other key personnel from November 4, 2019 to December 13, 2019 under Subtask 3b: PI Survey to Assess Collaboration and Challenges of Working in LMICs. The following section details survey results collected from the 20 active ACTs program projects in a brief summary of key findings organized by ACTs program themes and stated objectives, followed by survey methodology and results.

The results themselves have been organized into thematic sections as determined by the survey questions and objectives. These themes include perspectives on the ACTs program itself, collaboration (ACTs program objectives 1 and 3), commercialization (ACTs program objective 1 and 2), how the ACTs program influenced prospects for future work, and the extent to which technologies produced in the ACTs program could be used within the US healthcare setting.

5.1.2 Key Findings

The first objective of the ACTs program concerns the extent to which ACTs program grantees contributed to the science of cancer screening, diagnosis and treatment. Contributions to science can take the form of collaborations between scientists and commercialization of technology as well as more traditional journal articles and academic presentations. As such, the first objective relates to both the themes of collaboration and commercialization. In brief:

- Nine respondents (27 percent) stated that as a result of the ACTs program grant, they had begun a new collaboration with researchers who were not funded by the original ACTs program grant. Of these, three reported applying for additional funding.
- Five respondents (15 percent) reported that, based on their work on the ACTs program grant, they had developed entirely new partnerships with researchers who were not funded by the original grant. Of these, two reported applying for additional funding.
- Of those who began to market technology, two respondents reported licensing technology to other companies: one domestic company, and one company in an LMIC. The others said that they planned to market to LMICs, without specifying a country. Four respondents also reported sales of technology.
- Respondents reported an average of 11.4 conference presentations per ACTs program grant. The highest number of presentations reported was 30; 3 respondents reported no presentations. Respondents also reported an average of 4.1 journal publications per grant. One respondent reported 15 journal publications while nine respondents reported no journal publications.

The second objective of the ACTs program centers on the extent to which ACTs program grants have stimulated processes that have led to successful products for use within LMICs. While successful use of ACT's products in LMICs is not solely nor directly analogous to commercial

success, this objective falls into the thematic category of product commercialization. Results in this category indicated that:

- The majority of respondents reported having some to extensive interest in the ACTs program-funded technologies from commercial entities (55 percent). Four respondents (12 percent) also reported sales of program-developed technology.
- A majority of respondents reported having "some" to "extensive" interest in the ACTs program-funded technologies, including respondents from the healthcare community in the test location (88 percent); respondents from the healthcare community in other locations (83 percent); and researchers based in the test country who were not on the test team (77 percent).
- Fifty-one percent of respondents stated that technology could be operated by those with minimal healthcare training such as training provided by the clinic or researchers, while 18 percent reported that the technology could be operated by those who had received a high school education or less.

The third objective of the ACTs program is to establish long-lasting international and multidisciplinary collaborations around new and/or evolving cancer diagnosis, screening, or treatment technologies. This objective relates directly to the theme of collaboration. Generally, respondents were very positive about the current collaborations as well as collaborations established since the start of their ACTs program grant:

- All respondents reported that their work on the ACTs program grant encouraged them to continue to work internationally.
- Over 90 percent of respondents reported "some" to "close" collaboration among personnel. This included collaboration among U.S.-based personnel (94 percent), among LMIC-based personnel (97 percent); and between U.S.-based and LMIC-based personnel (94 percent).
- Fifteen respondents (45 percent) stated that while working on their ACTs program grant, they had developed scientific collaborations with other ACTs program grantees. Of these, eight respondents (24 percent) reported working with some or all of the original ACTs grant personnel on an offshoot project of the same technological innovation. Three respondents reported multiple types of collaborations (9 percent).
- Nine respondents (27 percent) reported collaborating with researchers who were not funded by the original ACTs program grant to work on new projects based on an aspect of the technological innovation that was developed for the original ACTs grant, and four respondents (12 percent) reported partnerships with researchers who were not funded by the original grant to develop an entirely new project. One respondent reported both types of collaboration.

5.2 METHODS

The ACTs program evaluation survey was conducted by Team Synergy in 2019 (November 4 to December 13) via web survey with ACTs program staff in both the United States and LMICs. The survey was fielded using Qualtrics™ online survey software (www.qualtrics.com).

The ACTs program participant survey included questions about

- respondent personal background;
- the extent of collaboration between ACTs Program PIs and staff and collaborations between ACTs program participants on other grants;
- the extent of commercialization of program-funded technology in lower- and middle-income countries (LMICs) and the potential for use in the US;
- PI and key personnel contributions to science via publications and patents, and;
- how participation in the ACTs program has influenced their desire to work internationally.

In all, 33 responses from 20 active grants were analyzed.

5.2.1 Who Responded to the Survey?

Sample

Survey participants were sampled from active ACTs program grant PIs and staff. Team Synergy implemented a snowball sampling procedure based on a list of 31 PIs of active ACTs program grants. When invited to participate in the survey by Team Synergy, PIs were also asked to distribute the survey to ACTs program grant key personnel, post-doctoral students, and early-stage U.S.- and LMIC-based investigators.

Responses

There were thirty-seven total responses from ACTs program PIs and staff. Of these 37 individuals, 32 completed the entire survey and five competed only part of the survey. Results described in this report include the 32 complete responses, as well as one response from a participant that completed 88 percent of the survey and is considered complete based on response to seven of the eight survey sections.

Seventy percent of the 33 respondents were PIs or co-PIs, 18 percent stated that they were co-investigators, 9 percent stated that they were researchers, 6 percent stated that they were business or technical partners, and 9 percent stated that they were research managers.[5] The success of the snowball sampling strategy was limited, with only three non-investigators included in the responding sample.

Fifty-six percent of respondents listed a scientific or research specialty of either oncology or another clinical specialty. Responses were distributed across RFA cohorts, with 36 percent from the 2014 cohort, 30 percent from the 2016 cohort, and 33 percent from the 2017 cohort. Analyses conducted to assess potential differences in response patterns between cohorts revealed few differences; those that were detected are discussed in each instance below.

Survey participants were asked, **"For your current ACTs program project, in what country is the main focus of your research?**" The format of this question allowed selection of only one country; respondents conducting research in multiple countries had to choose their primary country of focus. Organized by continent, 36 percent (12 respondents) stated that they were focused in Asian countries; 30 percent (10 respondents) of the respondents stated that they were

[5] Respondents may select more than one project role therefore categories total to more than 100 percent.

focused in African countries, 30 percent (10 respondents) stated that they were focused in Central and South American countries, and 3 percent (1 respondent) were focused in the U.S.

Additional respondent and grant characteristics are listed in Appendix B.2, tables 1 and 2.

5.2.2 The Survey Questions and Process

The "ACTs Evaluation Survey" in the *2017 Feasibility Study* was used as the basis for the 2019 survey. Additional questions on whether the technology could be applied to the U.S. as well as LMICs, specific questions on the challenges and highlights of working in an LMIC, questions about collaborations with other NCI-funded investigators and questions regarding commercialization of the products developed by the projects were added to the survey. The resultant 2019 survey included 52 survey items, most of which were closed-ended questions. The open-ended questions throughout the survey were designed to provide an opportunity for respondents to expand on specific key areas. A respondent's consent was assumed by their completion of the survey, and no OMB clearance was necessary. Responses are presented as aggregates in this report, and identifying characteristics were removed from verbatim responses.

A draft of the survey was made available to the ACTs program staff in October prior to the survey's creation in Qualtrics™. The survey was tested in Qualtrics™ from October 20 to October 30 by the Synergy team and program staff; and was released on November 4 to PIs with active grants, with an initial survey closing date of November 22. PIs were instructed to distribute the survey to key personnel based in both the U.S. and in LMIC site locations in the survey invitation and in all subsequent reminders.

The complete survey can be found in Appendix B.1. A list of all open-ended responses can be found in Appendix B.3.

The survey period was extended to December 13 to provide time for a sufficient number of complete responses from PIs and other grant staff. The timeline of invitations was as follows:

- November 4: Initial invitation
- November 15: Reminder sent
- November 22: Reminder sent
- December 3: Final reminder sent
- December 5: Reminder sent only to those who had not responded at all.
- December 13: Survey closed to any further participation

Responses from all 33 survey participants are reported except where noted.

5.2.3 Data Limitations

Participant sampling for the survey was based on a list of 31 PIs of active ACTs program grants. Survey invitations included instructions to distribute the survey to other ACTs program grant personnel including LMIC personnel, post-doctoral students, and early-stage investigators, with the intention of ensuring the inclusion of lower-level personnel. The final sample includes at least one response from personnel from each active ACTs program grant, however, these were primarily key personnel (PIs, co-PIs, co-investigators) with the exception of three research/clinical managers. In this way, the response rate could be considered low, as lower-level

personnel (e.g., U.S. or LMIC-based postdocs, trainees, or clinical workers) did not respond to survey invitations or were not forwarded the invitation from their PIs. Language limitations may also have been a factor, as the survey was only presented in English. Future surveys may need to incorporate sampling strategies to directly target lower-level personnel, and if possible, the survey should be translated into other languages to increase the number of respondents of all levels.

5.3 ACTs Program Evaluation Survey Results

ACTs program evaluation survey results are presented in thematic categories, beginning with respondent perspectives on the ACTs program and specific projects. The second section includes perspectives of respondents on their ACTs program collaborations and subsequent collaborations with other researchers. Responses in this section reflect both objectives 1 and 3 of the ACTs program: to contribute to the global research environment; and to create long-lasting international multidisciplinary partnerships. Results in the third section reveal respondent perspectives regarding the potential for commercialization of the ACTs program projects and the contributions to oncology-focused and other scientific literature, reflecting both objectives 1 and 2 of the ACTs program. The fourth section presents respondent beliefs concerning the impact of participating in an ACTs program project on research and career opportunities, and the final section of the report describes the perspectives of the respondents regarding the potential for use of the ACTs program-funded technology in the U.S. healthcare system.

5.3.1 Perspectives on the ACTs Program and Projects

Throughout the survey, respondents replied to a number of open-ended questions on grantee experiences in the ACTs program. While specific open-ended questions related to collaborations and commercial efforts are included in the relative report sections, a series of open-ended questions presented at the end of the survey are discussed in this section. Many respondents provided answers that fit into multiple categories, and totals of numbers and percentages presented may exceed the total number of survey responses. A complete list of open-ended question responses by question is included in Appendix B.3.

Twenty-one of the 29 replies (72 percent) to the open-ended question, "**What is working well with your ACTs program project?**" indicated collaboration with the LMIC partners was working well.

- One respondent replied "*1. Strong support from NIH. 2. Excellent collaboration with local researchers. 3. Strong support from the local communities."*
- Eight responses (28 percent) reported individual research projects proceeding according to plan
- Five grantees (17 percent) responded that support received from the ACTs Program/NIH was what was working well with their grants.
- One respondent did reply that they were *"not sure, not really connected over the last year."*
- A typical response is exemplified by the following: *"Clinical testing of technology has been very successful with excellent outcomes. The collaboration has also been extremely rewarding and we are confident that we have started something that will continue to grow."*

When asked, **"What is not working well with this project?"**:

- Nine respondents of the 28 who replied (32 percent) indicated that they were having logistical issues with the project including *"delays in local approvals in Phase I and logistical constraints in terms of financial transfers…"*
- Seven respondents (25 percent) indicated difficulties with LMICs including issues around recruitment and cultural issues.
- One respondent indicated that *"getting to understand better the culture, communication, and constraints of LMICs"* was one component that was not working well.
- One reported *"Lack of cancer awareness was a significant challenge to patient recruitment. Even patients who were identified with very suspicious lesions in preliminary screening camps were reluctant to come in for biopsy",* highlighting cancer-specific cultural differences between the U.S. and this LMIC.
- One respondent reported "*In LMIC countries, barriers are not only the lack of technology, but often the lack of political will and infrastructure readiness to scale up. In LMIC settings, there is also competition by other urgent needs to be addressed. Lastly, there are cultural barriers that at time may affect the effectiveness of creating an effective business relationship."*

Five respondents (18 percent) referenced commercialization and/or product development issues including *"sustainability over the long term"* and difficulties commercializing technology.

- One respondent stated, *"the technology development can be difficult to perform on such a tight timeline as required by the UG3."*
- Five respondents (18 percent) indicated that there was nothing that wasn't working, and that the project was proceeding according to plan.

One aspect of the program that was explored extensively was the nature of working in LMICs. While some of the respondents had experience with working in LMICs on research projects, others did not. Of the 22 individuals who replied to the question "**What did you wish you had known before starting this research project that you know now?**":

- Participants most frequently reported that they wished they had known more about the challenges of working in LMICs (8 respondents, 36 percent), particularly related to cultural differences.
- One respondent indicated that *"Processes and mechanisms are not well established in LMICs, and exactly what they are can be unpredictable."*
- Other responses indicated logistical issues that could have been better addressed with greater advance knowledge of what could be expected when working with an LMIC (7 respondents, 32 percent).
- One respondent noted that they wished they had *"a more realistic understanding of timelines needed and considering these in terms of strategies to keep things moving forward. a lot of prompting and support needed for local team".*

Respondents were also asked, "**What surprising issues have you encountered with the project?":**

- Thirteen of the 26 responses (50 percent) were research-related, involving challenges to the project such as *"Enrollment is much harder than I would have thought. There are many regulatory and site-specific issues that were not originally anticipated"*.
- Eight respondents (31 percent) reported commercial issues, such as the lack of interest from multi-national corporations in LMIC health care, and one noted *"insight into translating an idea into a product is an iterative process and, in hindsight, could have been a journey made easier with a manufacturer or a commercial partner working at the very start"*.

Finally, respondents were asked **what they thought ACTs program staff should know about the program or their particular project**.

- Generally, responses indicated a desire to share that their experiences were positive, with few calls for changes to the program.
- One respondent suggested provisions for the addition of study sites as project progresses, while another respondent reported a need for a "*clear way for additional funding."*
- Two respondents emphasized the need for additional time to complete the project.
- One wrote "*gap between the first 2 years and the last 3 years was problematic and set the project back,"* and another noted "*We think the UG3 phase should have been planned for longer duration to work out all the challenges encountered."*

Thirteen of the 21 who answered the question (62 percent) thanked ACTs program staff for their help with the project, as exemplified in the quote below:

> *"Despite the challenges we encountered, the support from the ACTs management has simply been outstanding and the ability to network (and sometimes commiserate) with other ACTs recipients enabled us to learn from each other and in some cases collaborate to solve certain problems. Finally, the experience of developing and growing collaborations with international staff in focus countries feels very rewarding."*

5.3.2 ACTs Program Collaboration Patterns and Challenges

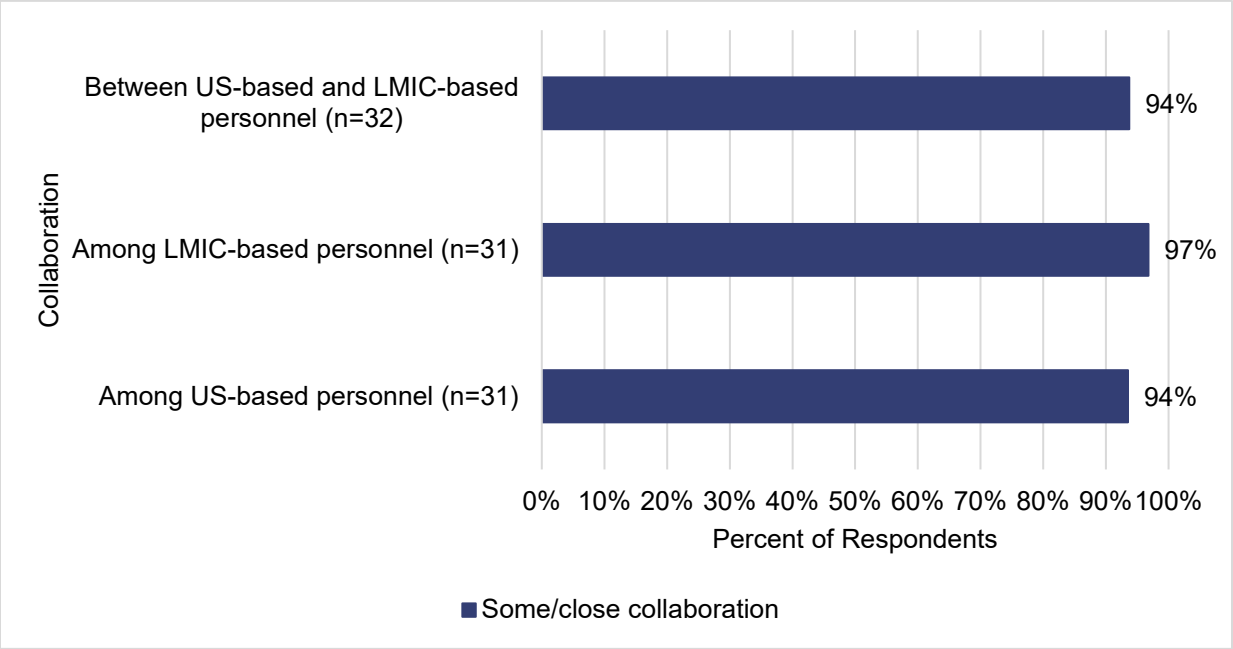
This section highlights the strengths and limitations of ACTs program project staff's internal and external collaborations, as well as ways these collaborations may have contributed to the global research environment (objectives 1 & 3). Collaborations include those between ACTs program participants within the ACTs program projects, between the ACTs program projects and between the ACTs program project staff and new collaborators.

5.3.2.1 Collaborations within Current ACT Project

To determine the nature of the collaborations within the active ACTs project, respondents were asked "**To the best of your knowledge, how would you characterize the level of collaboration among the following groups of personnel on your ACTs program grant, thus far?**" Groups included U.S.-based personnel, LMIC-based personnel, and collaboration between the U.S.-based and LMIC-based teams.

Over 93 percent of respondents responded that there was some/close collaboration within both U.S.-based and LMIC-based teams, as well as between the U.S.-based and LMIC-based teams (figure 5.1), indicating strong collaborations among U.S.-based teams and LMIC-based teams individually, as well as between the two.

Figure 5.1. Level of Collaboration Between and Among US-Based and LMIC-Based Personnel*



**Respondents were not required to answer all parts of this question.*

When asked "**During your ACTs program grant, were there any challenges to the collaboration between the U.S.-based and LMIC-based personnel?**", 20 respondents (61 percent) replied that there had been challenges to the collaboration. A follow-up open-ended question asked those who responded "Yes" to this question to describe the challenges they encountered. A full list of the responses can be found in Appendix B.3. The challenges described by respondents primarily involved logistics related to timely transportation of materials into the LMIC and transfer of funds to LMIC institutions and partners; communication issues due to time differences, cultural differences, translation issues; and enrollment. One respondent noted

> *"We implemented Phase 1 of our project … and encountered the following challenges: 1. lack of experience with rigorous study designs and with device trials (most experience with program implementation); 2. prolonged and complicated in-country review process; 3. problems with [LMIC's] financial system and being able to get funds to study team; 4. overestimation of ability to enroll sufficient numbers of women who meet inclusion criteria."*

Another reported *"The collaboration between teams is excellent though language and time zone challenges are present. The anticipated enrollment was a lot higher than actual enrollment which was another challenge."*

A third respondent indicated challenges related to *"1. Shipping the prototypes. It takes significant effort to send the prototypes to the collaborators in [LMIC] due to the customs*

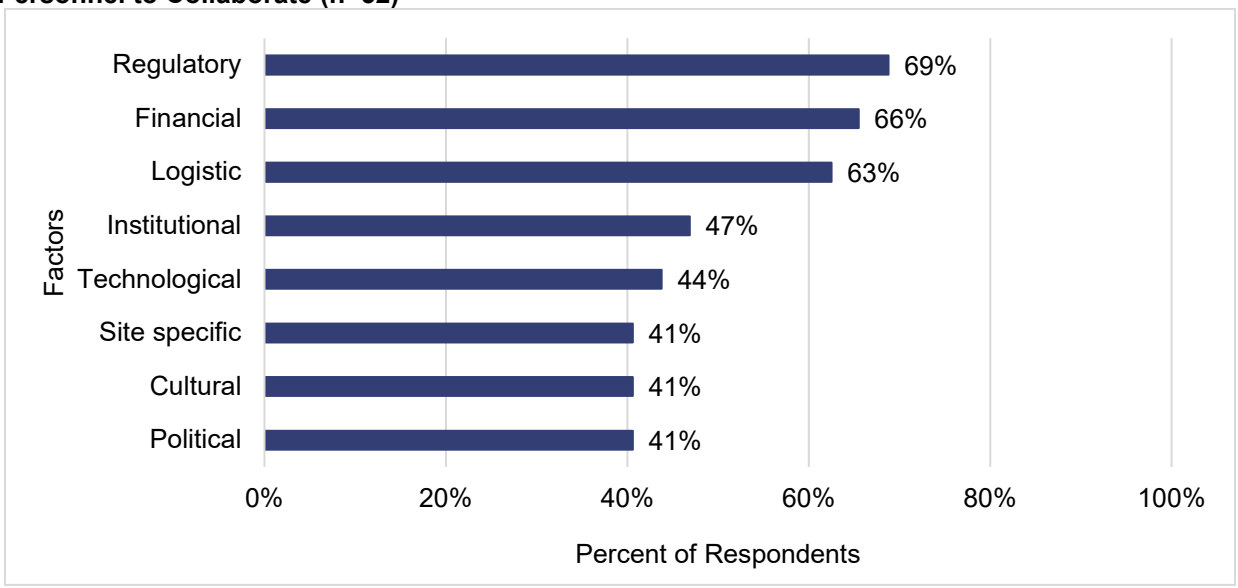
clearance. 2. Funding transfer. In LMIC, it is preferred to get the funding first to start the research."

Survey participants were asked, "**Using a scale from 1 to 5, where 1 means no influence and 5 means a lot of influence, please rate the extent to which the following factors influenced the ability of the U.S.- based teams and collaborating country partners to collaborate with each other on your ACT funded project: political, institutional, financial, logistic, regulatory, cultural, site specific, and technological issues.**" Responses of 1 and 2 were combined into a single category representing no or little influence, and responses of 3, 4, and 5 were combined to be a single category representing some to a lot of influence.

As shown in figure 5.2, the three factors seen as having the most influence on collaboration were regulatory factors (69 percent), financial factors (66 percent), and logistical factors (63 percent). The three factors that respondents ranked as having no or little influence were political (59 percent), cultural (59 percent), and site-specific (59 percent) factors. These responses corresponded with the themes from the open-ended question that asked respondents to describe challenges that affected their collaborations, which were primarily regulatory and logistical in nature.

Three individuals (9 percent) selected 5 (a lot of influence) for "Other" factors influencing the ability of U.S.-based teams and collaborating country partners to work together. Of the three, one indicated that they hadn't been involved in the project in some time, one cited *"lack of experience with rigorous studies-both in planning and execution"* affecting this working relationship, and one cited "*bureaucratic red tapes with various agencies"* as having a lot of impact on this relationship.

Figure 5.2. Factors that Provided Some/A Lot of Influence on the Ability of US and LMIC-Based Personnel to Collaborate (n=32)



Survey respondents were also asked to "**Please describe how the factors from the previous question (i.e., political, institutional, financial, logistic, regulatory, cultural, site specific, technological, and other issues) that you rated 4 and 5, influenced your ability to**

collaborate on the ACTs program grant." Responses to this open-ended question (Appendix B.3) described project-specific issues related to predominantly regulatory, financial, and logistical issues. For example:

> *"Financial considerations are important for all our sites … The biggest issues however have been regulatory (delays and difficulties in receiving IRB approvals and coordinating the home and site IRBs requirements) and systemic (as in some cases the health systems have significantly slowed down patient enrollment)."*
>
> *"There were challenges with obtaining regulatory approval in each country/location we wanted to work. This delays the effort."*
>
> *"Steep learning curve on how to move test platform through customs in [connecting country] (they impounded the test kit and associated hardware, which was returned on the trip back to the U.S.) for meeting with [LMIC] collaborators to introduce the technology and get feedback on their perspective on areas for improvement in its operation."*
>
> *"Logistics (from U.S. to the LMIC site) often delayed the deployment of devices, reagents, and other key instruments."*

Responses related to the level of support received from the ACTs program staff with regards to international collaborations were largely positive. When asked "**In thinking about your collaborations on the ACTs program grant, is there any assistance that ACTs program staff could have provided to make the collaboration process smoother?**", 15 of the 27 respondents (55 percent) who answered the question stated that there was no further assistance that the ACTs program staff could have provided to make the collaboration process smoother. Among the 12 respondents who described ways in which the ACTs program staff could have provided support, responses generally concerned logistical issues, including transportation, regulatory issues, and IRB issues. A full listing of the responses can be found in Appendix B.3.

Although the issues that negatively affected collaborations were specific to individual projects, there were a number of similarities. Respondents suggested a database of information regarding common problems and ways these problems were resolved by other grantees would be helpful. For example:

> *"It seems like a number of ACTs projects had some similar problems: local IRB bottlenecks and local study team lack of experience. it is hard to know how program staff could have addressed the former, given that it is very country specific; the two things that come to mind are making new PIs aware that this is common problem and potentially, keeping database of specific IRB requirements by country (if that is possible). We were in the first cohort of proposals funded; in future, linking new PIs who are working in a specific country with PIs who have been thru [sic] the process in that country might be useful. In terms of lack of experience of local study personnel, it might be helpful to develop a tool-kit or checklist or some other aids to help local staff get up to speed."*
>
> *"Assistance with IRB process in other countries/institutions, as available."*

"Maybe the addition of our transportation issues to "lessons learned" document. It also, from our limited experience, always takes longer to reach a consensus with our intentional collaborators than we have originally envisioned."

"We could benefit from logistics support from ACT staff with experience in shipping materials to these LMICs."

5.3.2.2 Collaborations between ACTs Program Grantees Across Projects

In order to evaluate collaborations and partnerships that had developed between teams, respondents were asked "**While working on your current ACTs program grant, have you developed any other scientific collaborations with other ACTs program grantees?**" Response options included "No"; "Yes, on an entirely new technology unrelated to the ACTs program project"; "Yes, with new collaborators from other ACTs program grants but on the same technological innovation"; and "Yes, with some or all of the original ACT grant personnel on an offshoot project on the same technological innovation". Eleven respondents (33 percent) from nine grants selected at least one of the three "Yes" options for different types of collaborations, and one respondent reported an entirely new project stemming from this new collaboration. Responses in each category are provided below in table 5.1 by respondent role, with full text responses in Appendix B.3.

Table 5.1. Table of New Collaborations Among ACTs Program Grantees, by Role on Grant (n=33)*

While working on your current ACTs program grant, have you developed any other scientific collaborations with other ACTs program grantees?				
Role	**No**	**Yes, on an entirely new technology unrelated to the ACTs program project**	**Yes, with new collaborators from other ACTs program grants but on the same technological innovation**	**Yes, with some or all of the original ACT grant personnel on an offshoot project on the same technological innovation**
PI/Co-PI	13		5	7
Co-Investigator	3			
Co-Investigator, Researcher	1			
Co-Investigator, Researcher, Business partner		1	1	1
Co-Investigator, Technical/Industrial partner	1			
Researcher	1			
Other: Research Manager	1			
Other: Research Director/Project Management	1			
Other: Clinical Research Manager	1			

**Respondents could select more than one response; total responses are greater than the number of respondents.*

5.3.2.3 New Collaborations with Researchers Not on the Original ACTs Program Grant

Several new research partnerships that resulted in new projects were reported. Respondents were asked "**As a result of the ACTs program grant, have you developed new partnerships with researchers who were not on the original ACTs program grant?**" and provided three response options: "No"; "Yes, to work on another aspect of the technology developed under the original ACT grant project"; "Yes, it's an entirely new project". Replies from 13 respondents (39.4 percent) were in the affirmative. Those who replied with one of the two "yes" responses were also asked "**To the best of your knowledge, have any grant applications been made based on this new project?**". Six respondents from four grants stated that they had applied for funding based on this new project. The table below provides number of new partnerships and projects by role. Full text responses are in Appendix B.3.

Table 5.2. New Projects with Researchers Who Were Not on the Original ACTs Program Grant, by Role (n=33)*

As a result of the ACTs program grant, have you developed new partnerships with researchers who were not on the original ACTs program grant?			
Role	**No**	**Yes, to work on another aspect of the technology developed under the original ACT grant project**	**Yes, it's an entirely new project**
PI/Co-PI	13	7	4
Co-Investigator	3		
Co-Investigator, Researcher		1	
Co-Investigator, Researcher, Business partner			1
Co-Investigator, Technical/Industrial partner	1		
Researcher		1	
Other: Research Manager	1		
Other: Research Director/Project Management	1		
Other: Clinical Research Manager	1		

**Respondents could select more than one response; total responses are greater than the number of respondents.*

5.3.2.4 How the ACTs Program Projects Encouraged International Collaboration

To measure to whether the international collaborative relationships on the ACTs projects inspired negative or positive feelings towards working with international partners again, the survey asked, "**Would you say that your work in this project has encouraged or discouraged you to conduct more projects involving international collaborations?**" Respondents who selected "Encouraged" – 32 respondents (100 percent) – were asked to "**Please briefly explain why your ACTs program experience encouraged you to conduct more projects involving international collaboration.**" Seventeen respondents (53 percent) stated that working with personnel from and within an LMIC environment was an encouraging factor, twelve respondents (38 percent) had general positive comments about the experience, four respondents (13 percent) commented on the impact their ACTs program work had on the prospects for commercialization

of the technology, and two respondents (6 percent) specifically referenced ACTs program staff assistance with their projects.

5.3.2.5 Further Funding Applications

Respondents were asked about pursuit of additional funding opportunities. These funding opportunities included funding to support continuation of the research funded by the original ACTs program grant, funding for projects formed from new partnerships with researchers who were not listed on the original ACTs program grant, and funding for other projects related to global health technology research/development.

When asked whether further grant applications had been made to continue the work started by the original ACTs grant, six respondents reported that further grant applications had been made. The breakdown of the types of grant application by ACTs program grant role is detailed in table 5.3 below, with full text responses in Appendix B.3.

Table 5.3. Further Grant Applications to Support Work Started by Original ACTs Program Grant, by Role (n=11)*

To the best of your knowledge, have any further grant applications been made to continue the work started by your original ACT grant?							
Role	**ACTs Program**	**Other NCI grant**	**Other NIH grant**	**Other federal agency**	**Foundation or NGO**	**No**	**I don't know**
PI/Co-PI		4		1	2	4	
Co-Investigator, Researcher, Business partner							1

**Respondents could select more than one response; total responses are greater than the number of respondents.*

Respondents were also asked about additional funding applications that had been made to support new projects with researchers who were not a part of the original ACTs program grant. Six of thirteen respondents (46.2 percent) indicated that they had applied for additional funding from either the ACTs Grant Program, another NCI grant, another NIH grant, or from a foundation or non-government organization (NGO) to support this new research. Response counts by ACTs role are provided below in table 5.4, with full responses in Appendix B.3.

Table 5.4. Further Grant Applications to Support New Projects with Researchers Who Were Not Part of the Original ACTs Program Grant, by Role (n=13)*

To the best of your knowledge, have any grant applications been made based on this new project?					
Role	**No**	**Yes: ACTs program grant**	**Yes: Other NCI grant**	**Yes: Other NIH grant**	**Yes: Foundation or NGO**
PI/Co-PI	6	1	2	1	2
Co-Investigator, Researcher	1				
Co-Investigator, Researcher, Business partner			1		
Researcher			1		1

**Respondents could select more than one response; total responses are greater than the number of respondents.*

To provide context for additional funding opportunities that respondents had pursued, respondents were asked whether they had ever applied for funding for a grant or other funding mechanism related to global health technology research/development. Thirteen respondents reported having applied and received funding for a grant in global health technology (39 percent). Ten respondents (30 percent) indicated having applied for but not receiving grant funding in this area of research, and ten respondents (30 percent) reported that they had not ever applied for a grant in this area of research.

When asked, "**Considering other NIH research opportunities: Academic Industrial Partnerships; Global small business research opportunities; or Other global technology opportunities, have you ever applied to and/or had another NIH grant funded?**", 18 respondents (55 percent) responded that they had applied for another NIH grant, 10 respondents (30 percent) reported that they had had another NIH grant, and nine respondents (27 percent) said that they had never applied to any other NIH research opportunities. Details of these funding opportunities are in Appendix B.3.

5.3.2.6 Conclusion and Recommendations

Although feedback for program staff was mostly positive, survey responses suggest participants felt that greater support for logistical issues could have helped projects run more smoothly and improved collaboration. Additional support could be provided through the establishment and maintenance of a database of regulatory and logistic issues, case studies, and lessons learned from other grantees.

Overall, respondents viewed their collaborations positively, reflected in the way respondents ranked various aspects of their collaborations, as well as in the fact that several new collaborations were fostered by contacts made on the ACTs projects. Additionally, all respondents said they were encouraged to pursue more international collaborations based on their experience on the ACTs project. Respondents also praised the ACTs program staff for their support:

> *"We have already received the strong support from ACTs program staff. No other assistance is needed for our research."*
>
> *"The NIH program staff have been very supportive."*
>
> *"The collaboration on our project was very strong. ACTs program staff were always very helpful and supportive of our research goals and provided helpful feedback on regular calls and at the annual meeting."*

5.3.3 Commercialization Efforts on the Part of ACTs Program Participants

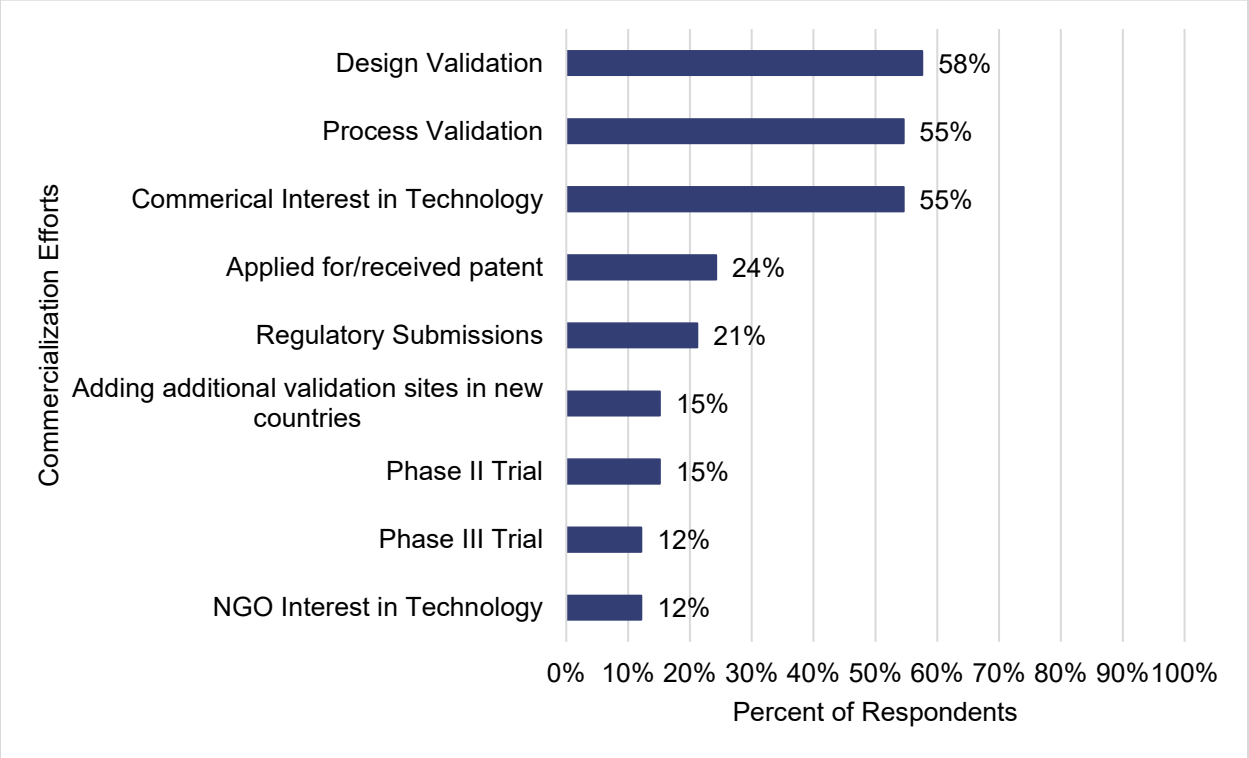
The overarching goal of the ACTs program is to fund projects that with potential for major impact on cancer screening, diagnosis and treatment in LMICs. Before a project can have a major impact on cancer care in an LMIC, there must be evidence of interest in the project from business and governmental entities as well as progress in terms of testing the technology in real world settings (ACTs program Objective 3). Publicizing project technology to the scientific and business communities via scientific literature, academic presentations and patents pursued is also a key component the program (ACTs program Objective 1). This section of the results reveals

respondents' perspectives of the commercial progress of their projects, including the amount of interest shown from various industrial sectors, any marketing or sales of the technology that may have occurred, any barriers to or facilitators of bringing the technology to market, and contributions to science.

5.3.3.1 Steps Toward Commercialization

ACTs program grantees reported various types of commercialization efforts in response to the question "**Which of the following steps towards commercialization are you currently working on in your project?"** (figure 5.3). Fifty-eight percent of respondents indicated that they were in the midst of design validation of project technology, and 55 percent of respondents indicated that they were in the midst of a process validation of the technology. These were the two most frequently reported steps towards commercialization among respondents. In contrast, only 12 percent of respondents reported a Phase III clinical trial or interest in the technology from NGOs.

Figure 5.3. Percent of ACTs Program Grantees Reporting Various Commercialization Efforts (n=33)*

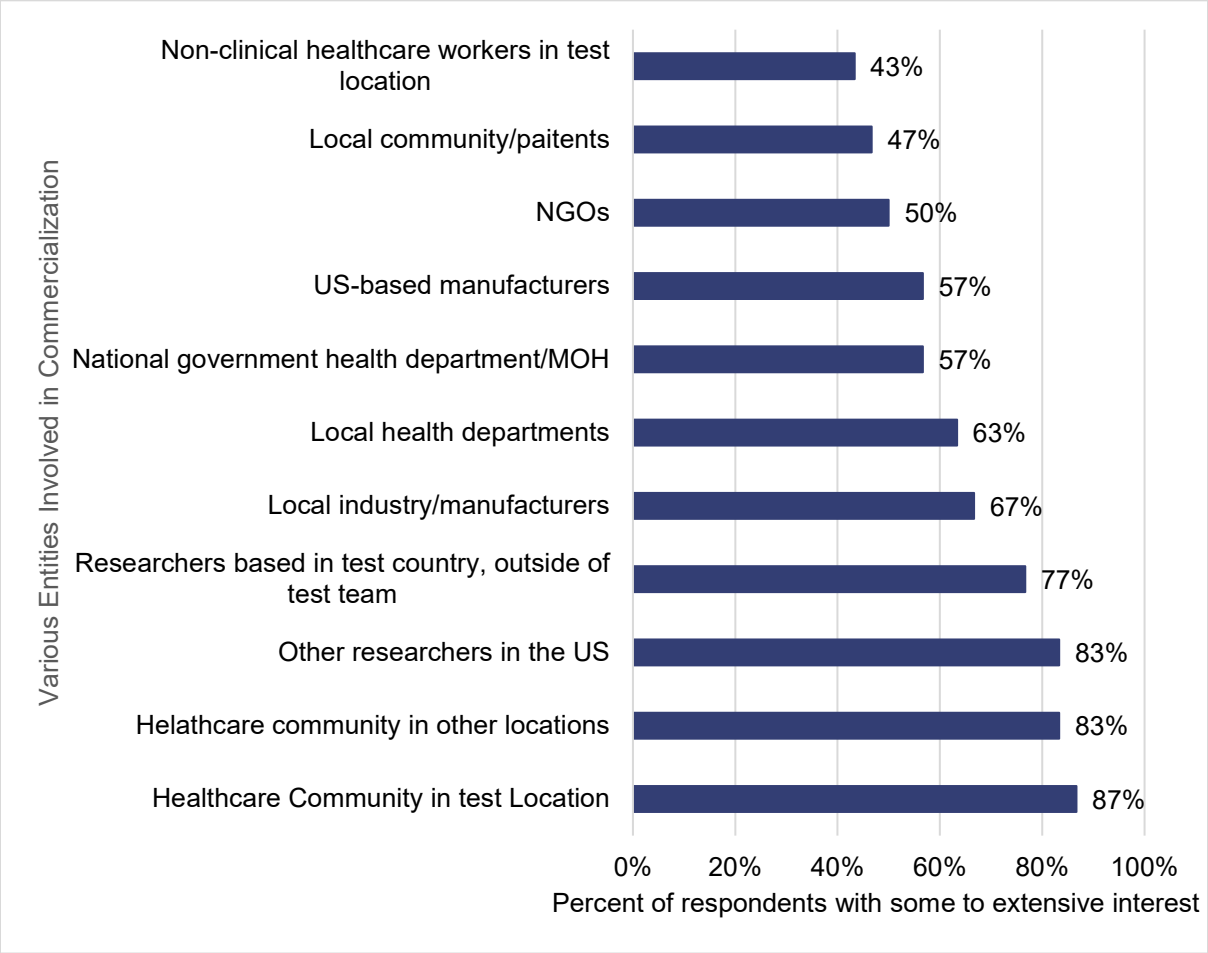


**Respondents could select more than one commercialization effort; percentages total more than 100 percent.*

5.3.3.2 Levels of Interest from Various Sectors in Local LMIC and US-based Economies

The level of interest from various sectors of the local LMIC- and US-based economy can have an impact on whether ACTs program-funded projects become part of broader healthcare practices in the LMIC. To determine interest from various entities, respondents were asked **"What level of interest have you had in the technology you're developing from the following outside entities?"**. Respondents could provide answers ranging from 1 ("none to date") to 5 ("extensive interest"). Figure 5.4 illustrates the percent of respondents reporting some to extensive interest in the ACTs program-funded technology exhibited by various groups.

Figure 5.4. Level of Interest From Various Commercial Entities in the ACTs Program-Funded Technology (n=30)

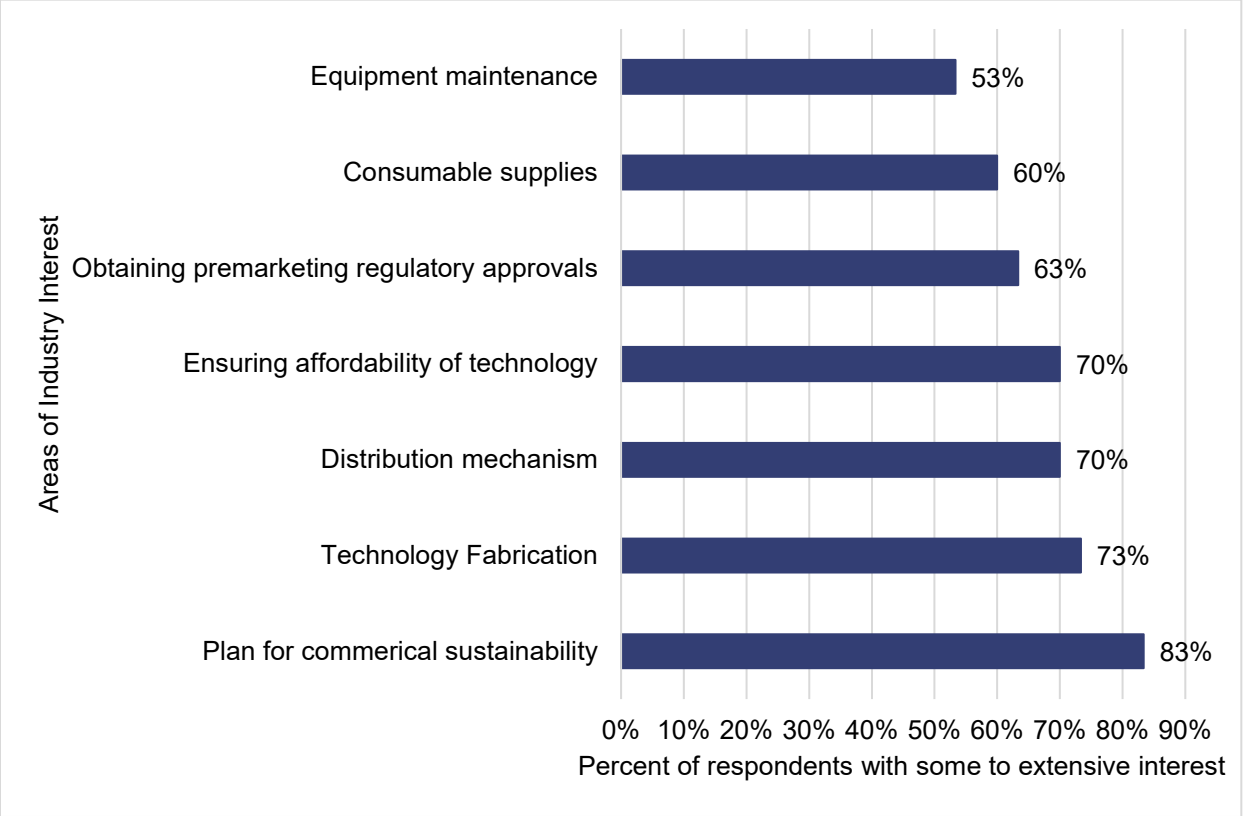


Over 83 percent of survey respondents reported that healthcare communities in the test locations (87 percent) and other locations (83 percent) showed some to extensive interest in the ACTs program-funded projects (figure 5.4). NNGOs, LMIC community/patients, and non-clinical health care workers in the test location showed comparatively less interest, with less than 50 percent of respondents reporting some to extensive interest in the technology from these groups.

5.3.3.3 Industry Interest

In addition to the question regarding interest from various commercial entities, survey respondents were asked **"How much interest from industry have you found in the following areas?".** Respondents were asked to provide answers ranging from 1 ("none to date") to 5 ("extensive interest"). Areas of interest included a wide range of topics from ensuring commercial sustainability to maintaining ACTs program-funded equipment (figure 5.5). In response to this question, survey participants reported some to extensive industrial entity interest in areas including planning for commercial sustainability (83 percent), fabricating project technology (76 percent), providing a distribution mechanism (72 percent), and ensuring affordability of the technology once produced (72 percent).

Figure 5.5. Level of Interest from Industry in by Area of Interest (n=30)

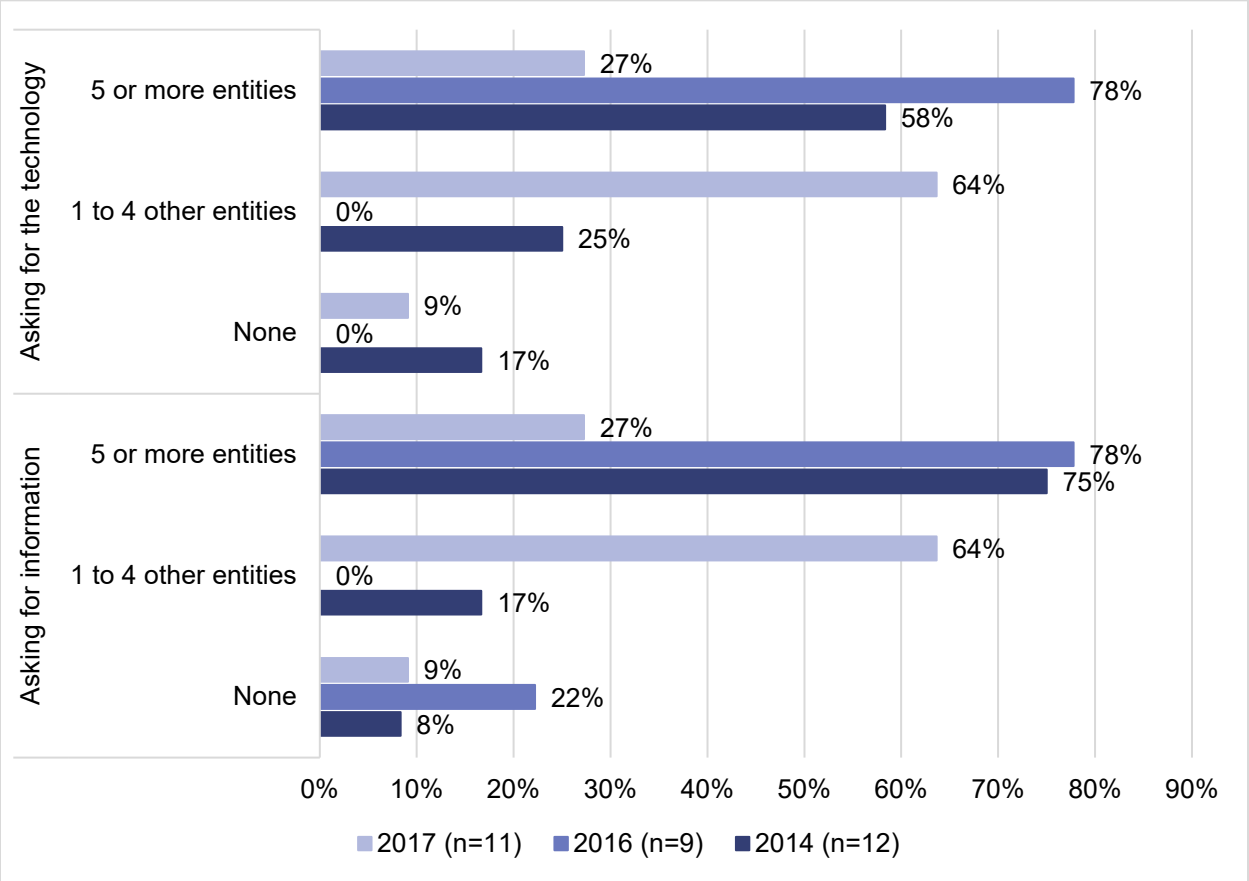


5.3.3.4 Requests for Information About the ACTs Program-Funded Projects and for the Technology Itself

The survey also asked, **"How many others (clinicians, health departments/ministries, businesses, etc.) have learned about and requested information about the technology or the technology itself?".** Response options were none, one to two other entities, three to four entities, or five or more entities. For this question, there were variations in the responses by cohort (figure 5.6). Seventy-eight percent of respondents from the 2016 cohort (7 respondents) and 75 percent of respondents from the 2014 cohort (9 respondents) reported 5 or more entities interested in information about the technology while 27 percent of the 2017 cohort reported 5 or more entities interested in the technology (3 respondents).

Interest in the technology itself also varied by cohort. Requests for the technology itself from 5 or more entities were reported by 78 percent of the 2016 cohort (7 respondents), 58 percent of the 2014 cohort (7 respondents) and 27 percent of the 2017 cohort (3 respondents).

Figure 5.6. Number of Entities Requesting Information About the Technology or the Technology Itself (N=32)



Survey respondents were also asked "**From which sector have these individuals requested information about the technology/the technology itself?"** Requestors of information and/or the technology itself were primarily healthcare organizations, universities and ministries of health in LMICs. One request from a commercial manufacturer was reported. A full list of responses can be found in Appendix B.3.

5.3.3.5 Marketing and Sales of the ACTs Program-Funded Technology

Although respondents reported that entities were seeking information about the technology or the technology itself, 73 percent of the 30 respondents who answered this question have not yet begun to market the technology. Of those who had begun to market the technology, two respondents reported licensing the technology to other companies, one domestic and one in an LMIC. The remaining respondents indicated that they planned to market to LMICs in general without mention of a specific country (Appendix B.3).

Four respondents also reported sales of the technology; three respondents from two grants in the 2014 cohort and one respondent from the 2016 cohort noted technology sales. The three respondents from the 2014 cohort stated that the technology had been sold to "*different sites and NGOs in LMICs*," "*a few private individuals*," and "*other research projects*." The 2016 cohort respondent did not indicate who purchased the technology.

5.3.3.6 Barriers and Facilitators of Bringing the Technology to Market

The survey asked respondents to **"Describe any barriers to bringing this technology to market."** Cost was a leading barrier to bringing the technology to market, reported by 10 respondents. Other barriers noted included regulatory hurdles that respondents needed to overcome to bring their products to market (7 respondents) and the lack of a market for the project (6 respondents). As one respondent noted:

> "*We were fortunate in being able to find an interested and motivated commercial manufacturer. There were a number of steps they had to go thru [sic] to be able to manufacture devices and to receive regulatory approval. I think the primary barriers were identification of an appropriate commercial entity and negotiating the legal steps needed for licensing transfer. An additional barrier was setting a cost that would be competitive with existing devices"*

Respondents were also asked to **"Describe any facilitators to bringing this technology to market."** The level of industry interest, from existing manufacturing partners or through working with industry partners was the leading facilitator, reported by 8 respondents. One respondent noted*:*

> *"Collaborating with colleagues in settings that are targeted for the commercialization of the technology provide insights into what works and what does not work early in the development process."*

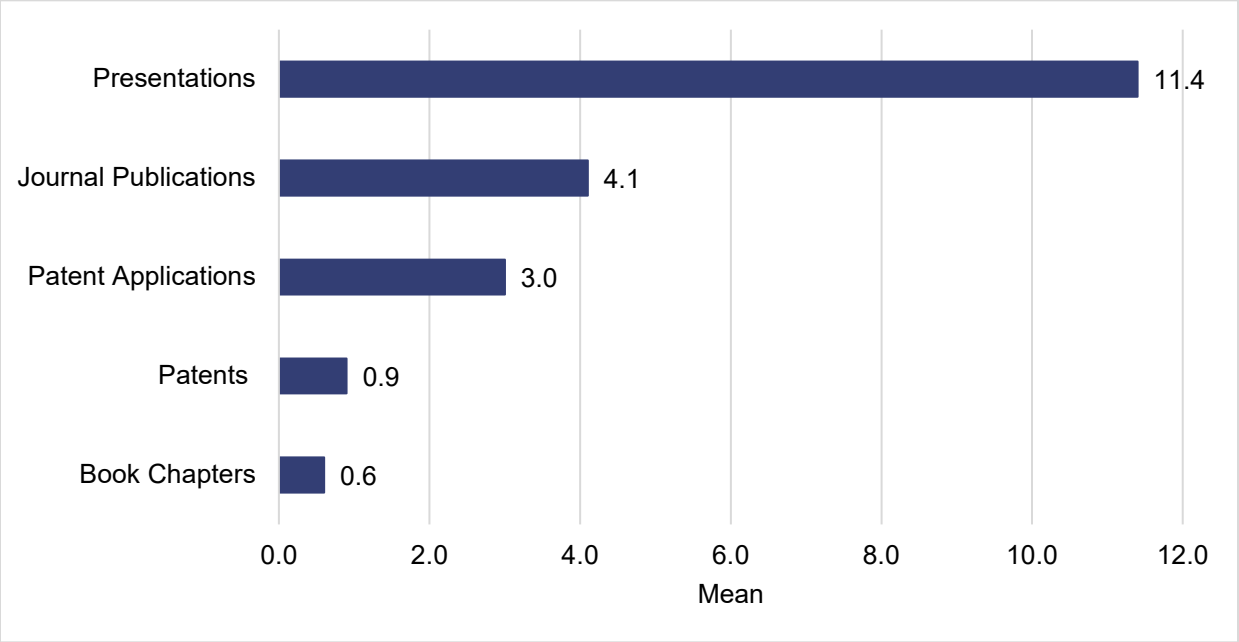
Other factors that were seen as helping bring the technology to market were assistance from the LMICs' ministries of health or local governments (3 respondents), NGO interest (4 respondents) and ACTs program assistance (3 respondents). A full list of responses can be found in Appendix B.3.

5.3.3.7 Contributions to the Science

An important aspect of the commercialization of technology is publication of its existence and efficacy, thereby contributing to scientific literature (Objective 1). To accomplish this, PIs may use academic presentations, journal publications, patents and patent applications, and book chapters to disseminate information. Figure 5.7 illustrates the mean number of presentations, publications, and patents reported by the ACTs program grantees[6]. Conference presentations were reported most frequently, with an average of 11.4 presentations per grant, while book chapters were reported the least, with less than 1 book chapter per grant. A full list of responses is provided in Appendix B table 3.

[6] Some PIs did not report any journal articles, book chapters, patents or patent applications.

Figure 5.7. Mean Number of Academic Presentations, Publications, and Patent Applications/Patents per Grant (n=20)[7]



5.3.3.8 ACTs Program Technology and Training

Building technology that can be used by LMIC personnel is another key aspect of working in LMICs and increases the possibility for commercialization. In response to the question "**What level of training do workers need to operate the technology?"**, only five respondents (15 percent) reported that they felt that the technology needed to be operated by a nurse or physician. Remaining respondents stated that the technology could be operated by those with minimal health care training, such as training provided by the clinic or researchers (17 respondents, 51 percent) or a high school education or less (6 respondents, 18 percent). Five respondents selected "other", which included *"Training via video instruction movie is possible"* and "*The technology itself is very simple to train a nonclinical person to use. The training that is needed is in making a decision to treat or to refer a screen positive results."* A full list of responses can be found in Appendix B.3.

In an additional question about training for use of the technology, respondents were asked, "**To the best of your knowledge, who has attended a training or a presentation about the technology? (Please select all that apply)."** LMIC clinical staff were most frequently reported by respondents (28 respondents, 85 percent) as having attended a training or presentation on the technology. Other frequently reported attendees included LMIC medical students and/or faculty (24 respondents, 74 percent); LMIC non-clinical health care workers [e.g., health educators, MOH staff and/or officials (22 respondents, 67 percent); and U.S.-based medical students or faculty (21 respondents, 64 percent). Two respondents reported other training attendees as "*undergraduate students*" and "*U.S.- based study staff."*

[7] This question was only asked of PIs, co-PIs, and Investigators.

5.3.3.9 Conclusion and Recommendations

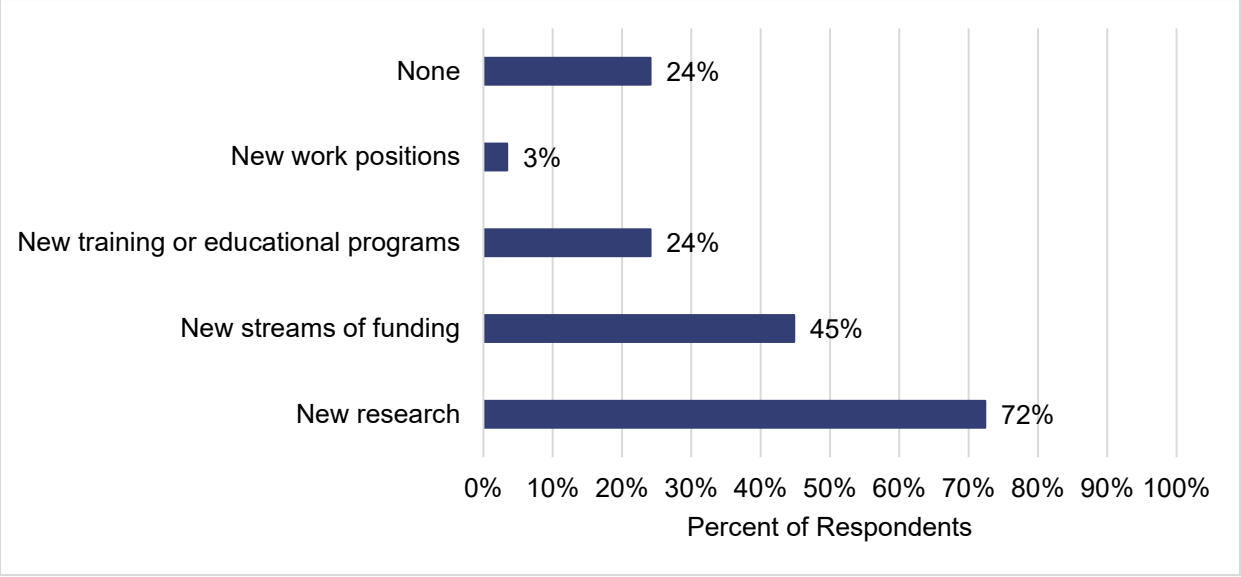
Overall, responses indicated that grantee perspectives on future prospects for the ACTs technology on the commercial market were positive. One suggestion for a way to help program participants improve their time to market included the development of a handbook of customs and other regulations by LMIC so that researchers could be more aware of potential issues before entering the countries to work. Another suggestion was to "select a local partner for commercialization", as there has been a "lack of interest on the part of multi-nationals in the market in LMICs." Many respondents reported that technology was not ready to be marketed, and additional issues may arise as commercialization efforts continue. As one respondent stated:

> *"While it is challenging to work across cultural and language barriers, as well as different time zones, it is a great learning opportunity that I can only recommend to anyone that wants to develop technologies & products for LMICs. There is no better way to learn about the challenges a technology or product will face in the environment where it will be deployed."*

5.3.4 ACTs Program and Prospects for Future Work

Thirty respondents replied to the question **"Did working on this project open up new work or study opportunities for you?".** Figure 5.8 shows the percentage of respondents who stated that their work on the ACTs project in LMICs has led to new opportunities, including new research (72 percent), new streams of funding (45 percent), new training or educational opportunities (24 percent) or new work opportunities (3 percent).[8]

Figure 5.8. Percent of Respondents Who Had New Opportunities Based on the ACTs Program Grant (Please Select All that Apply) (n=30)



[8] This section only pertains to those who answered a country outside of the U.S. to the question, "For your current ACTs program project, in what country is the main focus of your research."

While working on the ACTs program grant yielded new opportunities for many key project personnel, this was not the case for the three clinical or research managers who reported that working on this grant had not yielded any new opportunities (replied "none").

Of the individuals who reported "new training or educational opportunities," two indicated that their new opportunities were in the field of oncology, two reported opportunities in obstetrics and gynecology, and one reported an opportunity in community health. While most of these were degree-based or certification-based opportunities, one respondent reported being involved in a *"Training/Ed program [that] involves providers and health promoters in a[n] LMIC clinic".* Additionally, one respondent reported "*There is NOT a new position, but there is the perception of added qualification and skill through the project related activities, which in turn COULD open new work."* A full list of responses can be found in Appendix B.3.

The survey also asked, "**Based on this experience, what advice do you have for US-based researchers who wish to work with LMIC researchers?**". Advice provided ranged widely and involved all aspects of the projects. For example, 38 percent of respondents (10 respondents) noted the need for knowledge of LMIC rules and regulations, as one suggested *"Do some investigation on regulations in the country of performance and make sure that your team will follow those regulations and the US ones."* Development of strong partnerships was also advised, with 38 percent of respondents (10 respondents) providing this as advice. One respondent suggested *"Establish strong partnerships. That is the number one factor. Be present and listen to the needs. Be prepared to be extremely patient and focused on the long term goals."*

Many respondents also indicated a need for cultural understanding of the LMIC-based program participants (7 respondents, 27 percent). One respondent advised, *"Seek reliable and committed partners; visit regularly. Listen to actual problems. Do not inflict U.S. views of needs and priorities on LMIC researchers. They know their patients better than anyone else does."* Other advice included regular check-ins with staff (3 respondents), patience (2 respondents), and the importance of enlisting strong staff (3 respondents).

5.3.5 Possible Role for ACTs Program Technology in U.S. Healthcare

To gain insight into this whether the ACTs program technology can be utilized in the U.S., researchers were asked **"Do you think this technology could play a role in the U.S. healthcare system?"** Researchers who responded "yes" were asked **"How do you see this technology playing a role in the U.S. healthcare system?"**. Researchers who responded "no" were asked "**Why don't you think the technology could play a role in the U.S. healthcare system?"** A full list of responses can be found in Appendix B.3.

The majority of ACTs program grantees indicated a belief that their technology could play a role in the U.S healthcare system (25 respondents, 83 percent). Most of these respondents discussed ways the technology could provide an improvement in the current state of screening, diagnosis or treatment anywhere in the U.S. (19 respondents, 63 percent). Suggested type of improvement varied. Some respondents emphasized that the test would be more sensitive or non-invasive like *"there is a large percentage of the population that does not participate in […]cancer screening. a […] device would help minimize this."* Other respondents indicated that their technology would be more affordable than the technology currently used in the U.S. for the same problem. These responses sometimes overlapped with those that stated that their technology could be used in

remote/limited resources areas in the U.S. (5 respondents, 17 percent). For example, one respondent said *"The technology can be used in [a] dental office for quick screening of […] cancer, particularly in low-resource settings. The same technique can be re-engineered for cervical cancer screening as well in [the] US."*

Of the five respondents who disagreed that their technology could be used in the US, four argued that the need or interest is not the same in the U.S. and one wrote "Not used in the US only LMICs". One respondent noted, *"U.S. providers are generally not interested in ablative technologies since excision procedures play such a large role here. Regulatory bodies would be a barrier. If ablation therapy were approved by ASCCP there could be a role for office procedures and use in low-resource communities. Right now, there is a lot of resistance to use ablation in the U.S."*

5.4 Conclusion

Overall, survey respondents saw the ACTs program as a useful and fruitful endeavor that allowed them to generate projects needed to improve LMICs cancer screenings, diagnostics and therapies. In multiple sections of the survey, recommendations for improvements to the program were suggested. These included

- extending the time allotted for the initial section of the grant (UH2/UG3);
- providing a handbook or guidebook to working within the LMIC context for PIs that discusses potential issues with customs and other logistics, and;
- continued meetings to facilitate collaborations across projects as well as a forum for a "sounding board" for issues.

One area in which respondents did not suggest improvements was the collaborations developed while working on the ACTs program projects. Many of the respondents rated their collaborations highly, and many instigated new collaborative projects with some or all of the same team members, with members of other teams, with entirely new participants or combinations therein.

While all ACTs program grants are at various stages of completion and progress towards commercialization, the high levels of interest demonstrated in the project technologies suggests a strong basis for future funding and research success as described by one respondent:

> *"Despite the challenges we encountered, the support from the ACTs management has simply been outstanding and the ability to network (and sometimes commiserate) with other ACTs recipients enabled us to learn from each other and in some cases collaborate to solve certain problems. finally, the experience of developing and growing collaborations with international staff in focus countries feels very rewarding."*

6. CGH ACTS PROGRAM EVALUATION REPORT OF CASE STUDY FINDINGS (TASK 3C)

6.1 INTRODUCTION

To help deepen our understanding of challenges, barriers, and facilitators encountered by ACTs program grantees conducting research in LMICs, Team Synergy conducted case studies of four grant awards. Case studies are an ideal methodology to use when questions of "how" and "why" are being posed. The focus of this stage of our evaluation was not to determine the breadth and scope of grant outputs, but rather to dig deep into the difficulties and challenges ACTs investigators faced and the degree to which the ACTs grants were able to support investigator efforts.

We utilized a multi-case study design because we expected external influences on each of the ACTs grants to vary given that implementation took place in such varying environments. Conducting several case studies and comparing them with each other increased the robustness of our analysis and the external validity of our results (Yin, 2003[9]). Cases studies were conducted at the end of the research activities timeline so that they could build on all of the prior data collection activities.

Collecting different types of quantitative data from different sources (Subtasks 3a and 3b) and qualitative data (SME interviews in Task 2 and case studies in Subtask 3c) helped us cross-check and validate our findings. The case studies filled remaining information gaps in this evaluation by: (1) including information from additional key informants from the grantee teams (such as technical and LMIC staff); (2) collecting data from grants at later stages of grantees' work; (3) assessing the impact of the ACTs grants in greater depth; and (4) deepening the discussion of research barriers and facilitators.

6.2 KEY FINDINGS

Team Synergy conducted in-depth studies of 4 CGH ACTs Program grant teams. Despite some variations across grantee teams, such as intervention types, geographic location, stage in the program cycle, and productivity thus far, the opinions of grantees largely converged on several key topics.

Contribution and Impacts of The ACTs Program Grant

- All grantees elaborated enthusiastically on the significance of their work and its contribution to the global oncology field. Several felt that the research conducted under the ACTs grant was a high point in their career that resulted in a very tangible benefit to the diagnosis and treatment of cancer in LMICs.
- All grants without exception have involved a significant training component both in the US and the LMICs involved. Most grantees agreed that the ACTs grants also made a significant contribution to the improvement of the training infrastructure in the LMIC

[9] Yin, Robert K. 2003. *Case study research: design and methods*. Thousand Oaks, Calif: Sage Publications.

sites involved. In addition, most publications resulting from the ACTs grants have included LMIC team members as co-authors.

- Investigators interviewed saw the potential for wide applicability to the devices and interventions developed and tested through their ACTs grants. Two of the grants, in fact, specifically mentioned their technology being used in other countries (including the US) and for additional cancers beyond those for which it was originally designed.
- Though some are making initial contacts to enable commercialization, few have made concrete progress in that regard thus far. One project in particular noted that their planned commercial partner pulled out after the project began, forcing them to seek out new partners.

Collaboration/Partnerships

- All of the case study teams included in this report had previously established relationships with their LMIC partner that supported their ACTs work. In three cases, there had been existing institutional partnerships that facilitated the ACTs efforts. In the fourth, personal relationships were leveraged to support the grant.
- All grantees had positive comments about the collaboration between the US and LMIC institutions. Grantees did not articulate any significant partnership-related barriers, possibly due to the existing relationships that all had. (We anticipate that this may have been different if a new partnership had been developed for this grant.)

Challenges

- Challenges described by the grantees varied quite a bit by grant and were likely reflective of idiosyncratic issues specific to each LMIC and/or project. There were, however, two challenges that were mentioned by most grantees. These were delays and other difficulties related to IRB approvals, and problems related to the physical infrastructure within the LMICs.
- Other challenges mentioned included issues related to LMIC project staffing (e.g., turnover, high workload, political rivalries); language barriers; difficulties moving project funds from the US to the LMIC; challenges recruiting patients or ensuring that patients complete their participation in trials; and challenges related to maintenance of the technology within the LMIC.
- Due to the nature of the challenges experienced by grantees, interviewees for the most part did not feel that NCI could have helped solve them. One exception was the case of international IRB approvals; although researchers acknowledged that the difficulties differed in each country, they felt that NCI could perhaps provide general guidance on best practices for dealing with international IRB approvals.
- Three of the grantees felt that ACTs funding was sufficient, while the fourth felt it had been sufficient for the UH2 phase but not for the UH3 phase.
- Other supports requested from NCI related to funding, although they were not specific requests for overall increases in the ACTs funding level. One interviewee requested guidance and/or funding to help ease the transition from the UH2 to UH3 phases of the grant. Another interviewee suggested that “diversity supplements” could help fund

additional researchers or work within the LMIC. Another suggested that NCI provide funding to encourage ACTs grantees to collaborate with each other.

ACTs Program Improvements

- None of the grantees felt that a formal coordinating center would be useful in the ACTs program in the future. Grantees did, however, generally support NCI providing additional opportunities for researchers to come together and learn from each other.
- The annual meetings of ACTs grantees were well-regarded among all grantees, and several requested more similar meetings and or other opportunities to encourage further collaboration between members of different teams.
- Few suggestions for concrete program improvements were received. Requested improvements focused on the timeline of the grant: one grantee suggested lengthening the overall grant timeline, while another suggested getting rid of the UH2 and UH3 phases – which cause unnecessary delays and an interruption of activities.

6.3 METHODS

Our case study methodology closely followed Yin's approach (2003) to assess grantee experiences with their ACTs funded project:

1. **We employed an informational case study design** combining both objective and subjective data to increase understanding of each project's contributions and challenges. Team Synergy utilized both interviews with key personnel and reviews of reports and products. New data was reviewed in conjunction with project artifacts (see section 4).
2. We worked closely with NCI-CGH to **identify the highest yielding combination of case studies**. We selected grants that are fairly progressed in the program so that we have the opportunity to both observe a higher level of outputs and to obtain feedback on a broad range of grantee facilitators and barriers. We also selected cases that exemplify a range of both successes and difficulties faced by program grantees. Our cases also represent a range of geographic locations, cancer and intervention types, and stages in the ACTs program grant cycle.
3. We **prepared interview guides** for the case studies iteratively with NCI-CGH. We used the SME interview guides as a starting point but expanded significantly to be able to hone into information only privy to the grantees. We chose to implement a semi-structured interview design tailoring questions to the knowledge level, expertise, and role of each of respondent. The goal was not to accumulate responses on the same questions across all respondents, but rather to learn about each respondent's perspective of the program from his or her own angle. Table 6.1 presents a crosswalk between case study research questions and data collection methods utilized. The instrument used for the telephone interviews is provided in Appendix C.1. Topic areas included:
    - Contributions and impacts of the ACTs program
    - Collaborations
    - Challenges
    - Suggestions for ACTs program improvements
4. In total, **we conducted 3-5 interviews with scientific teams from 4 projects** via telephone. Discussions ranged from 30 to 70 minutes in length, were recorded and

transcribed. Each interview was conducted by a senior qualitative researcher and analyzed by a team of a senior researcher and an analyst.

Since research outputs are examined in detail in the artifacts analysis component of this evaluation, the report section below focuses on findings obtained through interviews and the review of progress reports.

Table 6.1. Evaluation Objectives and Case Study Components

Evaluation Objective	Guiding Questions	Interviews	Annual Reports	Outputs: Products, Publications, Citations, Etc.
Evaluate contributions to the research space (Objective 1)	• What are the contributions to the literature from ACTs program grantees? • How many early-stage researchers have been involved in ACTs program grants? • How many trainees have emerged from the ACTs program grants? • In what countries are the PIs located, and who are the collaborating research sites?	X X X	 X X	X
Quantify translational technology research from ACTs program grantees (Objectives 1 and 2)	• What new technologies or shared resources have emerged from the ACTs program? • What number and kind of intellectual property have originated in the ACTs program grants? • How many journal articles or citations have emerged from the program?	X X	X X	X X X
Assess what additional improvements are needed to the program (Objective 3)	• What are the challenges to the program? • What additional activities are needed to enhance the program's effectiveness? • How has international collaboration aided program participants, and in what ways has it hindered the research?	X X X		

6.4 Case Study Findings

6.4.1 Schmeler

AT A GLANCE: POINT-OF-CARE DIAGNOSTIC TOOLS TO IMPROVE GLOBAL CERVICAL CANCER CONTROL PROGRAMS (cohort 1)
PI: Schmeler, Kathleen (Rice University) **Start date:** Sept 2014 **Location:** South America/Brazil **Cancer type:** Cervical **Intervention type (i.e., screening, diagnosis, treatment, etc.):** Diagnosis **Where in health system intervention takes place:** Community, mobile unit **Nature of technology:** Imaging **Intervention description:** Here, we propose to optimize and validate a high resolution microendoscope (HRME) to be used in see- and-treat programs to improve specificity without reducing sensitivity. The goal of this application is to optimize and validate the performance of the HRME for real-time diagnosis of cervical cancer in urban and rural settings in Brazil. In the UH2 phase, we will

demonstrate successful implementation of the HRME in a novel mobile diagnostic and treatment unit for real-time diagnosis and treatment of cervical precancer in screen-positive women in a single visit in order to reduce the number of women lost to follow-up.

# of Pubs in iCite/pubmed: 2
# of New analytic techniques: 1
# of Resources created: 1
# of Trainings/professional development: 1
Type of trainings/professional development: Individual development plans

Drs. Kathleen Schmeler and Rebecca Richards-Kortum serve as co-Principal Investigators (PIs) for the grant *Point-of-Care Diagnostic Tools to Improve Global Cervical Cancer Programs*, along with Dr. Jose Humberto Tavares Guerreiro Fregnani as the Brazil-based co-PI. The aim of this grant is to test a technology (a high-resolution microendoscope) developed by Rice University to better detect cervical pre-cancer at the point of care in low-resource settings. As one co-PI explained, "…*the goal would be that this would enable essentially a single visit where you could screen, detect, and treat women who have high-grade cervical pre-cancer so that you prevent the development of cervical cancer.*" In the current UH3 phase of the project, testing is occurring in Brazil at Barretos Cancer Hospital. The division of responsibilities between the US-based and Brazil-based teams was characterized as, "*the US team was responsible for the development of the instrumentation and the Brazilian team, essentially, was responsible for the design of the clinical study and carrying out all of the clinical aspects of that study. And then we worked very closely together on the data analysis, troubleshooting any problems.*"

Researchers on this grant explained that, although great strides have been made in cervical cancer prevention through strong screening programs in wealthier countries, such as the United States, these strategies have not been as successful in LMICs due to the cost and expertise they require. One co-PI noted that "…*even though these technologies and treatment are available, they're too expensive and too labor-intensive. So you need specialists, you need pathologists, you need gynecologists. And so it just hasn't worked. And Brazil is a great example of that where they're a middle-income country and can do part of it, but just some of the follow-through is lost.*" The technology being developed through this grant is helping to bridge a gap between screening and treatment, where women are screened, but are then lost before they can receive treatment. The device, which can be used by a nurse or another non-physician, can do a visual biopsy which allows for immediate diagnosis and treatment of pre-cancerous lesions.

Interviewees noted a number of **successes** that had already been achieved through this grant, notably a successful pilot study in the UH2 phase with 200 patients that took the technology to community settings in a mobile van. That pilot study led to the larger UH3 study that is currently ongoing, which is attempting to show that the affordable technology developed through this project can be as effective as the traditional approach. (The traditional approach was described by one interviewee as "*we examine the patient, we do a biopsy, we tell the patient to come back in two to four weeks for the results, and then we'll tell them if they need another treatment.*") In addition to the work in Brazil, the research team has received USAID funding to study the application of the technology in Mozambique, Africa, and Cancer Prevention and Research Institute of Texas funding to study it in the Rio Grande Valley.

This grant has also impacted **scientist training** in both Brazil and the United States. Interviewees noted that several biomedical engineering doctoral students received training through this grant, and would hopefully go on to do more work in translational research in their careers. In addition, research nurses and research coordinators in the United States and Brazil were trained to use the new technology and to teach others to use it. Rice University's interest in developing partnerships with institutions in Latin America also led to training opportunities. As one co-PI noted, *"[a]t Rice, they wanted to strengthen partnership in Latin America and so they made some internal resources available for people that wanted to help build collaborations between institutions in Latin America and Rice... So we wrote a proposal to host a series of workshops that included not just my lab, but 20 other faculty from Rice. We went down to Barretos. We brought maybe a dozen undergrads and grad students, and then they worked with something like 40 graduate students and medical students at Barretos.*" Another notable training impact was the creation of a training model to allow clinicians to practice skills such as taking cytology samples or biopsies. As a co-PI described, *"…our students developed an anatomically correct, very low-cost training model that allowed providers to practice all of these skills in a way that was very physiologically realistic*."

Other notable successes included manuscript development. Co-PIs mentioned several papers that had already been published or were currently being drafted. These papers were authored by research team members from both the United States and Brazil. One co-PI summarized the papers as, "*one that described the results of the UH2 study, one that was a safety assessment of the contrast agent that we used, and then one that described the training model that we developed. And then we have two others that are in preparation, one that will describe the results of this very large, productive trial that we did as part of the UH3, and then one that will describe an improvement that we've made to the imaging system that we're hoping will further enhance the sensitivity and specificity.*"

The researchers involved in the grant agreed that the primary outcomes of the project had been to "*understand what was the diagnostic potential of the imaging technology that we developed and how does it compare to the existing tools that are out there.*" They felt that the potential of the technology had been demonstrated during the project's UH2 phase, and although the ongoing UH3 trial aimed to address the second outcome, it appeared that "*it looks like preliminarily…we'll be able to match the sensitivity and specificity of expert colposcopy in the performance of our automated imaging*."

When asked about **other applications** of the technology, co-PIs noted that it was already being used in the United States and in Africa (Mozambique). One PI also mentioned that they had been funded for a similar study in El Salvador. The main challenge in low-income countries was the lack of pathologists to read the biopsies. Although the goal was that the technology would one day make biopsies unnecessary, currently the technology is still being tested and requires comparison to biopsy results. One co-PI noted that *"…the quality of the pathology processing and the pathologist's skill and experience in reading these is a huge barrier in Africa and, to some degree, in El Salvador.*" In terms of using the technology for other cancers, one PI said that "[*w]e think our technology is useful for the detection of pre-cancer in many different organ sites…anywhere you have an epithelial cancer, which is a lot of places, like 85 percent of cancers*." Another PI said that *"…we started a protocol in Barretos using their device for oral cancer prevention.*"

The **collaborative** aspects of this project were also seen as a success, both in terms of the composition of the research team as well as the international partnerships developed. One interviewee said, "*So I think one of the biggest things was to sort of bring experts in medicine, and clinicians…together with bioengineers. And I think that's been one of the most rewarding things is to bring people who have very different outlooks and ways to solve a problem together because we really need each other. Right? We need their sort of brains and expertise on how to design these amazing technologies, but they need to really understand the problem and come up with a solution that we can use in the clinic and in the field. And so I think that collaboration has really been incredible*."

The collaboration between the US-based team at MD Anderson/Rice University and the Brazil-based team at Barretos Cancer Hospital had been established prior to this grant through a MD Anderson sister institution program. MD Anderson had made an effort to include institutions in LMICs among their sister institutions, and made funding available for pairs of PIs to apply to do research together. This internal sister institution network funding brought the grant's PIs together for the first time and allowed them to conduct a small pilot which led to the proposal for the UH2/UH3. As one PI described, *"…they're like little 50K grants that allowed us to do a pilot study with Barretos and really get to know the team there. We had our first protocol approved. We had done a pilot clinical study where our team worked on-site for two weeks. So we had a pretty good sense of what they were like to work with as partners, which was fantastic, and that we had shared goals and values.*"

The researchers on the grant noted very few partnership-specific challenges, aside from turnover of Brazil-based team members. One PI noted that, "*I have done a lot of collaborations in low and middle-income countries, and this was the smoothest ever. The team was just phenomenal.*" They attributed their success to ensuring that all stakeholders – in the United States and Brazil – had incentives to participate. As one PI described, "*I think the biggest thing is that there has to be something in it for everybody. Right? So I mean, we're all very generous and do a lot of things, but there has to be-- the Brazilians need to get something out of it. We can't just go and do research there. And then also there has to be something in it for us or we're not going to provide the support and dedication that we need. … And I think in this case, [we] really wanted to test these technologies and further develop these technologies…And the Brazilians were thrilled to be part of that, get some of this funding, to be affiliated with MD Anderson and Rice and have an NCI grant to help also move their academic careers forward. But I would say that the most important thing for all three of us and for our teams is that the end goal for everybody is to help prevent cancer in the patients that we see and treat.*"

The grant's co-PIs had differing perspectives on the primary **challenges** that were encountered on the grant. One notable challenge was the language barrier. Most of the US-based team did not speak Portuguese, and some members of the research team in Brazil did not speak English. This meant that meetings could take longer than they would without a language barrier. Over time, this has led the research team to move from weekly to monthly meetings. Bureaucratic issues of moving funds between the US and Brazil-based institutions were also challenging, and money often moved slowly as a consequence.

Institutional Review Board (IRB) approvals were mentioned as challenging. In Brazil, a national IRB has to approve studies, in addition to any local IRBs, which can delay a project. The Brazil-

based team also had to learn about the IRB requirements of MD Anderson and Rice University, and they had to adjust the study protocol in order to meet the requirements of the US institutions. One US-based co-PI described the IRB issues as follows: "*So we had a lot of learnings in that sense of how do we do this? Our rules are not their rules. They have their own rules, so we can't sort of push our-- MD Anderson, how we carry out a study onto them. But we also need, if we're going to be involved, to make sure that it's ethical and safe, and all that. So we had a lot of learnings in how to do that. How to get our IRBs to talk to each other, what really needs to be translated and what doesn't. What do we need to manage or micromanage from here, and what don't we need to manage?*"

Another challenge related to the goal of commercializing the technology. As one interviewee described, *"…the commercial partner that we went into with was BD initially, and they made a strategic corporate decision basically to really scale back their commitment to the global market that we were focused on. And so we were relying on internal resources from BD to support that part of the project, so, yeah, that was a challenge for us. And we're in conversation with two other partners about commercialization of the technologies that are emerging. They're smaller companies with less internal resources and so that has been the primary challenge on the funding side for us.*"

When asked about further support or resources needed from NCI, the co-PIs were generally quite positive about interactions with their funder. As one interviewee noted, *"…[NCI was], number one, always willing to be helpful when people ran into challenges, and that was very much appreciated. I think, number two, they did a fantastic job of creating a community of innovators that everyone who was part of the RFA benefited from.*"

The main way that grant staff felt that NCI could have helped them further was by fostering more opportunities for researchers working on ACTs grants to come together and learn from each other, including within LMIC settings, if possible. All three interviewees emphasized this:

> "*But I think one of the things they tried to do that didn't go so well but could have gone better is to really have the grantees talk with each other…there was some communication between groups and we had the meeting every year, which was very helpful. But one thing was they tried to set up sort of a committee for everyone to help each other, but when it started we were essentially competing with each other because the understanding was that they were only going to move a certain number on to the next phase. Weird dynamic, right?...I think in the end they ended up funding everybody. It was a non-issue, but that wasn't clear…But I think that's one thing, is to really create a collaborative environment for the teams to be able to help each other.*"

> "*I would definitely want to keep the PI meetings where people come together. I think it would be nice to think about having some of those meetings in one of the LMIC settings because it was very much typically the high-income partners that participated in that meeting. I know it could be expensive, but I think there would be a lot of benefit both to the site that hosted it as well as to the people that participated in the meeting.*"

"…when I went to Washington, I was shocked the other devices and the other protocols that the other researchers they were developing. So it was very, very interesting I guess. So I guess I'll just have-- we need to have access to this-- what the other teams are working with. So I didn't know more about the other projects... So we were very curious to know what happened with these devices."

Overall, the researchers working on this project appreciated the ACTs program and felt fortunate to have been funded. They were generally satisfied with the level of funding and other support that NCI provided and were hopeful that the funding would continue in the future.

6.4.2 Erickson

AT A GLANCE: EARLY STAGE DIAGNOSIS OF KAPOSI'S SARCOMA IN LIMITED RESOURCE SETTINGS USING KS-DETECT (cohort 2)

PI: Erickson, David Carl (Cornell University)
Start date: Aug 2016
Location: Africa/Uganda
Cancer type: Kaposi's Sarcoma
Intervention type (i.e., screening, diagnosis, treatment, etc.): Community
Where in health system intervention takes place: Diagnosis
Nature of technology: In-vitro assay (at POC)

Intervention description: we will field-test and clinically validate a rapid, point-of-care platform for the diagnosis of Kaposi's sarcoma (KS) in limited resource settings. Our "KS-Detect" diagnostic platform uses solar- power and smartphone technology enabling it to be operated without reliance on any external infrastructure, while maintaining a high degree of usability with low per-unit cost.

# of Pubs in iCite/pubmed: 4
# of New patents: 1
# of New analytic techniques: 2
# of Clinical protocols created: 1
# of Trainings/professional development: 3
Type of trainings/professional development: Trainings in LMICs and mentorship

Dr. David Erickson, PhD, and Dr. Jeffery Martin, MD serve as principle investigators for the grant of the *Early Stage Diagnosis of Kaposi's Sarcoma in Limited Resource Settings using KS-Detect* project. The main aim of this study is to develop a point-of-care technological device for the diagnosis of Kaposi's sarcoma (KS)—an AIDS related cancer. As one of the PI's, Dr. Erickson has specific responsibilities over the technical development of this new device, "TINY," within the project. Powered by electrical, solar, or thermal power, this technology can be utilized without any external infrastructure, which allows for the maintenance of usability at a low-cost.

According to an interviewee, Kaposi's Sarcoma is one of the top five most common cancers in sub-Saharan Africa. A proper diagnosis for KS is generally not possible till the more advanced stages of the disease, leading to low survival rates. A significant part of the problem with proper diagnosis is the lack of pathology services within the African region. While there are some pockets within the region that do offer pathology services, published data has shown that the pathologists in these areas are often inaccurate, and that test results are generated too slowly. The aim of this research is to help address this gap in oncology research by creating an easy to use medical device that can be utilized in these regions. The new technological innovation created is

a medical device that, per Dr. Erickson, " . . . *takes a biopsy and analyzes the nucleic acid content of that biopsy to determine if it is above a certain threshold. If it is above this certain threshold, there's a good chance that it is cancer, and if it is below a certain threshold, it is a good chance that it is not."* Dr. Martin added additional details of the technology, stating*, "It is a handheld device which will perform quantification of the DNA from the virus, Kaposi sarcoma-associated herpesvirus, KSHV, the viral causative agent of KS. And so what we're hypothesizing is that if we can quantify the amount of KSHV DNA in lesions of the skin that are suspicious for KS, that we can use that to make a diagnostic test for KS."*

In addition to the development of this device, our interviewee stated that he believes that one of the most significant **successes so far** in this project was the ability to develop an infrastructure that allowed for the evaluation of different tests. ". . . *To test whether or not a new diagnostic test is going to be adequate, you need a lot of cases of the condition in question. . . We have developed an infrastructure where we have efficiently been able to identify a large number of persons who truly have KS and a large number who don't; they have these so-called mimickers. And you might say, "How do you know they truly have it?" Well, part of that process of developing an infrastructure includes being able to get their material read by expert pathologists here in the US. But we've developed a platform that does allow us to identify a large number of cases and controls who are what we call gold standard phenotype."*

All interviewees agreed that working under the Affordable Cancer Technologies (ACT) grant allowed their **growth as scientists**. One interviewee stated that, *". . . it has opened some research questions for me*." Moreover, work under the ACT's grant resulted in a number of publications and presentations that have in turn helped mold the clinical research skills of additional study personnel. One interviewee emphasized the growth of training opportunities in the LMIC: *". . . We've had a number of presentations at scientific conferences, in many continents - Africa and the US. . . And part of that process involves training junior investigators from Africa . . . So this has been an opportunity to help him develop his skills in clinical research, such that he could run such a study on his own in the future.*" Interviewees agreed that this project also helped to contribute to the training of other US based scientists, particularly junior-level researchers such as post-doctoral and graduate students.

There was a consensus by staff on this project that the originally proposed study outcomes materialized. One interviewee commented that he would not change anything significant within the study, given current outcomes. When asked about the applicability of this work outside of the healthcare continuum, an interviewee relayed, "*It does turn out that what we are developing is directly applicable.*" Grantees similarly felt that the technology developed could potentially be used in the United Stated, but that US citizens would likely have access to alternate modes of diagnosis as well.

Study staff had varying answers when asked about the **challenges** that their projects faced. One interviewee relayed that the recruitment of patients and the demonstration of clinical efficacy had been the most difficult thing to establish. Another interviewee emphasized the various logistical and administrative challenges that go along with conducting this research in an LMIC: *"These are things that we take for granted in the US, where there's been billions and billions and billions of dollars of infrastructure put in for research. And the LMIC by definition, there's hardly any infrastructure. So you're having to build it along the way with people who are not*

experienced in research. And so I would take up weeks of your interview time talking about those everyday challenges. . . When you're working in the midst of poverty, you can imagine what happens. There's just problems around every corner. . . You can't just bring a machine there and turn it on, and it'll just produce research. There are humans in every step of all this working in an atmosphere of poverty. " Team members also agreed that there was an issue with receiving timely regulatory permissions within the LMIC. One interviewee said that, ". . . *the regulatory boards there are very, very slow and very, very inexperienced . . . their attitude towards research are very different than our regulatory boards are. . . They're suspicious of American-led research. . . Any day they could come in and find some little problem with what you're doing and shut you down."*

Yet another respondent spoke of cultural differences and rivalries among the LMIC researchers which presented a challenge for the US-based team. "*I do think, within this country, there's different ways of doing things, and there are some sort of political rivalries amongst the different people in the institution, and they don't always work together. And so I do think there's cultural differences and barriers too for some of the projects and all the aspects."*

Respondents disagreed on **whether funding for their ACT's work had been sufficient**. One interviewee said that while additional funding would be beneficial, he believed that the current funding had been sufficient. "*I would say that always more funding is better, but I think this was pretty good. Yeah, I would say that that's fair. I mean, there's always a challenge in terms of every year and flexibility in budgets."* Yet another interview argued that while the funding had been sufficient for the first phase of the research, it was not enough to be able to carry out the entire project. "*So the total amount of money in the second part really isn't enough. . . So we're not going to have enough money to get to the finish line. We'll use the available money to get as far as we can, but it's not going to be enough to finish the job."* A second interviewee agreed and stated that: "*So the funding for my part of the project for this, I don't think it's going to be sufficient. . . So I think I'm probably tapping into like startup funds and things like that to be able to continue this project. So yeah. No. It's not sufficient."*

Study staff were asked **how NCI, as the funding authority, could have better helped** the researchers overcome their various challenges. Two interviewees agreed that they would have liked additional administrative and monetary flexibility so as to ease the transition from the UH2 to the UH3 phases: "*Well, no UH2, UH3 split. Eliminate the commercialization plan. . . I think if they really-- and honestly, if they really want to get these things to the goal line, they would work with us at this stage to know how much money we're going to need and see if there's any way they can help in this regard. It's the usual. They've given us the money and that's all we're going to get, and I understand that. But if I was running it, I would have a better understanding where the individual projects are."* Two respondents also noted that the wait in between the two phases was too long.

The partnership for this grant was established through a pre-existing **collaborative relationship** between the US and LMIC bases teams. As explained by one interviewee, "*The NCI, now maybe 8 to 10 years ago, had a training grant mechanism for cancers that are-- especially with HIV infection, of which we were fortunate to get, which allowed me to partner with this group in Uganda. That actually allowed me to bring young physicians to UCSF, and ... is one of them. He*

studied in our graduate program that I direct." Interviewees also further described that several members of their team already knew and had worked with each other prior to this collaboration.

The collaborative efforts between the US and LMIC were described as harmonious and productive, with an equal amount of work shared between the teams. "*The US team developed the device. The US team developed the epidemiologic study design to test the device. The LMIC team implemented the study design, that is testing the device. They are finding the patients, doing the biopsies, collecting the specimens.*" In addition, the US team did not report encountering any challenges when working with the LMIC staff. One interviewee stated that keeping the US-LMIC relationship strong and long-lasting was key to the success of the study. Another interviewee pointed out the importance of building trust among researchers. "*Then I have also found, for them to start trusting you and responding to you, you also have to spend a lot of time working with them. So you can't just ask them to do something, and it's going to happen. You have to go and be there and be present and really gain their trust*." When asked about what NCI could do to help further support US-LMIC partnership, one interviewee, asked for assistance dealing with the IRB in the LMIC. This respondent felt that NCI was not forming actively pursuing a partnership with the LMIC IRBs which are in serious need of modernization. Respondents did not feel that the existence of a coordinating center could be beneficial to their studies.

When asked to recommend **program improvements**, interviewees had little to offer. One respondent suggested that it would be advantageous for the program to consider the strength of partnerships while reviewing future applications. "*I think what I would state in caution is, as they considered renewal, consider ways to better tease out what the strength of the partnerships. . . I think that that's a key thing to success."* Overall, respondents overwhelmingly agreed that their ACTs grant has made significant contributions to the global oncology field while offering opportunities for the training of young scientists. The strong partnership of the US and LMIC teams was largely credited for the success of this particular grant. While this team of researchers would prefer a larger grant award, no other suggestions were offered for program improvements.

6.4.3 Weissleder

AT A GLANCE: SMARTPHONE FOR MOLECULAR CANCER DIAGNOSTIC IN AFRICA (cohort 2)

PI: Weissleder, Ralph (Massachusetts General Hospital)
Project start: July 2016
Project location: Africa/Botswana
Cancer type: Lymphomas
Intervention type (i.e., screening, diagnosis, treatment, etc.): Diagnosis
Nature of technology: In-vitro assay (at POC)

Intervention description: We have developed a low-cost, simple holography-based molecular detection strategy that has been implemented on smartphones.

# of Pubs in iCite/pubmed: 9
# of Trainings/professional development: 2
Type of trainings/professional development: Trainings in LMICs and Individual development plans

Dr. Ralph Weissleder and Dr. Bruce Chabner serve as co-Principal Investigators (PIs) for the grant *Smartphone for Molecular Cancer Diagnostic in Africa*. As initially conceived and developed, the technology was a smartphone-based portable optical system (a holography-based

molecular cell analytical strategy) that could be used for cancer diagnosis at the point of care. Over time, largely due to hardware changes and increasing expense associated with smartphones, the technology evolved and is now a standalone box (although it is still roughly the same size as a smartphone). The technology was initially developed for diagnosing lymphomas, but is currently also being used for breast cancer. Testing is occurring at multiple sites in the country of Botswana in Africa. In terms of division of responsibilities between the US-based and Botswana-based teams, US researchers developed and validated the technology, and trained the team in Botswana. The Botswana team is applying the technology and leading the current data collection.

Members of the project team for this grant highlighted the difficulties faced by patients in LMICs, such as Botswana, in getting a timely cancer diagnosis, largely due to a lack of pathologists to serve the population. As one of the team's biomedical engineers noted, "…*when we visited Botswana last year, we realized that there are three or four pathologists for the entire country. It's not the city. It's the entire country. And then they said…that it would take about six months to get the results back.*" The technology developed through this grant has the potential to greatly reduce the time to diagnosis, which consequently could also reduce the time that elapses before the patient can begin treatment. As another interviewee noted, "*I think that what our device can do is it can tell or help the clinician to make the diagnosis much faster, within a day, instead of waiting…months.*"

Researchers noted that the primary initial success of the grant was demonstrating that they could not only create a successful innovative technology, but also evolve it to better serve the needs of the local populations and respond to cost concerns. As noted previously, the device was initially smartphone-based, but as the research team had discussions with staff at Apple and Samsung, and became aware of the increasing cost of smartphones, they decided to change their approach. One interviewee described the evolution of the technology: "*So we figured out smartphone is getting more expensive. And Apple and Samsung, they are changing the camera every time in each year. So for us, it's hard to follow making the accessories that can be fit into the iPhone 6, 7, 8, and X, and etc. So what we actually end with is to have a wide adoption of our device. We now make our own independent device, taking out the camera, taking out the computer side, taking out the Bluetooth or wireless communication parts out of smartphones and making into a new integrated box…it's not really much bigger than the smartphone. But it can be more powerful and can be more cost effective, because we don't need to use every fancy screens and those kind of things, expensive part of our latest smartphone.*"

In addition to making the technology more reliable and cost-effective, the research team was also pleased to report that they found it was feasible to train local staff in Botswana in the correct use of the device, regardless of whether or not they had any previous clinical experience. Creating a device that requires minimal training was seen as crucial to overcoming the shortage of pathologists in the country. The research team member who led the grant's in-country efforts described their **training successes**: *"So then we assessed how well they did with the way we trained them, then we'd do an observed lab practical to see how they would do. And we were very encouraged by the results, but those who had…a degree in the biological sciences, they've been working on the research side for a while, all of them did it perfectly correctly within just a half day of training. And then those who had an intermediate level, about 75 percent of them did it correct after a half day of training. But then we had one person who had never touched that*

test before who did it correctly after a half day of training. And so those things I think were very encouraging too, that we wanted to prove, is this actually feasible if we put this in a place that isn't the capital, and that we're not going to have PhDs to be doing our processing of lab samples, doing the work. And we were pretty encouraged…All of them who had in-person training did it correctly."

As alluded above, this grant has contributed to the training of researchers in Botswana, but also in the United States. One of the key research team members who worked in Botswana, for example, was a US-based fourth-year medical student who felt that working on this grant had been a significant growth opportunity. He described his experience as follows: *"…being a medical student who is able to be a main clinic person on the ground for a clinical trial is a pretty rare experience, I think…this was really the first time that I was able to do something to this degree. And, I mean, I got to help write the IRB…and with some other help in the country, developed a lot of training materials and connected with the training…And also, I think, it put me into a lot of very practical skills…So I think when I conceptualize projects in the future, I'll always reflect on what my experiences were like this year.*" The biomedical engineers who led the technology development mentioned that 3 to 4 research fellows and many graduate students had played important roles in the project. US-based clinical staff had the opportunity to train local staff in Botswana, and some Botswana-based personnel had been able to come to the US for training as well. In addition, the research team produced other training resources, such as YouTube videos, of clinical skills to assist with training efforts.

The project outcome that grant researchers had hoped for was to create a technology that was accurate and could be used successfully anywhere in the world. In fact, the initial idea for the technology had not been for use in an LMIC, but rather to reduce lab processing times at Massachusetts General Hospital. Although researchers agreed that more clinical trial data was needed to assess whether or not they had met this outcome, at least one biomedical engineer was confident that they were "*70 percent or 80 percent there*."

Project staff noted rising **interest in using this technology** in other countries beyond Botswana. For example, staff noted that, *"…from other countries like Nigeria and South Africa, a lot of clinicians are actually showing…interest of using our technologies*" and *"…we're also having a clinical trial using a similar device for breast cancer. And our collaborator is in Korea.*" The technology is also being rolled out in the US, but several project researchers noted that there may be less need here because there is not a lack of pathologists.

Researchers also felt that the technology could be applicable to other cancers. As noted above, although originally developed for use with lymphomas, it is already being used in the diagnosis of breast cancer. One clinician working on the project noted that, *"[n]o cancer is off limits. At the end of the day, with the technology measures, protein measures, DNA-- and so all of these malignancies, solid or liquid results from mutations and proteins and DNA, so that's not a problem. And again, I just alluded to we were able to transition from lymphoma to breast cancer. So we've done some work as well based on the technology on cervical cancer. So we're able to detect HPV on cervical specimens, brushings, so that's another aspect.*" With respect to possible commercialization, another researcher mentioned that, *"…several large drug companies in the US are very interested in using this technology to look at effective novel treatments. . . It's*

a slight spinoff of what we're doing in Africa, so it's not exactly the same application. It uses the same technology, but it's a different application."

The **collaboration** between the US institutions (Harvard University/Massachusetts General Hospital) and the primary Botswana institution (Princess Marina Hospital) had been in existence for at least fifteen years prior to this grant. The initial US-Botswana collaboration was developed to address the HIV epidemic at a time when a significant percentage of Botswana's population had died from it. Harvard made a significant investment in anti-retroviral drugs for Botswana, which reduced the rate of HIV-related deaths and engendered goodwill towards Harvard within Botswana. As populations that may have previously died from HIV are growing older, their attention is turning to diseases such as cancer. Through these existing partnerships, the teams in the US and Botswana were already familiar with each other. Possibly due to these previous experiences working together, project staff reported very few partnership-related challenges with this grant.

The researchers working on the grant felt that, beyond benefitting from their existing relationship and the trust that had built, they had done several things that helped increase their success in working internationally. A significant portion of the project funding goes to Botswana, which encourages their participation. As one researcher noted, "*If you were to build a new partnership, make sure that some of the money actually goes down there so they're monetarily incentivized in participating. And so we have done that. So more than half the money actually goes to Botswana right now.*" In addition, it was important to determine the needs of the local population, rather than trying to impose an idea on them: "*You cannot just say, "Harvard people make this great technology. Why don't you just use it?" like that. Yeah. So you need to kind of try to approach them and see what they really need and how you can adjust our technology to meet their requirements or something like that. That is the first part. And that's why we come up with all different training sessions, etc. And then when we work with other countries, other collaborators, for example, in Korea, their need is slightly different, even though they are a developed country and a great healthcare system. So I think understanding their need is the first part and then trying to approach them in an open mind, not just forcing them to use or follow our rules.*" Several other research staff also mentioned that this grant has a focus on training and providing research opportunities to local staff in Botswana, which also provides an incentive for active participation.

Project staff mentioned a variety of **challenges** they encountered in their work, several of which related to on-the-ground conditions of working in Botswana. (They did not feel that any of the challenges they encountered, however, could be addressed by further support from NCI.) Because the physical infrastructure there is less stable than in countries like the US, weather difficulties could create large problems. For example, a cyclone hit the country during the trial and caused a widespread power outage that lasted for several weeks. Specialty tools needed to maintain the device were not available anywhere in the country, and had to be obtained from South Africa. Internet connections are slow and unreliable. Shipping was also extremely slow and unreliable; project staff noted that it was sometimes quicker to send or bring items from the United States rather than to have them shipped from a nearby African country. All of these issues caused delays, some of which were unavoidable.

Institutional Review Board (IRB) approval was another challenge noted by several researchers. In addition to getting approvals from Harvard and Massachusetts General in the US, IRB approval in Botswana went beyond the local hospital and into Botswana's Ministry of Health. The research team felt that *"…we don't know what to do, basically*" and wished they could have had guidance in this area.

Another significant challenge, which had not been addressed, was the ongoing maintenance needs of the devices. One research staff member explained that the challenge is *"…if the device in its current state breaks, we still need to-- we haven't entirely ironed out how maintenance would be done from any biomedical engineers who are in the country. And I think really most engineers could probably figure out the technology and fix it, but the challenge is that there aren't any within the institution where we work, and so the hiring of someone who's outside who we haven't specifically trained is kind of a challenge. And so right now, if something were to go wrong, we would probably need to send over one of the grad students from the US to fix it, which obviously, is not an ideal solution.*"

When asked about other **support or resources needed from NCI**, project staff made several suggestions. Several of these related to additional funding. One researcher requested diversity supplements that researchers in Botswana could apply for directly to fund more staff or networks within the country. Another researcher suggested additional "seed money" that could be used to encourage different ACTs grantees to collaborate with each other. Another researcher suggested online support/webinars (or in-country seminars) on topics such as statistics to help develop research capacity within the LMICs. The US-based teams often have to provide some of this basic support to their in-country partners, but it was seen as something that perhaps NCI could handle. Another researcher requested more opportunities like the annual meeting that bring grantees together to network and learn from each other. Finally, one person worried about what was going to happen after the end date of the ACTs program and requested communication about this as soon as possible.

In terms of **potential program changes**, few concrete suggestions were made. However, the grant timeline was seen to be too short and staff would like to see it lengthened: "*I think it was overly ambitious in the beginning to say that, during a five-year cycle, you have to develop a new technology, take it to a low and middle-income country, make sure that it works by itself, test the efficacy, and commercialize it all in a five-year period. The average commercialization cycle is 13 to 20 years in the US when everything works fine. That cycle, it just doesn't work, right? It's just way too ambitious and way too short.*"

Project staff felt overall that the ACTs program was valuable, filled a need in global oncology research, and hoped to see it continue. A biomedical engineer mentioned a specific wish to apply for ACTs or another similar program to support his work: "*It would be great if [NCI] can initiate the similar program and fund other technologies or investigators. Actually, we have a very great technology that we want to really apply for cervical cancer. But we have kind of a hard time to find a good funding mechanism to support our work. So ACT is a great support. And if there is a similar program, we really want to definitely try…*"

The overall viewpoint of grant staff was best summed up by a clinician who described the program as follows: "*I mean, I think it's been transformative, as I mentioned earlier, just*

personally and professionally, and it's even transformed folks that weren't initially involved in the grant…And so I think it definitely fills-- not so much an unmet need from our standpoint. We're always going to do our work, irrespective. But I think the impact of how this could be transformative to a partnering country, I think that's something that should be emphasized, and hopefully the metrics show that once we show the partnerships and the publication and who we've engaged. But it's those intangibles that I hope doesn't get lost once the program is online formally at the end."

6.4.4 Hasan

AT A GLANCE: LOW-COST ENABLING TECHNOLOGY FOR IMAGE-GUIDED PHOTODYNAMIC THERAPY (PDT) OF ORAL CANCERS (cohort 1)

PI: Hasan, Tayyaba (Massachusetts General Hospital)
Start date: Sept 2014
Location: Asia (South)/India
Cancer type: Oral
Intervention type (i.e., screening, diagnosis, treatment, etc.): Treatment
Nature of technology: Therapy (photodynamic)

Intervention description: This application aims to address the problem of oral cancer by using a low cost adaptation of photodynamic therapy (PDT), an active area of research in our group. The thrust of the study is to design a platform that can be used at sites without medical infrastructure and uses battery-powered light sources and smart phones along with d-aminolevulinic acid, (ALA) as the photodynamic agent.

# of Pubs in iCite/pubmed: 4
# of New analytic techniques: 1
# of Trainings/professional development: 4
Type of trainings/professional development: Individual development plans

Dr. Tayyaba Hasan, PhD, and Dr. Jonathan Celli, PhD, serve as the principle investigators on the United States team for the grant of *Low-cost Enabling Technology for Image-guided Photodynamic Therapy (PDT) of Oral Cancers*. Dr. Shahid Siddiqi, MD, serves as the principle investigator in India heading the LMIC team. India has one of the highest oral cancer rates in the world accounting for 30 percent of cases globally. Based upon results from earlier clinical trials, these researchers aim to implement photodynamic therapy (PDT) as a low-cost technology alternative for treatment of early stage oral malignancies. PDT has been shown to achieve complete tumor necrosis and healing of oral mucosa. Researchers on this project created a portable and battery-operated smartphone-controlled device that allows for PDT light delivery with the aim to test out this technology in rural settings that lack the needed infrastructure for radiotherapy and surgical treatments. This device is currently being tested in patients with early stage (T1N0M0) disease.

Treatment for oral cancer in India is expensive, and there is a lack of proper care from patients when it is in its early phases. As per Dr. Hasan, "*The problem in many countries, India particularly, is huge. And right now, they do nothing for early cancer of the oral cavity. And so that's a huge gap because you wait till it's grown to a metastatic advanced-stage disease, and then the treatments are extremely invasive and not appropriate for any country, but certainly not for a poor country because injury, radiation, and chemo are all debilitating.*" Through the new technology fielded through the ACT grant, significant improvements were observed in patient outcomes. Dr. Hasan relayed that roughly 70 percent of patients who had undergone a single

treatment with this technology have been cancer-free for two years. Dr. Celli suggested the immense potential of this technology for even greater impact. "*I think it's the fact that we've sort of got it to the point where it's working in the clinic, established the clinical feasibility of the technology that we developed. And it's been demonstrated that it works in patients in India. And I think the main significance of that is that it sort of establishes that it can, hopefully, indeed be scaled up and disseminated more broadly. I think time will tell if that broader impact is realized. But I think the fact that we've got it to the point where it has now been used in a clinical study, has actually treated oral cancer patients, is a really key milestone."*

Interviewees emphasized the extent of their personal **scientific growth** in the course of their ACT's grant as well as the new training opportunities that emerged for young scientists. One interviewee noted that this grant provided an opportunity for learning how to conduct a study with a foreign partner. "*So what it did do was provided me and taught me a lot of challenges doing global health. I mean, I was born in India, and I thought I knew the culture, but I realized I knew nothing. So just the whole thing of dealing with the government regulatory-- so far, I've done quite a few clinical trials, but they've all been in this country, and that's been a very different ball game. Doing it globally is extremely challenging and making sure that nothing goes wrong. So it's taught me a lot.*" Similarly another interviewee noted, "*I think this was my first experience within an international translational project we're not just translating a technology from the bench to the bedside but from the bench in the US to the bedside in a different country, which came with sort of additional challenges. So I think that's been an invaluable experience."*

Along with providing the opportunity for scientific growth for the PI's involved, the grant has allowed **young scientists** to gain valuable research experience. Researchers noted that key roles have been played by post-doctoral students in the study, such as in the development of the light source technology used. "*So there is a postdoc in the LMIC setting who has been on this project for a couple years. And I think it's been a very sort of key project for his career development. On this side, also, so there was a postdoc working in my lab who did a lot of the development of the light source that I just described to you, really the device itself.* " Young scientist training has occurred in both the US and the LMIC teams. So far this grant has resulted in four publications, one submission, and a paper currently in the works which include both US and LMIC coauthors. The grant was also instrumental, according to two interviewees in putting a training infrastructure in place at the LMIC: "*We had to go and set everything up, and that's what I meant by challenges there. . . . I think the fact that they're very interested in doing it and they have retained the infrastructure we set up is, to me, a great achievement.*"

When looking at the **broader applicability** of the implemented technology, there was a general consensus by both PI's that it could be beneficial in other settings, including the United States and for other early and non-large tumors. "*In fact, we're talking to people about using it for cervical cancer in the developing countries.*" While the treatment has appeared to be successful in the patients who have received it, project PIs believe that it is still too early to say if there has been an improvement in healthcare delivery through the development of their device. One stated, "*I think it's too early to say that. I think it's too early to say that on the basis of one clinical study. Yeah, maybe in the long-term but I couldn't say that at this point*."

Both PI's had ideas of what they **would have done differently** in the course of their study to improve their outcomes. One felt that patient enrollment could have been differently defined: "*I think we would have perhaps brought in the scope of the clinical work to increase patient enrollment. I think we would've maybe defined the enrollment criteria slightly differently*." Another wondered if some of the regulatory challenges could have been avoided: "*I think I would have, knowing what I know now, possibly looked into the regulatory part even more carefully and made connections. So I think this is a great program. The NCI has been absolutely wonderful for this. I think it's visionary, but where they haven't been useful has been this making of connections. And I had anticipated that they would have some mechanism that they've developed for infrastructure help, but that was not coming*."

While there was no prior formal **partnership** in place between the US and the LMIC before starting this research, key members of the US and LMIC team knew each other well prior to the start of the project. Overall, both US and LMIC members found the collaboration to have gone very smoothly. One challenge pertained to the heavy workloads of LMIC clinicians which allowed them little time for participation in the study: "*But this project was new, it was inventive, and you needed some scientists and a full-time connection. And these are all busy people who already had jobs. So the resistance to that was hard. But we overcome them.*" However, once the project was running, all interviewees agreed, the teams did work smoothly together: "*No. I mean, truly, the LMIC team have been fantastic and really been committed to this. And their willingness to participate in conference calls at inconvenient hours for them and that sort of thing and just commit a lot of time to this was essential in making the project work.*" While the division of tasks did not appear to be equal, the value of what the LMIC team personnel provided made up for the labor. "*What the India team provided was the clinical setup. . . And so, I would say that probably 60/40, 70/30, something like that. But the value of that is different because I couldn't have done that clinical part here. So maybe in terms of time and resources, it was less. But in terms of value, I think it was the same. Yeah. I don't think it could have happened without either of the parties."*

Researchers also mentioned some **challenges** they faced in the course of their project. Interviewees agreed that the funding provided by NCI for their project was sufficient—albeit, barely. Initially, the team assumed that they had a large amount of funding to carry out their work, but realized that this was not the case due to high international travel costs: "*Initially, I thought, "Oh, the funding is very high, and we'll do a lot," but it turned out to be just sufficient because the big lesson is you've got to have enough funding so you can travel back and forth, and that international travel."* One of the US PIs noted the cultural challenges encountered while working with the Indian population. She stated that poverty-level patients who were diagnosed with cancer were more likely to continue to work, as opposed to coming in for treatment: ". . .*for them, the cancer is less scary than having to give up their job for a day or two for treatment*." Finally, another team member noted that it had taken her a year and a half to receive her visa to be able to travel to India.

Several suggestions came up in our interviews regarding potential **program improvements**. A researcher suggested that the NCI could play an instrumental role in assisting with "preparing the ground" and developing the local infrastructure before the start of each study: "*We have to look into the feasibility, whether we can carry on with the study at our station or not*." The same researcher requested help with assistance with making connections in the LMIC, for example, so

as to enable appropriate staffing. Another researcher asked that the ACTs program offer more opportunities for collaboration between the various grantees: "*And the one thing that they could have done was to have encouraged-- or created some resources for more collaborations because there was a group doing cervical cancer and here we're doing oral cancer. And we talked a lot, but I would have loved to have worked with that team to apply this treatment to cervical cancer. But nothing happens unless you have manpower. And it would have been, of course, much less needed because a lot of the work had been done. But you still need some resources for that. Yeah. I think they would get much more bang for their buck if they had some stashed somewhere which they can give for some joint projects."* One investigator felt that having a coordinating center to handle the administrative and managerial aspect of the project would also be helpful. The same interviewee asked for assistance specifically with managing local regulatory authorities as their project had been delayed for over a year. Finally, another investigator asked that the grant is not split into two phases: "*It would be nice if there was sort of ways to support work like this that isn't so clearly split-up into two phases where there's two years of getting the technology, it's design and adaptation and testing in the US and then the second three years in the partner country. I mean, for example, if we were to do this now, we have all kinds of ideas where I think we would be looking for sort of like a five-year support structure to go straight into India, probably, straight into the LMIC country."*

Despite the challenges and program improvements described above, team members were overall very positive about their ACTs grant experience. Two researchers praised highly the annual meetings organized by NCI, in particular: "*And the annual meetings, I thought, were very stimulating and good. And it also gave you some grounding on how you had done compared to other groups. And you learned about challenges. Everyone had these challenges."* There was a consensus that the ACTs program offers a great opportunity for researcher growth and training and makes a unique contribution to global oncology research.

7. CONCLUSION

Overall, the ACTs program was well-received and well-regarded among grantees, and many researchers expressed gratitude for the opportunity to conduct research with funding from the program. The evaluation established that research conducted under the grant has made important contributions to the oncology literature and the global research environment (objective 1), as exemplified by the resulting publications and presentations, and the diversity of the personnel involved based in HICs and LMICs. Additionally, the evaluation showed that the ACTs program technologies had already begun to generate interest from commercial entities, and that about half of the grantees had submitted FDA IND/IDE applications and/or patent applications (objective 2). Finally, the evaluation team's exploration of the extent to which the ACTs program creates long-lasting, international, multidisciplinary partnerships around new and/or evolving cancer diagnosis, screening, or treatment technologies (objective 3) showed that all grantees involved a training component in the US and LMIC study locations, and that many grants supported NIs, ESIs, students, and post-docs on their projects.

The concluding section of this report provides a final summary of the limitations to this evaluation and presents grantees' recommendations for program improvements.

7.1 LIMITATIONS

The primary overall limitation of this evaluation was that grantees self-reported much of the data. This was the case for the SME interviews, the survey, the case studies, and to a lesser degree, the analysis of program artifacts. The caveat associated with self-reported data is the potential for introducing bias into the evaluation. In this case, the individuals who were contacted knew the information was being collected to inform future decisions about continuing the program. In addition, grantees may have felt pressure to present the work emerging from their own grants in a positive light. Therefore, respondents who took part in SME interviews, the web survey, or the case study interviews could have presented views and opinions that were more positive than their true feelings. Of these three elements of the study, the only one that was anonymous was the survey; however, enough personal data were collected that identifying individuals by their responses would not have been difficult.

Another critical limitation of the evaluation is that the various grants studied belong in various cohorts and are thus in different stages of development. Therefore, making broad generalizations about where ACTs program projects are in the process of the publication and dissemination of results as well as the product commercialization timeline is often difficult and even inappropriate. Readers should note that grants from recent cohorts are sometimes being compared to earlier cohorts, and that follow-up evaluation activities after the completion of all grant activities would present grant outcomes more accurately.

Other limitations pertaining to the collection of data through the various evaluation activities have been described in each report section and are summarized once again here:

- **SME Interviews (Task 2)**: It was difficult to schedule interviews with individuals who knew enough about this particularly specialized area of expertise. In addition, in an attempt to recruit unbiased respondents who knew about the program but were not actual

grantees, evaluators spoke to individuals who had fairly peripheral knowledge of the precise details of the program.

- **Analysis of Artifacts (Subtask 3a)**: There were different reports and information available for each grant, as each was at a different point in the grant timeline, depending on its cohort and other factors. Additionally, not all key personnel were present in the NIH databases, so other resources were used to determine affiliations.
- **Survey of Key Personnel (Subtask 3b)**: The survey was sent to PIs and intended to be forwarded to other team members; however, it is unclear if this occurred. Therefore, the majority of survey respondents were key personnel, making it impossible to glean the views of the personnel in other roles.
- **Case Studies (Subtask 3c)**: It was a challenge to reach and talk to a range of people, including lower-level personnel, associated with the grants that were chosen for each case study, and the views of those who were not in leadership roles were often not represented. Obtaining interviews from LMIC staff was also challenging and thus fewer of those interviews took place.

7.2 RECOMMENDATIONS

Several recommendations emerged from the various evaluation activities. Broadly speaking, the three most common recommendations made by grant personnel had to do with collaboration opportunities, help with logistics, and the grant time frame.

- **Collaboration Opportunities**: Survey respondents and those interviewed for the case study reports mentioned that it would be beneficial if the ACTs program enhanced its efforts to encourage collaborations between grantees. There were multiple suggestions as to how this could be done. None of the grantees felt there was a need for a formal coordinating center; however, many did suggest holding additional meetings or other opportunities during the year to allow for more contact between grantees so as to encourage more collaboration on current and future projects.
- **Logistical Help**: Some respondents reported that additional help with logistics, perhaps in the form of a handbook or database, would be useful to help grantees navigate logistics such as local LMIC customs, capabilities, and IRB regulations. Several grantees reported having issues with transporting their devices into their LMIC sites and hiring knowledgeable personnel within LMICs. Many respondents noted that information about regulatory processes — and potentially suitable relevant contacts — from the ACTs program would have been invaluable for preventing such delays.
- **Time Frame**: Results from the survey and case study interviews suggest that longer rounds of funding would allow for IRB delays and give grantees more time to get their devices ready for marketing and commercialization. In addition, grantees requested further support via bridge funding between the UH2 and UH3 phases (or a single-phase mechanism) so as to avoid unnecessary interruptions in their research.

Overall, researchers and personnel had uniformly positive things to say about the program. One grantee provided this apt summation:

> *"I hope the funding mechanism continues and provides opportunities to develop more new technologies for global health."*

ACTs PROGRAM REPORT APPENDIXES

APPENDIX A: ACTs PROGRAM ARTIFACTS REPORT (SUBTASK 3A)

Appendix A.1 Table of Publications by Base Project Number, Journal Area of Interest and Impact Factor

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
CA211415	Anderson K	Serum Immune Profiling for Early Detection of Cervical Disease.	Ewaisha, Radwa; Panicker, Gitika; Maranian, Paul; Unger, Elizabeth R; Anderson, Karen S	2017	Theranostics	Personalized Medicine	8.537
CA211415	Anderson K	A compact, low-cost, quantitative and multiplexed fluorescence detection platform for point-of-care applications.	Obahiagbon, Uwadiae; Smith, Joseph T; Zhu, Meilin; Katchman, Benjamin A; Arafa, Hany; Anderson, Karen S; Blain Christen, Jennifer M	2018 Oct 15	Biosensors & Bioelectronics	Biosensor	8.173
CA211232	Chilkoti	Inkjet-printed point-of-care immunoassay on a nanoscale polymer brush enables subpicomolar detection of analytes in blood.	Joh, Daniel Y; Hucknall, Angus M; Wei, Qingshan; Mason, Kelly A; Lund, Margaret L; Fontes, Cassio M; Hill, Ryan T; Blair, Rebecca; Zimmers, Zackary; Achar, Rohan K; Tseng, Derek; Gordan, Raluca; Freemark, Michael; Ozcan, Aydogan; Chilkoti, Ashutosh	2017 08 22	Proceedings Of The National Academy Of Sciences Of The United States Of America	Interdisciplinary	
CA211232	Chilkoti	Architectural Modification of Conformal PEG-Bottlebrush Coatings Minimizes Anti-PEG Antigenicity While Preserving Stealth Properties.	Joh, Daniel Y; Zimmers, Zackary; Avlani, Manav; Heggestad, Jacob T; Aydin, Hakan B; Ganson, Nancy; Kumar, Shourya; Fontes, Cassio M; Achar, Rohan K; Hershfield, Michael S; Hucknall, Angus M; Chilkoti, Ashutosh	2019 Apr	Advanced Healthcare Materials	Interdisciplinary	5.609
CA211139	Chiu	A Self-Digitization Dielectrophoretic (SD-DEP) Chip for High-Efficiency Single-Cell Capture, On-Demand Compartmentalization, and Downstream Nucleic Acid Analysis.	Qin, Yuling; Wu, Li; Schneider, Thomas; Yen, Gloria S; Wang, Jiasi; Xu, Shihan; Li, Min; Paguirigan, Amy L; Smith, Jordan L; Radich, Jerald P; Anand, Robbyn K; Chiu, Daniel T	2018 08 27	Angewandte Chemie (International Ed. In English)	Chemistry	

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
CA202665	Court	Model for Estimating Power and Downtime Effects on Teletherapy Units in Low-Resource Settings.	McCarroll, Rachel; Youssef, Bassem; Beadle, Beth; Bojador, Maureen; Cardan, Rex; Famiglietti, Robin; Followill, David; Ibbott, Geoffrey; Jhingran, Anuja; Trauernicht, Christoph; Balter, Peter; Court, Laurence	2017 Oct	Journal Of Global Oncology	Oncology	
CA202665	Court	Retrospective Validation and Clinical Implementation of Automated Contouring of Organs at Risk in the Head and Neck: A Step Toward Automated Radiation Treatment Planning for Low- and Middle-Income Countries.	McCarroll, Rachel E; Beadle, Beth M; Balter, Peter A; Burger, Hester; Cardenas, Carlos E; Dalvie, Sameera; Followill, David S; Kisling, Kelly D; Mejia, Michael; Naidoo, Komeela; Nelson, Chris L; Peterson, Christine B; Vorster, Karin; Wetter, Julie; Zhang, Lifei; Court, Laurence E; Yang, Jinzhong	2018 07	Journal Of Global Oncology	Oncology	
CA202665	Court	Fully Automatic Treatment Planning for External-Beam Radiation Therapy of Locally Advanced Cervical Cancer: A Tool for Low-Resource Clinics.	Kisling, Kelly; Zhang, Lifei; Simonds, Hannah; Fakie, Nazia; Yang, Jinzhong; McCarroll, Rachel; Balter, Peter; Burger, Hester; Bogler, Oliver; Howell, Rebecca; Schmeler, Kathleen; Mejia, Mike; Beadle, Beth M; Jhingran, Anuja; Court, Laurence	2019 Jan	Journal Of Global Oncology	Oncology	
CA202665	Court	A risk assessment of automated treatment planning and recommendations for clinical deployment.	Kisling, Kelly; Johnson, Jennifer L; Simonds, Hannah; Zhang, Lifei; Jhingran, Anuja; Beadle, Beth M; Burger, Hester; du Toit, Monique; Joubert, Nanette; Makufa, Remigio; Shaw, William; Trauernicht, Christoph; Balter, Peter; Howell, Rebecca M; Schmeler, Kathleen; Court, Laurence	2019 Jun	Medical Physics	Physics, Medicine	2.884

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
CA202665	Court	Automated treatment planning of postmastectomy radiotherapy.	Kisling, Kelly; Zhang, Lifei; Shaitelman, Simona F; Anderson, David; Thebe, Tselane; Yang, Jinzhong; Balter, Peter A; Howell, Rebecca M; Jhingran, Anuja; Schmeler, Kathleen; Simonds, Hannah; du Toit, Monique; Trauernicht, Christoph; Burger, Hester; Botha, Kobus; Joubert, Nanette; Beadle, Beth M; Court, Laurence	2019 Sep	Medical Physics	Physics, Medicine	2.884
CA202665	Court	Automatic detection of contouring errors using convolutional neural networks.	Rhee, Dong Joo; Cardenas, Carlos E; Elhalawani, Hesham; McCarroll, Rachel; Zhang, Lifei; Yang, Jinzhong; Garden, Adam S; Peterson, Christine B; Beadle, Beth M; Court, Laurence E	2019 Sep 10	Medical Physics	Physics, Medicine	2.884
CA202665	Court	Automatic detection of graticule isocenter and scale from kV and MV images.	Fang, Raymond; Yang, Jinzhong; Du, Weiliang; Court, Laurence	2019 Apr	Journal Of Applied Clinical Medical Physics	Applied Clinical Medical Physics	1.301
CA202665	Court	Radiation Planning Assistant - A Streamlined, Fully Automated Radiotherapy Treatment Planning System.	Court, Laurence E; Kisling, Kelly; McCarroll, Rachel; Zhang, Lifei; Yang, Jinzhong; Simonds, Hannah; du Toit, Monique; Trauernicht, Chris; Burger, Hester; Parkes, Jeannette; Mejia, Mike; Bojador, Maureen; Balter, Peter; Branco, Daniela; Steinmann, Angela; Baltz, Garrett; Gay, Skylar; Anderson, Brian; Cardenas, Carlos; Jhingran, Anuja; Shaitelman, Simona; Bogler, Oliver; Schmeller, Kathleen; Followill, David; Howell, Rebecca; Nelson, Christopher; Peterson, Christine; Beadle, Beth	2018 04 11	Journal Of Visualized Experiments : Jove	Life Science, Physical Science	1.184

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
CA189883	Cremer	A Non-Gas-Based Cryotherapy System for the Treatment of Cervical Intraepithelial Neoplasia: A Mixed-Methods Approach for Initial Development and Testing.	Cremer, Miriam; Paul, Proma; Bergman, Katie; Haas, Michael; Maza, Mauricio; Zevallos, Albert; Ossandon, Miguel; Garai, Jillian D; Winkler, Jennifer L	2017 03 24	Global Health, Science And Practice	Global Health	
CA189883	Cremer	Depth of Cervical Intraepithelial Neoplasia Grade 3 in Peruvian Women: Implications for Therapeutic Depth of Necrosis.	Taxa, Luis; Jeronimo, Jose; Alonzo, Todd A; Gage, Julia; Castle, Philip E; Cremer, Miriam L; Felix, Juan C	2018 Jan	Journal Of Lower Genital Tract Disease	Lower Genital Tract Disease	
CA202723	Erickson	A portable device for nucleic acid quantification powered by sunlight, a flame or electricity.	Snodgrass, Ryan; Gardner, Andrea; Semeere, Aggrey; Kopparthy, Varun Lingaiah; Duru, Jens; Maurer, Toby; Martin, Jeffrey; Cesarman, Ethel; Erickson, David	2018 Sep	Nature Biomedical Engineering	Biomedical Engineering	
CA202723	Erickson	Kaposi sarcoma.	Cesarman, Ethel; Damania, Blossom; Krown, Susan E; Martin, Jeffrey; Bower, Mark; Whitby, Denise	2019 01 31	Nature Reviews. Disease Primers	Medicine	16.071
CA202723	Erickson	Point of care technologies for sepsis diagnosis and treatment.	Oeschger, Taylor; McCloskey, Duncan; Kopparthy, Varun; Singh, Ankur; Erickson, David	2019 02 26	Lab On A Chip	Miniaturization	5.995
CA202723	Erickson	KS-Detect - Validation of Solar Thermal PCR for the Diagnosis of Kaposi's Sarcoma Using Pseudo-Biopsy Samples.	Snodgrass, Ryan; Gardner, Andrea; Jiang, Li; Fu, Cheng; Cesarman, Ethel; Erickson, David	2016	Plos One	Interdisciplinary	2.806

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
	Ford	A ring-based compensator IMRT system optimized for low- and middle-income countries: Design and treatment planning study	Van Schelt, Jonathon; Smith, Daniel L.; Fong, Nicholas; Toomeh, Dolla; Sponseller, Patricia A.; Brown, Derek W.; Macomber, Meghan W.; Mayr, Nina A.; Patel, Shilpen; Shulman, Adam; Subrahmanyam, G. V.; Govindarajan, K. N.; Ford, Eric C.	2018	Medical Physics	Physics, Medicine	
CA189901	Hasan	Development and evaluation of a low-cost, portable, LED-based device for PDT treatment of early-stage oral cancer in resource-limited settings.	Liu, Hui; Daly, Liam; Rudd, Grant; Khan, Amjad P; Mallidi, Srivalleesha; Liu, Yiran; Cuckov, Filip; Hasan, Tayyaba; Celli, Jonathan P	2019 Apr	Lasers In Surgery And Medicine	Lasers In Medicine	
CA189901	Hasan	Quantum dot light emitting devices for photomedical applications.	Chen, Hao; He, Juan; Lanzafame, Raymond; Stadler, Istvan; Hamidi, Hamid El; Liu, Hui; Celli, Jonathan; Hamblin, Michael R; Huang, Yingying; Oakley, Emily; Shafirstein, Gal; Chung, Ho-Kyoon; Wu, Shin-Tson; Dong, Yajie	2017 Mar	Journal Of The Society For Information Display	Information Display	1.102
EB024965	Kingham	Urinary Metabolomics to Identify a Unique Biomarker Panel for Detecting Colorectal Cancer: A Multicenter Study.	Deng, Lu; Ismond, Kathleen; Liu, Zhengjun; Constable, Jeremy; Wang, Haili; Alatise, Olusegun I; Weiser, Martin R; Kingham, T P; Chang, David	2019 Aug	Cancer Epidemiology, Biomarkers & Prevention : A Publication Of The American Association For Cancer Research, Cosponsored By The American Society Of Preventive Oncology	Oncology	

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
CA189908	Kuhn	Utility of Xpert® HPV for cervical cancer screening of HIV-positive women	Kuhn, Louise	2017 Oct 23	Journal Of Virus Eradication	Viral Eradication	
CA189908	Kuhn	The time is now to implement HPV testing for primary screening in low resource settings.	Kuhn, Louise; Denny, Lynette	2017 May	Preventive Medicine	Preventative Health, Public Health	3.483
CA239682	Liang	Automatic classification of dual-modalilty, smartphone-based oral dysplasia and malignancy images using deep learning.	Song, Bofan; Sunny, Sumsum; Uthoff, Ross D; Patrick, Sanjana; Suresh, Amritha; Kolur, Trupti; Keerthi, G; Anbarani, Afarin; Wilder-Smith, Petra; Kuriakose, Moni Abraham; Birur, Praveen; Rodriguez, Jeffrey J; Liang, Rongguang	2018 Nov 01	Biomedical Optics Express	Optical Science	3.482
CA239682	Liang	Ray mapping with surface information for freeform illumination design.	Gannon, Caleb; Liang, Rongguang	2017 Apr 17	Optics Express	Optical Science	3.356
CA239682	Liang	Point-of-care, smartphone-based, dual-modality, dual-view, oral cancer screening device with neural network classification for low-resource communities.	Uthoff, Ross D; Song, Bofan; Sunny, Sumsum; Patrick, Sanjana; Suresh, Amritha; Kolur, Trupti; Keerthi, G; Spires, Oliver; Anbarani, Afarin; Wilder-Smith, Petra; Kuriakose, Moni Abraham; Birur, Praveen; Liang, Rongguang	2018	Plos One	Interdisciplinary	2.766
CA189966	Love	Palpable Breast Lump Triage by Minimally Trained Operators in Mexico Using Computer-Assisted Diagnosis and Low-Cost Ultrasound.	Love, Susan M; Berg, Wendie A; Podilchuk, Christine; López Aldrete, Ana Lilia; Gaxiola Mascareño, Aarón Patricio; Pathicherikollamparambil, Krishnamohan; Sankarasubramanian, Ananth; Eshraghi, Leah; Mammone, Richard	2018 08	Journal Of Global Oncology	Oncology	

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
CA211457	Meltzer	Gastric Cancer in the Era of Precision Medicine.	Liu, Xi; Meltzer, Stephen J	2017 May	Cellular And Molecular Gastroenterology And Hepatology	Gastroenterology And Hepatology	
CA211457	Meltzer	RNA sequencing of esophageal adenocarcinomas identifies novel fusion transcripts, including NPC1-MELK, arising from a complex chromosomal rearrangement.	Wang, Zhixiong; Cheng, Yulan; Abraham, John M; Yan, Rong; Liu, Xi; Chen, Wei; Ibrahim, Sariat; Schroth, Gary P; Ke, Xiquan; He, Yulong; Meltzer, Stephen J	2017 Oct 15	Cancer	Oncology	
CA211457	Meltzer	Novel circular RNA NF1 acts as a molecular sponge, promoting gastric cancer by absorbing miR-16.	Wang, Zhe; Ma, Ke; Pitts, Steffie; Cheng, Yulan; Liu, Xi; Ke, Xiquan; Kovaka, Samuel; Ashktorab, Hassan; Smoot, Duane T; Schatz, Michael; Wang, Zhirong; Meltzer, Stephen J	2018 12 01	Endocrine-Related Cancer	Oncology, Endocrinology	
CA211457	Meltzer	Long Noncoding RNAs in the Pathogenesis of Barrett's Esophagus and Esophageal Carcinoma.	Abraham, John M; Meltzer, Stephen J	2017 07	Gastroenterology	Gastroenterology	18.392
CA211457	Meltzer	Methylation Biomarker Panel Performance in EsophaCap Cytology Samples for Diagnosing Barrett's Esophagus: A Prospective Validation Study.	Wang, Zhixiong; Kambhampati, Swetha; Cheng, Yulan; Ma, Ke; Simsek, Cem; Tieu, Alan H; Abraham, John M; Liu, Xi; Prasath, Vishnu; Duncan, Mark; Stark, Alejandro; Trick, Alexander; Tsai, Hua-Ling; Wang, Hao; He, Yulong; Khashab, Mouen A; Ngamruengphong, Saowanee; Shin, Eun J; Wang, Tza-Huei; Meltzer, Stephen J	2019 Apr 01	Clinical Cancer Research : An Official Journal Of The American Association For Cancer Research	Oncology	10.199

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
CA211457	Meltzer	Modeling Wnt signaling by CRISPR-Cas9 genome editing recapitulates neoplasia in human Barrett epithelial organoids.	Liu, Xi; Cheng, Yulan; Abraham, John M; Wang, Zhixiong; Wang, Zhe; Ke, Xiquan; Yan, Rong; Shin, Eun Ji; Ngamruengphong, Saowanee; Khashab, Mouen A; Zhang, Guanjun; McNamara, George; Ewald, Andrew J; Lin, DeChen; Liu, Zhengwen; Meltzer, Stephen J	2018 11 01	Cancer Letters	Oncology	6.491
CA211457	Meltzer	Multilayer microfluidic array for highly efficient sample loading and digital melt analysis of DNA methylation.	O'Keefe, Christine M; Giammanco, Daniel; Li, Sixuan; Pisanic, Thomas R; Wang, Tza-Huei Jeff	2019 01 29	Lab On A Chip	Miniaturization	5.995
CA211457	Meltzer	Synthetic Circular RNA Functions as a miR-21 Sponge to Suppress Gastric Carcinoma Cell Proliferation.	Liu, Xi; Abraham, John M; Cheng, Yulan; Wang, Zhixiong; Wang, Zhe; Zhang, Guanjun; Ashktorab, Hassan; Smoot, Duane T; Cole, Robert N; Boronina, Tatiana N; DeVine, Lauren R; Talbot Jr, C Conover; Liu, Zhengwen; Meltzer, Stephen J	2018 Dec 07	Molecular Therapy. Nucleic Acids	Nucleic Acid-Based Therapeutics	5.66
CA211457	Meltzer	Esophageal Adenocarcinoma-Derived Extracellular Vesicle MicroRNAs Induce a Neoplastic Phenotype in Gastric Organoids.	Ke, Xiquan; Yan, Rong; Sun, Zhenguo; Cheng, Yulan; Meltzer, Amy; Lu, Nonghua; Shu, Xu; Wang, Zhe; Huang, Binbin; Liu, Xi; Wang, Zhixiong; Song, Jee Hoon; Ng, Christopher K; Ibrahim, Sariat; Abraham, John M; Shin, Eun Ji; He, Shuixiang; Meltzer, Stephen J	2017 Nov	Neoplasia (New York, N.Y.)	Oncology	5.006
	Meltzer	Synthetic circular multi-miR sponge simultaneously inhibits miR-21 and miR-93 in esophageal carcinoma	Wang, Zhe; Ma, Ke; Cheng, Yulan; Abraham, John M.; Liu, Xi; Ke, Xiquan; Wang, Zhirong; Meltzer, Stephen J.	2019 Oct	Laboratory Investigation	Pathology	4.254

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
CA211457	Meltzer	Epigenetic alterations of a novel antioxidant gene SLC22A3 predispose susceptible individuals to increased risk of esophageal cancer.	Xiong, Ji-Xian; Wang, Yan-Song; Sheng, Jingyi; Xiang, Di; Huang, Tu-Xiong; Tan, Bin-Bin; Zeng, Cui-Mian; Li, Hua-Hui; Yang, Jiao; Meltzer, Stephen J; Mori, Yuriko; Qin, Yan-Ru; Guan, Xin-Yuan; Fu, Li	2018	International Journal Of Biological Sciences	Life Sciences	4.057
	Meltzer	Kruppel-like Factor 5 Promotes Sonic Hedgehog Signaling and Neoplasia in Barrett's Esophagues and Esophageal Adenocarcinoma	Ng, Christopher K.; Ma, Ke; Cheng, Yulan; Miyashita, Tomoharu; Harmon, John W.; Meltzer, Stephen J.	2019 Nov	Translational Oncology	Oncology	3.071
	Meltzer	Determination of absolute expression profiles using multiplexed miRNA analysis.	Song, Yunke; Kilburn, Duncan; Song, Jee Hoon; Cheng, Yulan; Saeui, Christopher T; Cheung, Douglas G; Croce, Carlo M; Yarema, Kevin J; Meltzer, Stephen J; Liu, Kelvin J; Wang, Tza-Huei		Plos One	Interdisciplinary	2.766
CA211457	Meltzer	A sample-to-answer droplet magnetofluidic assay platform for quantitative methylation-specific PCR.	Stark, Alejandro; Shin, Dong Jin; Wang, Tza-Huei	2018 03 28	Biomedical Microdevices	Engingeering	2.077
	Meltzer	Detection of Novel Fusion Transcript VTI1A-CFAP46 in Hepatocellular Carcinoma	Tsuge, Shunichi; Saberi, Behnam; Cheng, Yulan; Wang, Zhixiong; Kim, Amy; Luu, Harry; Abraham, John M.; Ybanez, Maria D.; Hamilton, James P.; Selaru, Florin M.; Villacorta-Martin, Carlos; Schlesinger, Felix; Philosophe, Benjamin; Cameron, Andrew M.; Zhu, Qingfeng; Anders, Robert; Gurakar, Ahmet; Meltzer, Stephen J.	2018	Gastrointestinal Tumors	Gastroenterology	

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
	Meltzer	Super-Enhancer-Driven Long Non-Coding RNA LINC01503, Regulated by TP63, Is Over-Expressed and Oncogenic in Squamous Cell Carcinoma	Xie, Jian-Jun; Jiang, Yan-Yi; Jiang, Yuan; Li, Chun-Quan; Lim, Mei-Chee; An, Omer; Mayakonda, Anand; Ding, Ling-Wen; Long, Lin; Sun, Chun; Lin, Le-Hang; Chen, Li; Wu, Jian-Yi; Wu, Zhi-Yong; Cao, Qi; Fang, Wang-Kai; Yang, Wei; Soukiasian, Harmik; Meltzer, Stephen J.; Yang, Henry; Fullwood, Melissa; Xu, Li-Yan; Li, En-Min; Lin, De-Chen; Koeffler, H. Phillip	2018	Gastroenterology	Gastroenterology	
	Meltzer	MiRNA-194 activates the Wnt/beta-catenin signaling pathway in gastric cancer by targeting the negative Wnt regulator, SUFU	Peng, Yin; Zhang, Xiaojing; Ma, Qiang; Yan, Ruibin; Qin, Ying; Zhao, Yanqiu; Cheng, Yulan; Yang, Mengting; Wang, Qixiang; Feng, Xianling; Huang, Yong; Huang, Weiling; Zhao, Zhenfu; Wang, Liang; Wei, Yanjie; He, Zhendan; Fan, Xinmin; Li, Song; Jin, Zhe; Meltzer, Stephen J.	2017	Cancer Letters	Oncology	
CA189965	Murphy	Immiscible phase filter extraction and equivalent amplification of genotypes 1-6 of hepatitis C RNA: The building blocks for point-of-care diagnosis.	Neto, Mário F; Butzler, Matthew A; Reed, Jennifer L; Rui, Xiang; Fisher, Mark J; Kelso, David M; McFall, Sally M	2017 10	Journal Of Virological Methods	Immunology, Mocrobiology	1.756

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
CA189910	Schmeler	Diagnosing Cervical Neoplasia in Rural Brazil Using a Mobile Van Equipped with In Vivo Microscopy: A Cluster-Randomized Community Trial.	Hunt, Brady; Fregnani, José Humberto Tavares Guerreiro; Schwarz, Richard A; Pantano, Naitielle; Tesoni, Suelen; Possati-Resende, Júlio César; Antoniazzi, Marcio; de Oliveira Fonseca, Bruno; de Macêdo Matsushita, Graziela; Scapulatempo-Neto, Cristovam; Kerr, Ligia; Castle, Philip E; Schmeler, Kathleen; Richards-Kortum, Rebecca	2018 06	Cancer Prevention Research (Philadelphia, Pa.)	Oncology	
CA189910	Schmeler	Low-cost photodynamic therapy devices for global health settings: Characterization of battery-powered LED performance and smartphone imaging in 3D tumor models.	Hempstead, Joshua; Jones, Dustin P; Ziouche, Abdelali; Cramer, Gwendolyn M; Rizvi, Imran; Arnason, Stephen; Hasan, Tayyaba; Celli, Jonathan P	2015 May 12	Scientific Reports	Natural Science	5.228
CA189910	Schmeler	In vivo evaluation of battery-operated light-emitting diode-based photodynamic therapy efficacy using tumor volume and biomarker expression as endpoints.	Mallidi, Srivalleesha; Mai, Zhiming; Rizvi, Imran; Hempstead, Joshua; Arnason, Stephen; Celli, Jonathan; Hasan, Tayyaba	2015 Apr	Journal Of Biomedical Optics	Biomedical Engineering	2.556
CA189910	Schmeler	Is Proflavine Exposure Associated with Disease Progression in Women with Cervical Dysplasia? A Brief Report.	Pantano, Naitielle; Hunt, Brady; Schwarz, Richard A; Parra, Sonia; Cherry, Katelin; Possati-Resende, Júlio César; Longatto-Filho, Adhemar; Fregnani, José Humberto Tavares Guerreiro; Castle, Philip E; Schmeler, Kathleen; Richards-Kortum, Rebecca	2018 11	Photochemistry And Photobiology	Photochemistry, Photobiology	2.214

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
CA202637	Weissleder	Digital diffraction analysis enables low-cost molecular diagnostics on a smartphone.	Im, Hyungsoon; Castro, Cesar M; Shao, Huilin; Liong, Monty; Song, Jun; Pathania, Divya; Fexon, Lioubov; Min, Changwook; Avila-Wallace, Maria; Zurkiya, Omar; Rho, Junsung; Magaoay, Brady; Tambouret, Rosemary H; Pivovarov, Misha; Weissleder, Ralph; Lee, Hakho	2015 May 05	Proceedings Of The National Academy Of Sciences Of The United States Of America	Interdisciplinary	
CA202637	Weissleder	Nanostar Clustering Improves the Sensitivity of Plasmonic Assays.	Park, Yong Il; Im, Hyungsoon; Weissleder, Ralph; Lee, Hakho	2015 Aug 19	Bioconjugate Chemistry	Chemistry, Molecular Biology	
CA202637	Weissleder	Design and clinical validation of a point-of-care device for the diagnosis of lymphoma via contrast-enhanced microholography and machine learning.	Im, Hyungsoon; Pathania, Divya; McFarland, Philip J; Sohani, Aliyah R; Degani, Ismail; Allen, Matthew; Coble, Benjamin; Kilcoyne, Aoife; Hong, Seonki; Rohrer, Lucas; Abramson, Jeremy S; Dryden-Peterson, Scott; Fexon, Lioubov; Pivovarov, Misha; Chabner, Bruce; Lee, Hakho; Castro, Cesar M; Weissleder, Ralph	2018 Sep	Nature Biomedical Engineering	Biomedical Engineering	
CA202637	Weissleder	Glass Chemistry to Analyze Human Cells under Adverse Conditions.	Marquard, Angela N; Carlson, Jonathan C T; Weissleder, Ralph	2019 Jul 31	ACS Omega	Chemistry	
CA202637	Weissleder	Computational Optics Enables Breast Cancer Profiling in Point-of-Care Settings.	Min, Jouha; Im, Hyungsoon; Allen, Matthew; McFarland, Phillip J; Degani, Ismail; Yu, Hojeong; Normandin, Erica; Pathania, Divya; Patel, Jaymin M; Castro, Cesar M; Weissleder, Ralph; Lee, Hakho	2018 09 25	ACS Nano	Nanoscience, Nanotechnology	13.709

Base Project ID	PI	Pub Title	Author List	Pub Date	Journal Name	Journal Area	Impact Factor
CA202637	Weissleder	Holographic Assessment of Lymphoma Tissue (HALT) for Global Oncology Field Applications.	Pathania, Divya; Im, Hyungsoon; Kilcoyne, Aoife; Sohani, Aliyah R; Fexon, Lioubov; Pivovarov, Misha; Abramson, Jeremy S; Randall, Thomas C; Chabner, Bruce A; Weissleder, Ralph; Lee, Hakho; Castro, Cesar M	2016	Theranostics	Personalized Medicine	8.712
CA202637	Weissleder	Digital diffraction detection of protein markers for avian influenza.	Im, Hyungsoon; Park, Yong Il; Pathania, Divya; Castro, Cesar M; Weissleder, Ralph; Lee, Hakho	2016 Apr 21	Lab On A Chip	Miniaturization	6.045
CA202637	Weissleder	Sparsity-Based Pixel Super Resolution for Lens-Free Digital In-line Holography.	Song, Jun; Leon Swisher, Christine; Im, Hyungsoon; Jeong, Sangmoo; Pathania, Divya; Iwamoto, Yoshiko; Pivovarov, Misha; Weissleder, Ralph; Lee, Hakho	2016 Apr 21	Scientific Reports	Natural Science	4.259
CA202637	Weissleder	Deep transfer learning-based hologram classification for molecular diagnostics.	Kim, Sung-Jin; Wang, Chuangqi; Zhao, Bing; Im, Hyungsoon; Min, Jouha; Choi, Hee June; Tadros, Joseph; Choi, Nu Ri; Castro, Cesar M; Weissleder, Ralph; Lee, Hakho; Lee, Kwonmoo	2018 11 19	Scientific Reports	Natural Science	4.122
CA202637	Weissleder	Advances in clinical MRI technology	Harisinghani, Mukesh G.; O'shea, Aileen; Weissleder, Ralph		Science Translational Medicine	Translational Medicine	

Appendix A.2 First and Last Author by Role, Affiliation, Early or New Investigator Status by PMID and Base Project Number

First author	First author Country	First author Role	First Author ESI/NI	Last Author	Last Author Country	Last Author Role	Last Author ESI/NI	PMID
Abraham, John M	United States	co-Investigator	NI	Meltzer, Stephen J	United States	PI		28528706
Cesarman, Ethel	United States	co-Investigator		Whitby, Denise	United States	Not Listed		30705286
Chen, Hao	United States, China	Not Listed		Dong, Yajie	United States	Not Listed		28867926
Court, Laurence E	United States	PI		Beadle, Beth	United States	PI		29708544
Cremer, Miriam	United States	PI		Winkler, Jennifer L	United States	Not Listed		28351879
Deng, Lu	Canada	Not Listed		Chang, David	United States, Canada	Not Listed		31151939
Ewaisha, Radwa	United States	Graduate Student		Anderson, Karen S	United States	PI		29109779
Fang, Raymond	United States	Not Listed		Court, Laurence	United States	PI		30843335
Gannon, Caleb	United States	Not Listed		Liang, Rongguang	United States	PI		28437904
Harisinghani, Mukesh G.	United States	Not Listed		Weissleder, Ralph	United States	PI		31852796
Hempstead, Joshua	United States	Graduate Student		Celli, Jonathan P	United States	PI	ESI, NI	25965295
Hunt, Brady	United States	Graduate Student		Richards-Kortum, Rebecca	United States	PI		29618459
Im, Hyungsoon	United States	co-Investigator	ESI, NI	Lee, Hakho	United States	co-Investigator		25870273
Im, Hyungsoon	United States	co-Investigator	ESI, NI	Lee, Hakho	United States	co-Investigator		30555750
Im, Hyungsoon	United States	co-Investigator	ESI, NI	Weissleder, Ralph	United States	PI		26980325
Joh, Daniel Y	United States	Not Listed	NI	Chilkoti, Ashutosh	United States	PI		28784765
Joh, Daniel Y	United States	Not Listed	NI	Chilkoti, Ashutosh	United States	PI		30908902
Ke, Xiquan	China	Not Listed		Meltzer, Stephen J	United States	PI		28968550
Kim, Sung-Jin	United States	Not Listed		Lee, Kwonmoo	United States	Not Listed		30451953
Kisling, Kelly	United States	Graduate Student		Court, Laurence	United States	PI		31002389

First author	First author Country	First author Role	First Author ESI/NI	Last Author	Last Author Country	Last Author Role	Last Author ESI/NI	PMID
Kisling, Kelly	United States	Graduate Student		Court, Laurence	United States	PI		31077593
Kisling, Kelly	United States	Graduate Student		Court, Laurence	United States	PI		30629457
Kuhn, Louise	United States	PI		Denny, Lynette	South Africa	co-Investigator	NI	28279263
Kuhn, Louise	United States	PI						29564148
Liu, Hui	China	Post-Doc	ESI, NI	Celli, Jonathan P	United States	PI	ESI, NI	30168618
Liu, Xi	China	Not Listed		Meltzer, Stephen J	United States	PI		30326427
Liu, Xi	China	Not Listed		Meltzer, Stephen J	United States	PI		30144514
Liu, Xi	China	Not Listed		Meltzer, Stephen J	United States	PI		28462377
Love, Susan M	United States	PI	NI	Mammone, Richard	United States	Consultant	N/A	30156946
Mallidi, Srivalleesha	United States	Staff Scientist (not Key Personnel)	ESI, NI	Hasan, Tayyaba	United States	PI		25909707
Marquard, Angela N	United States	Not Listed		Weissleder, Ralph	United States	PI		25909707
McCarroll, Rachel	United States	Not Listed		Court, Laurence	United States	PI		29094096
McCarroll, Rachel E	United States	Not Listed		Yang, Jinzhong	United States	co-Investigator	ESI, NI	30110221
Min, Jouha	United States	Not Listed		Lee, Hakho	United States	co-Investigator		30113824
Neto, Mário F	United States	Not Listed		McFall, Sally M	United States	co-Investigator		28673855
Ng, Christopher K.	United States	Not Listed		Meltzer, Stephen J.	United States	PI		31401336
Obahiagbon, Uwadiae	United States	Graduate Student		Blain Christen, Jennifer M	United States	co-Investigator	NI	29894852
Oeschger, Taylor	United States	Not Listed		Erickson, David	United States	PI		30724931
O'Keefe, Christine M	United States	Not Listed		Wang, Tza-Huei Jeff	United States	co-Investigator	NI	30623957
Pantano, Naitielle	Brazil	Nurse Coordinator (not Key personnel)		Richards-Kortum, Rebecca	United States	PI		29981148
Park, Yong Il	South Korea	Not Listed		Lee, Hakho	United States	co-Investigator		26102604

First author	First author Country	First author Role	First Author ESI/NI	Last Author	Last Author Country	Last Author Role	Last Author ESI/NI	PMID
Pathania, Divya	United States	Post-Doc		Castro, Cesar M	United States	co-Investigator		27446494
Peng, Yin		Not Listed		Meltzer, Stephen J.	United States	PI		27810403
Qin, Yuling	United States	Not Listed		Chiu, Daniel T	United States	PI		30003660
Rhee, Dong Joo	United States	Not Listed		Court, Laurence E	United States	PI		31505046
Snodgrass, Ryan	United States	Graduate Student		Erickson, David	United States	PI		26799834
Snodgrass, Ryan	United States	Graduate Student		Erickson, David	United States	PI		30906647
Song, Bofan	United States	Post-Doc		Liang, Rongguang	United States	PI		30460130
Song, Jun	United States, China	Not Listed		Lee, Hakho	United States	co-Investigator		27098438
Song, Yunke		Not Listed		Wang, Tza-Huei	United States	co-Investigator	NI	28704432
Stark, Alejandro	United States	Not Listed		Wang, Tza-Huei	United States	co-Investigator	NI	29594810
Taxa, Luis	Peru	Not Listed		Felix, Juan C	United States	PI		29271853
Tsuge, Shunichi		Not Listed		Meltzer, Stephen J.	United States	PI		31602373
Uthoff, Ross D	United States	Graduate Student		Liang, Rongguang	United States	PI		30517120
Van Schelt, Jonathon		Not Listed		Ford, Eric C.	United States	PI		29777595
Wang, Zhe	United States	Not Listed		Meltzer, Stephen J	United States	PI		31217510
Wang, Zhe	United States	Not Listed		Meltzer, Stephen J.	United States	PI		30576282
Wang, Zhixiong	United States	Not Listed		Meltzer, Stephen J	United States	PI		28640357
Wang, Zhixiong	United States	Not Listed		Meltzer, Stephen J	United States	PI		30670490
Xie, Jian-Jun		Not Listed		Koeffler, H. Phillip	United States	Not Listed		29454790
Xiong, Ji-Xian	China	Not Listed		Fu, Li	China	Not Listed		30416380

Appendix A.3 List of Key Personnel and Students by Base Project Number, Affiliation and ESI/NI Status

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
CA189883	Basic Health International	Maza, Mauricio A	US	Co-Investigator			x
	Cleveland Clinic	Cremer, Miriam	US	PD/PI	No	No	
	Cryopen, Inc.	Haas, Michael J	US	Co-Investigator	No	Yes	
	Harvard School Of Public Health	Campos, Nicole Gastineau	US	Co-Investigator	Yes	Yes	
		Kim, Jane J	US	Co-Investigator	No	No	
	Instituto Nacional De Cancerologia	Gonzalez, Mauricio	LMIC	Co-Investigator			x
	Keck School Of Medicine (University Of Southern California)	Alonzo, Todd A	US	Co-Investigator	No	No	
	Malibuiq	Simmons, Harold L	US	Other (Specify)-Collaborator			x
	National Institute Of Neoplastic Diseases	Alvarez, Manuel Jesus	US	Co-Investigator			x
	Path	Jeronimo, Jose Antonio	US	Other (Specify)-Collaborator	No	Yes	
	University Of Southern California	Felix, Juan C	US	Co-Investigator	No	Yes	
CA189901	Aligarh Muslim University	Hasan, Syed Abrar	LMIC	Other (Specify)-Subcontract PI			x
		Hashmi, Shahab Farkhund	LMIC	Co-Investigator			x
		Siddiqi, Shahid Ali	LMIC	Other (Specify via text entry) Investigator			x
	Harvard School Of Public Health	Alkhateeb, Ahmed	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position			x
	Massachusetts General Hospital	Bano, Shazia	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position			x

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
		Khan, Amjad Pervez	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position/Staff scientist (Doctoral level)			x
	National Medical Laser Centre	Bown, Stephen G	HIC	Consultant			x
		Hopper, Colin	HIC	Consultant			x
	The General Hospital Corporation	Bouma, Brett E	US	Co-Investigator	No	No	
		Hasan, Tayyaba	US	PD/PI	No	No	
		Rizvi, Imran	US	Other (Specify)-Investigator/Coordinator	Yes	Yes	
	University Of Massachusetts Boston	Celli, Jonathan P	US	MPI	Yes	Yes	
		Cuckov, Filip	US	Co-Investigator	No	Yes	
		Hempstead, Josh	US	Graduate Student (research assistant)			x
		Kennedy Sheldon, Lisa	US	Co-Investigator	Yes	Yes	x
		Liu, Hui	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position	Yes (2023)	Yes	
		Petrovic, Ljubica	US	Graduate Student (research assistant)			x
		Sheldon, Lisa Kennedy	US	Co-Investigator			x
	University Of Rhode Island	Anderson, Michael David	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position	Yes	Yes	
CA189908	Cepheid	Persing, David	US	Other (Specify)-Other Significant Contributor	No	Yes	
	Columbia University Health Sciences	Tsai, Wei-Yann	US	Co-Investigator	No	No	
		Kuhn, Louise	US	PD/PI	No	No	

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
	The Trustees Of Columbia University In The City Of New York	Tergas, Ana Isabel	US	Co-Investigator	Yes	Yes	
		Wright, Thomas	US	Other (Specify)-Other Significant Contributor	No	No	
	University Of Cape Town	Denny, Lynette	LMIC	Co-Investigator	No	Yes	
		Moodley, Jennifer	LMIC	Co-Investigator			x
		Saidu, Rakiya	LMIC	Co-Investigator			x
CA189910	Becton Dickinson	Gadde, Renuka	US	Other (Specify)-Other Significant Contributor			x
		Malinowski, Douglas	US	Other (Specify)-Other Significant Contributor			x
	Rice University	Hunt, Brady	US	Graduate Student (research assistant)			x
		Majors, Catherine Elizabeth	US	Graduate Student (research assistant)			x
		Quang, Timothy	US	Graduate Student (research assistant)			x
	The University Of Texas Md Anderson Cancer Center	Schmeler, Kathleen	US	MPI	No	No	
CA189910/CA189883/EB024965	Global Coalition Against Cervical Cancer/Preventative Oncology International	Castle, Philip E	US	Co-Investigator	No	No	
CA189923	Cancer Institute Foundation, Inc. For Moving As One	Ladines-Llave, Cecilia	US	Other (Specify via text entry)Site Investigator			x
	Jhpiego	Lu, Enriquito	US	Other (Specify)-Global healthcare delivery expert			x
		Varady, Marton	US	Other (Specify)-Engineering and tech development expert			x
	Johns Hopkins University	Anderson, Jean	US	PD/PI	No	Yes	

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
		Peterson, Kristy	US	Other (Specify)-Business development expert			x
CA189965	Jos University Teaching Hospital	Agbaji, Oche	LMIC	Co-Investigator	No	Yes	
		Akanbi, Maxwell	LMIC	Other (Specify)-Subcontract PI	Yes	Yes	
		Okeke, Edith	LMIC	Co-Investigator			x
	Mayo Clinic Rochester	Roberts, Lewis R	US	Other (Specify)-Subcontract PI	No	No	
	Northwestern University	Cheng, Monica	US	Undergraduate Student			x
		Elghanian, Robert	US	Co-Investigator			x
		Faustinoneto, Mariojoao	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position			x
		Hawkins, Claudia A	US	Co-Investigator	No	Yes	
		Kelman, Julie Rose	US	Undergraduate Student			x
		Mcfall, Sally Maureen	US	Co-Investigator	No	No	
		Murphy, Robert L	US	PD/PI	No	No	
		Palamountain, Kara	US	Co-Investigator	N/A	N/A	
CA189966	Clear View Diagnostics Inc	Mammone, Richard	US	Consultant	N/A	N/A	
		Podilchuk, Christine	US	Co-Investigator	No	Yes	
	Dr.Susan Love Research Foundation	Love, Susan M	US	PD/PI	No	Yes	
	University Of Pittsburgh - School Of Medicine	Berg, Wendie A	US	Co-Investigator	No	Yes	
CA202637	Biosky	Petropoulos, Evangelos	US	Other (Specify)-Other Significant Contributor			x
	Botswana Harvard Aids Institute	Makhema, Joseph	LMIC	Other (Specify)-Other Significant Contributor	No	Yes	

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
		Mmalane, Mompati Oganne	LMIC	Other (Specify via text entry) Sub PI			x
		Moyo, Sikhulile	LMIC	Co-Investigator			x
	Brigham And Women's Hospital	Dryden-Peterson, Scott	US	Other (Specify)-Subcontract PI	No	No	
	Dana Farber Cancer Institute	Canellos, George	US	Other (Specify)-Other Significant Contributor	No	No	
	Harvard School Of Public Health	Essex, Myron E	US	Other (Specify)-Other Significant Contributor	No	No	
	Harvard University	Westervelt, Robert M	US	Other (Specify)-Other Significant Contributor	No	No	
	Massachusetts General Hospital	Abramson, Jeremy Slade	US	Co-Investigator	N/A	N/A	
		Bigger, Elizabeth	US	Co-Investigator			x
		Castro, Cesar M	US	Co-Investigator	No	No	
		Castro, Daniel	US	Other (Specify)-Other Significant Contributor	Yes	Yes	
		Chabner, Bruce Allan	US	MPI	No	No	
		Im, Hyungsoon	US	Co-Investigator	Yes	Yes	
		Lee, Hakho	US	Co-Investigator	No	No	
		Pathania, Divya	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position			x
		Pivovarov, Misha	US	Co-Investigator			x
		Randall, Thomas C	US	Other (Specify)-Other Significant Contributor	No	Yes	
		Roberts, Drucilla Jane	US	Other (Specify)-Other Significant Contributor	No	No	
		Skates, Steven J	US	Other (Specify)-Other Significant Contributor	No	No	
		Sohani, Aliyah	US	Co-Investigator			x

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
		Walker, Bruce D	US	Other (Specify)-Other Significant Contributor	No	No	
		Weissleder, Ralph	US	PD/PI	No	No	
		Yang, Katherine	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position			
	Massachusetts Institute Of Technology	Cima, Michael J	US	Other (Specify)-Other Significant Contributor	No	No	
		Langer, Robert Samuel	US	Other (Specify)-Other Significant Contributor	No	No	
CA202663	Barretos Cancer Hospital	Longatto-Filho, Adhemer	LMIC	Co-Investigator			x
	Becton, Dickinson And Company	Dixon, Eric	US	Co-Investigator	N/A	N/A	
		Sebba, David	US	Co-Investigator	No	Yes	
		Vinson, Andrea	US	PD/PI	No	Yes	
		Weidemaier, Kristin	US	PD/PI	No	Yes	
	Chinese Academy Of Medical Sci And Peking Union Med College	Qiao, You-Lin	LMIC	Co-Investigator	No	Yes	
		Zhao, Fan-Hui	LMIC	Co-Investigator			x
	Kenya Medical Research Institute	Mugo, Nelly	LMIC	Co-Investigator	No	Yes	
	University Of North Carolina Chapel Hill	Elston Lafata, Jennifer	US	Co-Investigator	No	No	
		Rohweder, Catherine	US	Co-Investigator			x
		Wheeler, Stephanie	US	Co-Investigator	No	No	
		Smith, Jennifer Susan	US	MPI	No	No	
		Fokar, Ali	US	Co-Investigator			x
		Hudgens, Mark (Mike?)	US	Co-Investigator	No	No	x
	University Of Nairobi	Kosgei, Rose	LMIC	Co-Investigator	No	Yes	
	University Of New Mexico School Of Medicine	Clark, Douglas	US	Co-Investigator	No	No	
	University Of Virginia	Stoler, Mark	US	Co-Investigator	No	No	

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
	University Of Washington	Mcclelland, Scott (Raymond Scott)	US	Co-Investigator	No	No	x
CA202663/ CA189910	Barretos Cancer Hospital	Fregnani, Jose Humberto	LMIC	Co-Investigator			x
CA202665	LSU Health Sciences Center	Wang, Jeffrey	US	Co-Investigator	Yes	Yes	
	Rice University	Peterson, Christine B	US	Co-Investigator			x
	Stellenbosch University	Sewram, Vikash	LMIC	Co-Investigator	Yes	Yes	
	University Of Santo Tomas	Mejia, Michael A	LMIC	Co-Investigator			x
	University Of Tx Md Anderson Can Ctr	Balter, Peter	US	Co-Investigator			x
		Beadle, Beth M	US	MPI	No	No	
		Court, Laurence E	US	PD/PI	No	Yes	
		Kisling, Kelly D	US	Graduate Student (research assistant)			x
		Yang, Jinzhong	US	Co-Investigator	Yes	Yes	
CA202721	African Centre Of Excellence For Women's Cancer Control	Phiri, Guy	LMIC	Co-Investigator			x
	International Agency For Res On Cancer	Sankaranarayanan, Rengaswamy	HIC	PD/PI	No	Yes	
	International Agency For Research On Cancer	Basu, Partha	HIC	Co-Investigator/PD/PI	Yes	Yes	
	Intl Federation For Cervical Pathology And Colposcopy	Prendiville, Walter	US	Co-Investigator			x
	Liger Medical Llc.	Wallace, Dean	US	Co-Investigator			x
	University Of North Carolina At Chapel Hill	Chibewsha, Carla	US	Co-Investigator			x
		Parham, Groesbeck Preer	US	Co-Investigator	N/A	N/A	
CA202723	AAs, Inc.	Jiang, Li	US	Co-Investigator	N/A	N/A	
	Cornell University	Erickson, David Carl	US	PD/PI	No	No	
		Kopparthy, Varunlingaiah	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position			x

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
		Snodgrass, Ryan	US	Graduate Student (research assistant)			x
	Infectious Diseases Institute	Semeere, Aggrey	US	Co-Investigator	N/A	N/A	
	Makerere University/Infectious Diseases Institute	Lukande, Robert	LMIC	Co-Investigator	N/A	N/A	
	University Of California, San Francisco	Boyle, Colin	US	Co-Investigator			x
		Martin, Jeffrey N	US	MPI	No	No	
		Maurer, Toby Annette	US	Co-Investigator			x
	Weill Medical Coll Of Cornell Univ	Cesarman, Ethel	US	Co-Investigator	No	No	
		Mccloskey, Duncan	US	Graduate Student (research assistant)			x
CA202730	Arbor Vita Corporation	Belmares, Michael P	US	Co-Investigator	No	Yes	
		Schweizer, Johannes	US	Co-Investigator	No	No	
	Autonomous National University	Ferrera, Annabelle	LMIC	Co-Investigator			x
	Costa Rican Department Of Social Security	Saenz Delgado, Luis Bernardo	LMIC	Co-Investigator			x
	Honorary Commission Of Fighting Against Cancer	Rodriguez Perez, Guillermo Jose	LMIC	Co-Investigator			x
	Hospital Of Clinicas Jose De San Martin	Tatti, Silvio	LMIC	Co-Investigator			x
	International Agency For Research On Cancer (IARC)	Herrero, Rolando	HIC	PD/PI	No	Yes	
		Almonte, Maribel	HIC	Co-Investigator	No	Yes	
		Murillo, Raul	HIC	Co-Investigator			x
	Mayor, Real And Pontificial Univ.Of S. F. Xavier Chuquisaca	Teran, Carolina	LMIC	Co-Investigator			x
	National Cancer Institute	Wiesner Ceballos, Carolina	US	Co-Investigator			x

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
	National Institute Of Infectious Diseases	Picconi, Maria Alejandra	US	Co-Investigator			x
	National Institute Of Public Health	Cruz, Aurelio	US	Co-Investigator			x
	National University Of Paraguay	Kasamatsu, Elena Satiko	LMIC	Co-Investigator			x
	Peruvian League Against Cancer	Venegas Rodriguez, Gino Giovanny	LMIC	Co-Investigator			x
	University Of Antioquia	Sanchez, Gloria Ines	LMIC	Co-Investigator			x
CA211139	Fred Hutchinson Cancer Research Center	Paguirigan, Amy	US	Other Professional-Staff Scientist	No	No	
		Radich, Jerald Patrick	US	Co-Investigator	No	No	
	University Of Washington	Chiu, Daniel T	US	PD/PI	No	No	
		Fujimoto, Bryant Shigeo	US	Other Professional-Staff Scientist			x
		Schiro, Perry G	US	Other (Specify)-CTO at Micareo			x
CA211232	Duke University	Chao, Nelson J	US	MPI	No	No	
		Chilkoti, Ashutosh	US	PD/PI	No	No	
		Heggestad, Jacob	US	Graduate Student (research assistant)			x
		Hyslop, Terry	US	Other Professional-Co Investigator	No	No	
		Yang, Yiping	US	Other Professional-Co Investigator	No	No	
	Immucor, Inc.	Spadoro, Joanne	US	Other Professional-Subcontractor PI			x
	Zhejian Provincial People'S Hospital	Defei, Hong	LMIC	Other Professional-Subcontractor PI			x
CA211310	Johns Hopkins University	Ford, Eric C	US	PD/PI	No	No	

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
	Ohio State University	Mayr, Nina A	US	Co-Investigator	No	No	
	Panacea Medical Technologies Pvt Ltd	Goteti, Subrahmanyam Venkata	LMIC	Co-Investigator			x
	Paterson Cancer Center	Srinivasan, Vijayaraghavan	US	Co-Investigator			x
	Psg Hospital	Kambainallur, Govindarajan	LMIC	Consultant			x
	Radiating Hope	Shulman, Adam	US	Consultant			x
	The Regents Of The Univ. Of Calif., U.C. San Diego	Brown, Derek	US	Co-Investigator	N/A	N/A	
	University Of Washington	Patel, Shilpen Ajit	US	Co-Investigator			x
		Sponseller, Patricia	US	Other (Specify)-Medical Dosimetrist			x
		Toomeh, Dolla	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position			x
CA211415	All India Institute Of Medical Sciences	Bhatla, Neerja	LMIC	Co-Investigator			x
		Dar, Lalit	LMIC	Co-Investigator			x
		Mathur, Sandeep R.	LMIC	Co-Investigator			x
	Arizona State University-Tempe Campus	Anderson, Karen S	US	PD/PI	No	No	
		Ewaisha, Radwa	US	Graduate Student (research assistant)			x
	Az Board Of Regents On Behalf Of Arizona State University	Blain Christen, Jennifer Mary	US	Co-Investigator	No	Yes	x
	University Of Arizona	Hou, Chingwen	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position	Yes (2017)	Yes	
	University Of California, San Francisco	Unger, Elizabeth K	US	Consultant	Yes	Yes	
	University Of Michigan At Ann Arbor	Brenner, Dean E	US	MPI	No	No	
		Ruffin, Mack T	US	Co-Investigator	No	No	
		Sen, Ananda	US	Co-Investigator	No	Yes	

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
		Obahiagbon, Uwadiae	US	Graduate Student (research assistant)			x
CA211457	Capnostics, Inc.	Von Dyck, Martin	US	Other (Specify)-President & CEO	No	Yes	
	Johns Hopkins University	Abraham, John Martin	US	Co-Investigator	No	Yes	
		Bollinger, Robert C	US	Co-Investigator	No	No	
		Liu, Kelvin	US	Other (Specify)-CEO	No	No	
		Meltzer, Stephen J	US	PD/PI	No	No	
		Shin, Dongjin	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position			x
		Starkquiroz, Alejandro	US	Graduate Student (research assistant)			x
		Wang, Tzahuei	US	MPI	No	No	
CA211551	B & W Tek, Inc.	Wang, Sean Xiaolu	US	Co-Investigator	No	Yes	
	Brigham Young University	Badamjav, Odgerel	US	Consultant			x
	International Medical Center	Enkh-Amgalan, Tsiiregsen	US	Co-Investigator			x
	Medmira Laboratories, Inc.	Vats, Neeraj	HIC	Co-Investigator			x
	Univ Of North Carolina Chapel Hill	Soto, Robert Joseph	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position	Yes	Yes	
	University Of Utah	Granger, Jennifer Harnisch	US	Co-Investigator	No	Yes	
		Porter, Marc D	US	PD/PI	No	No	
		Price, Raymond R	US	Co-Investigator			x
		Scaife, Courtney L	US	MPI	No	No	
		Shea, Jill Ellen	US	Co-Investigator	No	Yes	
		Skuratovsky, Aleksander	US	Graduate Student (research assistant)			x
CA239682	Carestream Health Inc	Wong, Victor	US	Co-Investigator			x

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
	K.L.E Society's Institute Of Dental Sciences	Praveen, Birur	LMIC	Co-Investigator			x
	Mazumdar-Shaw Cancer Center	Kekatpure, Vikram D	LMIC	Co-Investigator			x
		Sunny, Sumsum P	LMIC	Co-Investigator			x
	Roswell Park Cancer Institute Corp	Kuriakose, Moni	US	Co-Investigator	N/A	N/A	
		Platek, Mary Elizabeth	US	Co-Investigator	Yes	No	
	University Of Arizona	Liang, Rongguang	US	PD/PI	No	No	
		Rodriguez, Jeffrey J	US	Co-Investigator	No	Yes	
		Song, Bofan	US	Postdoctoral Scholar, Fellow, or Other Postdoctoral Position			x
		Uthoff, Ross David	US	Graduate Student (research assistant)			x
	University Of California-Irvine	Osann, Kathryn	US	Other Professional-Statistician			x
		Wildersmith, Petra E	US	Co-Investigator			x
EB024965	Albert Einstein College Of Medicine	Adedimeji, Adebola	US	Co-Investigator	No	Yes	
	The University Of Alberta	Chen, Jie	HIC	Co-Investigator	No	Yes	
		Fedorak, Richard N	HIC	MPI	No	No	
		Nguyen, Thanh	HIC	Co-Investigator			x
		Wishart, David	HIC	Co-Investigator	No	Yes	
	Md Anderson Cancer Center	Levin, Bernard	US	Other (Specify)-Advisory Committee	No	No	
	Obafemi Awolowo Univ Tech Hospital Complex	Alatise, Olusegun Isaac	LMIC	MPI	No	No	
	Obafemi Awolowo University	Durosimi, Muheez	LMIC	Other (Specify)-Advisory Committee			x

Base Project Number	Affiliation	Name	Country	Role	ESI (at time of award)	NI	Not In QVR
	Rice University	Richards-Kortum, Rebecca Rae	US	Other (Specify)-Advisory Committee	No	No	
	Sloan-Kettering Inst Can Research	Gonen, Mithat	US	Co-Investigator	No	Yes	
		Kingham, T Peter	US	PD/PI	No	No	
		Vakiani, Efsevia	US	Co-Investigator	No	Yes	
		Zauber, Ann Graham	US	Other (Specify)-Other Significant Contributor	No	No	

Appendix A.4 New Awards or Pending Awards to ACTs Program PIs Following the Start of the ACTs Program Grant

Base Grant Number	PIs	Grant Cohort	Number of PIs other than ACTs Program PIs	Number of new awards or pending awards since the start of the ACTs Program Grants	Activity of awards	Title of Awards	PIs
CA189883	Miriam Cremer	2014	2	2	U54	Comparison of cervical intraepithelial neoplasia 2/3 treatment outcomes with a portable LMIC-adapted thermal ablation device vs. gas-based cryotherapy	Cremer, Miriam
					R01	HEALTH Study: HPV Elimination and Prevention in El Salvador and Haiti Targeting HIV Positive Women	Alfaro, Karla; Cremer, Miriam (Contact); Masch, Rachel
CA189901	Tayyaba Hasan, Jonathan Celli	2014	2	9	R00	Mechanism-based therapies for pancreatic cancer informed by stromal microrheology	Celli, Jonathan P
					P01	Molecular Response and Imaging-based Combination Strategies for Optimal PDT	Hasan, Tayyaba (Contact); Pogue, Brian W.
					R21	Optical imaging guided resection and photodynamic therapy of glioma with targeted photoactivable agents	Hasan, Tayyaba
					R01	Dual function theranostic constructs for photoacoustic guided surgery and photodynamic therapy	Hasan, Tayyaba
					R13	17th Biennial International Photodynamic Association World Congress	Hasan, Tayyaba
					R21	Rapid treatment guidance for antibiotic-resistant disease at the point of care	Hasan, Tayyaba (Contact); Palanisami, Akilan

Base Grant Number	PIs	Grant Cohort	Number of PIs other than ACTs Program PIs	Number of new awards or pending awards since the start of the ACTs Program Grants	Activity of awards	Title of Awards	PIs
CA189908	Louise Kuhn	2014	0	4	R01	Oral microbial signatures in perinatal HIV infection	Kuhn, Louise
					R01	Treatment Options for Protease Inhibitor Exposed Children	Kuhn, Louise
					R01	Host epigenetic and mitochondrial function in HIV-infected children	Kuhn, Louise
					U01	Early neonatal treatment and immune quiescence	Kuhn, Louise
CA189910	Kathleen Schmeler, Rebecca Richards-Kortum	2014	10	11	R01	High Resolution Microendoscopy for the Management of Esophageal Neoplasia	Anandasabapathy, Sharmila (Contact); Richards-Kortum, Rebecca Rae
					R01	Automated, Augmented Reality High Resolution Microendoscopy for the Management of Esophageal Neoplasia	Anandasabapathy, Sharmila (Contact); Richards-Kortum, Rebecca Rae
					R01	(PQC2) Optical Hallmarks of Aggressive Clones Within Oral Field Cancerization	Gillenwater, Ann M; Richards-Kortum, Rebecca Rae (Contact); Schwarz, Richard Alan
					R01	High resolution imaging & HPV oncoprotein detection for global prevention of cervical cancer	Richards-Kortum, Rebecca Rae
					T32	Interdisciplinary Translational Pre/Postdoctoral Program in Cancer Nanotechnology	Krishnan, Sunil; Richards-Kortum, Rebecca Rae; Sokolov, Konstantin V (Contact)
					R01	Multimodal Optical Imaging to Improve Real-Time Margin Assessment During Oral Cancer Surgery	Gillenwater, Ann M (Contact); Richards-Kortum, Rebecca R.; Schwarz, Richard Alan; Williams, Michelle

Base Grant Number	PIs	Grant Cohort	Number of PIs other than ACTs Program PIs	Number of new awards or pending awards since the start of the ACTs Program Grants	Activity of awards	Title of Awards	PIs
					R21	A Low-Cost Tethered Capsule Endoscope for Esophageal Cancer Screening	Richards-Kortum, Rebecca Rae
					P20	UEM Regional Center of Research Excellence Mozambique	Moon, D. Troy (Contact); Schmeler, Kathleen; Sidat, Mohsin
					P50	SPORE for Immunologic Approaches to HPV-Related Cancers	Schmeler, Kathleen; Sturgis, Erich M (Contact)
					R01	A Randomized Clinical Trial to Assess the Effectiveness of Ablative Treatments for Cervical-Cancer Risk Reduction in HIV+ Women living in Mozambique	Castle, Philip E (Contact); Schmeler, Kathleen
					R01	Low-cost mobile colposcopy and confocal imaging for global prevention of cervical cancer	Richards-Kortum, Rebecca R. (Contact); Schmeler, Kathleen
CA189923	Jean Anderson	2014	0	1	P50	Electroporation delivery of pNGVL4aCRTE6E7L2 DNA for treatment of HPV16+ CIN2/3 patients	Anderson, Jean
CA189965	Robert L. Murphy	2014	7	8	D43	Northwestern and Jos University Research Training Program in HIV and Malignancies	Murphy, Robert L. (Contact); Von Roenn, Jamie H
					D43	HIV and Mycobacterial Disease in Mali	Diallo, Souleymane; Murphy, Robert L (Contact)
					U54	Career Enhancement Core	Murphy, Robert L
					U54	Epigenomic Biomarkers of HIV-Associated Cancers in Nigeria	Hou, Lifang (Contact); Murphy, Robert L; Ogunsola, Folasade

Base Grant Number	PIs	Grant Cohort	Number of PIs other than ACTs Program PIs	Number of new awards or pending awards since the start of the ACTs Program Grants	Activity of awards	Title of Awards	PIs
							Tolulope; Sagay, Atiene Solomon
					U54	Admin-Core	Murphy, Robert L
					U54	The Center for Innovation in Point-of-Care Technologies for HIV/AIDS at Northwestern University (C-THAN)	Mcfall, Sally Maureen; Murphy, Robert L (Contact)
					D43	Northwestern/Nigeria Research Training Program in HIV and Malignancies (NN-HAM)	Hou, Lifang (Contact); Murphy, Robert L
CA189966	Susan M. Love	2014	0	0			
CA202637	Ralph Weissleder, Bruce Chabner	2016	6	10	R01	Multiplexed analysis of exosomes in cancer nano therapy	Weissleder, Ralph
					R01	Imaging tumor associated macrophage (TAM) function	Pittet, Mikael; Weissleder, Ralph (Contact)
					R01	Ultrasenstive vesicle analysis in precancerous pancreatic neoplasm (IPMN)	Weissleder, Ralph
					R01	Quantitative nanoparticle imaging of macrophages	Nahrendorf, Matthias (Contact); Weissleder, Ralph
					R21	Single Circulating Vesicle Analysis for Early Cancer Detection	Weissleder, Ralph
					R33	Analysis of scant cancer cells in fine needle aspirates	Weissleder, Ralph
					U01	Imaging of nanotherapeutic drug action	Weissleder, Ralph

Base Grant Number	PIs	Grant Cohort	Number of PIs other than ACTs Program PIs	Number of new awards or pending awards since the start of the ACTs Program Grants	Activity of awards	Title of Awards	PIs
					P20	Planning for NCDs Research Center of Excellence in Southern Africa	Chabner, Bruce Allan; Lockman, Shahin; Ramogola-Masire, Doreen; Tapela, Neo (Contact)
					UH2	Smartphone for molecular cancer diagnostic in Africa	Chabner, Bruce Allan; Weissleder, Ralph (Contact)
					K12	Dana Farber/Harvard Cancer Consortium Career Development Program in Clinical Oncology	Chabner, Bruce Allan; Graubert, Timothy A (Contact)
CA202663	Andrea Vinson, Jennifer Susan Smith, Kristine Weidemaier	2016	0	0			
CA202665	Laurence Court, Beth Beadle	2016	4	2	UG1	Stanford University NCTN - Network Lead Academic Site	Beadle, Beth M; Coutre, Steven Edward; Dorigo, Oliver; Wakelee, Heather Ann (Contact); Wapnir, Irene Leonor
					R21	Understanding Uncertainties in Radiomics Studies	Court, Laurence E
CA202721	Partha Basu	2016	0	0			
CA202723	David Erickson, Jeffery Martin	2016	3	4	R01	FeverPhone: Point of Care Diagnosis of Acute Febrile Illness using a Mobile Device	Erickson, David (Contact); Mehta, Saurabh
					R03	Development of a Point of Care Multiplexed Diagnostic Platform to Target Anemia and Micronutrient Deficiencies	Erickson, David; Finkelstein, Julia L. (Contact)

Base Grant Number	PIs	Grant Cohort	Number of PIs other than ACTs Program PIs	Number of new awards or pending awards since the start of the ACTs Program Grants	Activity of awards	Title of Awards	PIs
					R21	RIDAR - Rapid IDentification of Antibiotic Resistance	Erickson, David (Contact); Mehta, Saurabh
					U54	Point of Care Technologies for Infection and Nutrition (POCTIN)	Erickson, David (Contact); Glesby, Marshall J; Mehta, Saurabh
CA202730	Rolando Herrero	2016	0	0			
CA211139	Daniel T. Chiu	2017	3	3	R01	Developing Bioinformatic and Microfluidic Single Cell Methods for Studying Intratumoral Heterogeneity in Acute Myeloid Leukemia	Chiu, Daniel T; Paguirigan, Amy (Contact); Radich, Jerald Patrick
					R01	High-precision mapping of the spatial organization of synaptic-vesicle membrane proteins	Chiu, Daniel T
					R01	Spatially Resolved Transcriptomics Enabled by Ultrabright Pdot Probes for Interrogation of Complex Tissues	Chiu, Daniel T (Contact); Vaughan, Joshua
CA211232	Nelson Chao, Ashutosh Chilkoti	2017	9	13	P01	Pro-fibrotic Pathways in GVHD	Chao, Nelson J.; Sarantopoulos, Stefanie (Contact)
					R21	Evaluating Effects of Age-related Microbiota Modulations in Hematopoietic Stem Cell Transplant Patients	Chao, Nelson J.; Sung, Anthony (Contact)
					T32	Duke-UNC Chapel Hill Immunotherapy Training Grant	Chao, Nelson J.; Serody, Jonathan Stuart (Contact)
					U01	Mitigators of Radiation-Induced Endovascular Injury: Targeting Tie2 and Thrombocytopenia	Chao, Nelson J. (Contact); Kontos, Christopher D

Base Grant Number	PIs	Grant Cohort	Number of PIs other than ACTs Program PIs	Number of new awards or pending awards since the start of the ACTs Program Grants	Activity of awards	Title of Awards	PIs
					UG3	AZD9668 and Neutrophil Elastase Inhibition to Prevent Graft-versus-Host Disease	Chao, Nelson J. (Contact); Pavletic, Steven
					R01	Injectable Depots of Bi-Specific Peptide Drugs for Diabetes Treatment	Chilkoti, Ashutosh
					R01	A unimolecular dual agonist that creates an injectable depot for combination therapy of type 2 diabetes	Chilkoti, Ashutosh
					R21	A novel sustained-release immunotoxin for treatment of glioblastoma multiforme	Chilkoti, Ashutosh
					R21	Point of Care Testing to Improve Monitoring of LVAD Patients	Chilkoti, Ashutosh (Contact); Franklin, Aaron; Rogers, Joseph G.
					R33	Point-of-care digital pathology of breast tumors on a cell phone	Chilkoti, Ashutosh
					R35	Genetically Encoded Smart Biohybrid Materials	Chilkoti, Ashutosh
					R41	Development of a POEGMA-Aptamer rapid onset anticoagulant that eliminates antigenicity to anti-PEG antibodies	Chilkoti, Ashutosh
					R61	Rapid diagnosis and quantification of HIV by direct capture, labelling and detection of individual virions	Chilkoti, Ashutosh; Lynch, Michael David (Contact); Naggie, Susanna
CA211310	Eric C. Ford	2017	0	0			
CA211415	Karen S. Anderson,	2017	2	2	UG1	Midwest cancer prevention consortium	Brenner, Dean E. (Contact); Djuric, Zora

Base Grant Number	PIs	Grant Cohort	Number of PIs other than ACTs Program PIs	Number of new awards or pending awards since the start of the ACTs Program Grants	Activity of awards	Title of Awards	PIs
	Dean E. Brenner				R33	Nanotechnology for High Throughput Generation of Functional T cell Receptors	Anderson, Karen S. (Contact); Blattman, Joseph N
CA211457	Jeffery Martin, Tza-Huei Wang	2017	5	6	R01	Academic-Industrial Partnership for Non-invasive Barrett's Esophagus Detection	Meltzer, Stephen J (Contact)
					R33	New Technologies for Minimally Invasive Cancer Diagnosis	Meltzer, Stephen J (Contact); Wang, Tza-Huei
					R01	A "Culture" Shift: Integrated Bacterial Screening and Antibacterial Susceptibility Test on Microfluidic Digital Array for Bloodstream Infections	Wang, Tza-Huei (Contact); Yang, Samuel
					R01	Technology development for point-of-care detection and antimicrobial susceptibility testing of Neisseria gonorrhoeae	Gaydos, Charlotte Ann; Wang, Tza-Huei (Contact)
					R01	Development of Digital DNA methylation Assay Platform for Detecting Ovarian Cancer from Cervical-Vaginal Fluid	Shih, Ie-Ming; Wang, Tian-Li; Wang, Tza-Huei (Contact)
					R44	PicoSep - A Microfluidic Platform for Single Molecule DNA and RNA Sizing	Liu, Kelvin (Contact); Wang, Tza-Huei
CA211551	Marc D. Porter, Courtney L. Scaife	2017	0	0			
CA239682	Rongguang Liang	2017	1	2	R21	Low-Cost and Compact Multimodal Intraoral Confocal Probe for Oral Cancer Detection and Diagnosis	Liang, Rongguang

Base Grant Number	PIs	Grant Cohort	Number of PIs other than ACTs Program PIs	Number of new awards or pending awards since the start of the ACTs Program Grants	Activity of awards	Title of Awards	PIs
					R21	Fourier Ptychographic Endoscopy	Liang, Rongguang (Contact); Zheng, Guoan
EB024965	T. Peter Kingham, Olusegun Issac Alatise, David Wishart	2017	1	2	R21	Determining the unique biology and risk factors for colorectal cancer in Nigeria	Alatise, Olusegun Isaac; Du, Mengmeng; Kingham, T Peter (Contact)
					U2C	Computational Core	Wishart, David

Appendix A.5 List of New PIs on Grants with ACTs Program PIs and Affiliation

Base Project Number, ACTs Program Status and Affiliation	Number of PIs
CA189883	**3**
ACTs Program	1
Cleveland Clinic	1
NonACTs Program	2
N/A	2
CA189901	**4**
ACTs Program	2
Massachusetts General Hospital	1
University Of Massachusetts Boston	1
NonACTs Program	2
Dartmouth College	1
Massachusetts General Hospital	1
CA189908	**1**
ACTs Program	1
Columbia University	1
CA189910	**9**
ACTs Program	3
Global Coalition Against Cervical Cancer/Preventative Oncology International	1
Rice University	1
University Of Texas	1
NonACTs Program	6
Baylor College Of Medicine	1
Johns Hopkins University	1
Mayo Clinic	1
Md Anderson Cancer Center	2
Vanderbilt University	1
CA189923	**1**
ACTs Program	1
Johns Hopkins University	1
CA189965	**6**
ACTs Program	2
Northwestern University	2
NonACTs Program	4
American Society Of Clinical Oncology	1
Northwestern University	1
Univ Of Sciences, Tech & Tech Of Bamako	1
University Of Jos	1
CA202637	**8**
ACTs Program	2
Massachusetts General Hospital	2

Base Project Number, ACTs Program Status and Affiliation	Number of PIs
NonACTs Program	6
Harvard University	2
Harvard-Botswana Aids Institute	1
Massachusetts General Hospital	2
University Of Botswana	1
CA202665	**6**
ACTs Program	2
University Of Tx Md Anderson Can Ctr	2
NonACTs Program	4
Stanford University	3
University Of California Los Angeles	1
CA202723	**4**
ACTs Program	1
Cornell University	1
NonACTs Program	3
Cornell University	3
CA211139	**3**
ACTs Program	2
Fred Hutchinson Cancer Research Center	1
University Of Washington	1
NonACTs Program	1
University Of Washington	1
CA211232	**9**
ACTs Program	2
Duke University	2
NonACTs Program	7
Duke University	4
National Cancer Institute	1
University Of North Carolina	2
CA211415	**4**
ACTs Program	2
Arizona State University-Tempe Campus	1
University Of Michigan At Ann Arbor	1
NonACTs Program	2
Arizona State University-Tempe Campus	1
University Of Michigan At Ann Arbor	1
CA211457	**7**
ACTs Program	3
Johns Hopkins University	3
NonACTs Program	4
Johns Hopkins University	3

Base Project Number, ACTs Program Status and Affiliation	Number of PIs
Stanford University	1
CA239682	**2**
ACTs Program	1
University Of Arizona	1
NonACTs Program	1
University Of Connecticut	1
EB024965	**4**
ACTs Program	3
Obafemi Awolowo Univ Tech Hospital Complex	1
Sloan-Kettering Institute	1
University Of Alberta	1
NonACTs Program	1
Duke University	1
Grand Total	71

Appendix A.6 Summary of Contributions Reported in RPPRs for ACTs Program Grants

Base Project Number	Total Number of Trainings	Total Number of Journal Articles	Total Number of New Analytic Techniques	Total Number of Patents	Total Number of Resources	Total Number of Other	Total Number of FDA IND/IDE Applications	Total Reported Contributions in the RPPRs
CA188901	2	0	1	0	0	0	0	3
CA189883	3	1	3	0	0	0	3	10
CA189901	4	2	2	0	0	0	0	8
CA189908	6	1	1	0	1	0	0	9
CA189910	2	2	2	0	1	0	1	8
CA189923	0	0	0	0	0	0	1	1
CA189965	2	0	0	0	0	0	0	2
CA189966	0	0	2	0	0	0	2	4
CA202637	4	13	0	0	0	0	0	17
CA202663	0	0	0	0	0	0	0	0
CA202665	6	7	1	0	0	0	0	14
CA202721	0	0	1	0	0	0	2	3
CA202723	3	6	2	2	1	0	0	14
CA202730	9	0	0	0	0	0	0	9
CA211139	1	0	0	0	0	0	0	1
CA211232	3	1	0	0	0	0	0	4
CA211310	2	0	0	0	0	0	0	2
CA211415	1	0	0	0	0	3	0	4
CA211457	0	0	0	0	0	0	0	0
CA211551	1	0	0	0	0	1	0	2
CA239682	0	2	0	0	0	0	0	2
EB019889	0	0	1	0	0	1	0	2
EB022623	0	1	0	0	0	0	1	2
EB024965	0	0	0	0	0	0	1	1
Overall Total	49	36	16	2	3	5	11	122

APPENDIX B: SURVEY REPORT (SUBTASK 3B)

Appendix B.1 Survey Questions

NCI's Affordable Care Technologies Program Evaluation Survey

[Bracketed Text Refers to Qualtrics™ Survey Logic / Options]

Welcome to the ACTs Program Evaluation Survey. We anticipate that this survey will take approximately 20-25 minutes to complete. You may stop and restart your survey at any time until November 22, 2019, 9:00 PM EST. Thank you very much for your participation in this survey.

Section 1: Background – Mandatory section

1.1 What is the grant number for your ACTs program grant project? [Drop down with grant number and PI] Please give the month and year that you started working on the project. [2 pull down menus for month and year]

1.2 Which of the following best describes your role on your current ACTs program funded project? (Please select all that apply)

- ❒ Principal Investigator / Co-Principal Investigator
- ❒ Co-Investigator
- ❒ Researcher
- ❒ Technical / Industrial partner
- ❒ Business partner
- ❒ Clinic staff
- ❒ Other (please specify): _____

1.3 What is your scientific/research specialty? (Please select all that apply)

- ❒ Oncology
  - Subspecialty: _____
- ❒ Other Clinical Specialty (please specify):_____
- ❒ Engineering
- ❒ Public Health
- ❒ Business/Technology development
- ❒ Other: _____
- ❒ N/A

1.4 For your current ACTs program project, in what country is the main focus of your research: [Pull down menu with US first, and then other countries taken from FACTs and performance sites in the QVR and Other option with a text box].

1.5 What is the main use of this technology? (Please select all that apply)

- ❒ Cancer Screening
- ❒ Cancer Diagnosis
- ❒ Cancer Treatment

1.6 Other (please specify):_____Which of the following steps towards commercialization are you currently working on in your project? [Please select all that apply]

1.7 Which of the following steps towards commercialization are you currently working on in your project? [Please select all that apply]

- ❒ Regulatory submissions
- ❒ Phase II trial
- ❒ Phase III trial
- ❒ Process validation
- ❒ Design validation
- ❒ Applied for/received patent
- ❒ Commercial interest in technology
- ❒ NGO interest in technology
- ❒ Adding additional validation sites in new countries

Section 2: Collaboration

2.1 To the best of your knowledge, how would you characterize the level of collaboration among the following groups of personnel on your ACTs program grant, thus far?

	1 (No Collaboration)	2	3 (Some Collaboration)	4	5 (Close Collaboration)
Among the US-based personnel					
Among the LMIC-based personnel					
Between the US-based and LMIC-based personnel					

2.2 During your ACTs program grant, were there any challenges to the collaboration between the US-based and LMIC-based personnel?

- ❒ No
- ❒ Yes (please describe): _____

2.3 Using a scale from 1 to 5, where 1 means no influence and 5 means a lot of influence, please rate the extent to which the following factors influenced the ability of the U.S.-based teams and collaborating country partners collaborate with each other on your ACT funded project.

	1 (No influence)	2	3 (Some influence)	4	5 (A lot of influence)
Political (i.e. relationship with Ministry of Health)					
Institutional (i.e. lack of adequate health insurance and health systems)					
Financial (i.e. lack of adequate funds or difficulties distributing funds to LMIC partners)					
Logistic (i.e. transportation, etc.)					
Regulatory (i.e. difficulties with LMIC IRBs)					
Cultural (i.e. difficulty reaching and engaging patients, low levels of cancer awareness)					
Site specific (i.e. lack of appropriate staffing or equipment)					
Technological (i.e. internet connectivity)					
Other: (please describe) _____					

2.4 [If answered 4 or 5 to any above] Please describe how the items checked above influenced your ability to collaborate on the ACTs program grant.

2.5 In thinking about your collaborations on the ACTs program grant, is there any assistance that ACTs program staff could have provided to make the collaboration process smoother? [Text box]

Section 3: Funding partnerships

3.1 While working on your current ACTs program grant, have you developed any other scientific collaborations with other ACTs program grantees? (Please select all that apply)

- ❒ No [skip to Q16]
- ❒ Yes, with some or all of the original ACT grant personnel on an offshoot project on the same technological innovation. Briefly describe: [textbox]
- ❒ Yes, with new collaborators from other ACTs program grants but on the same technological innovation. Briefly describe: [textbox]
- ❒ Yes, on an entirely new technology unrelated to the ACTs program project. Briefly describe: [textbox]

3.1.1 To the best of your knowledge, have any further grant applications been made to continue the work started by your original ACT grant? [Only to PIs. Q3, answer B/C]

- ❒ No [skip to 16]
- ❒ Don't know [skip to 16]
- ❒ Yes

3.1.2 If yes to 3.1.1, from whom? (Select all that apply)

- ❒ ACTs Program
- ❒ Other NCI grant
  - If so, which grant program did you apply to:_____
- ❒ Other NIH grant
  - If so, which grant program did you apply to:_____
- ❒ Other federal agency
  - If so, which grant program did you apply to: _____
- ❒ Foundation or NGO
  - If so, which foundation or NGO did you apply to: _____
- ❒ Other (please describe)

3.2 As a result of the ACTs program grant, have you developed new partnerships with researchers who were not on the original ACTs program grant? (Please select all that apply)

- ❒ No
- ❒ Yes, to work on an another aspect of the technology developed under the original ACT grant project
- ❒ Yes, it's an entirely new project

3.2.1 [If yes to either] Please describe

3.2.2 [If yes to either], to the best of your knowledge, have you applied for funding based on this new project?

- ❒ No [skip to 3.3]
- ❒ Yes [skip to 3.2.3]

3.2.3 [If yes to either], From whom did you apply for funding? (Please select all that apply)

- ❒ ACTs Program
- ❒ Other NCI grant
  - If so, which grant program did you apply to: _____
- ❒ Other NIH grant
  - If so, which grant program did you apply to: _____
- ❒ Other federal agency
  - If so, which grant program did you apply to: _____
- ❒ Foundation or NGO
  - If so, which foundation or NGO did you apply to: _____

3.3 Other than the ACTs program grant, have you ever applied for a grant or other funding mechanism related to global health technology research/development? Please

include in your response NGO and non-US agency opportunities (e.g., Wellcome Trust, Bill and Melinda Gates Foundation).

- ❒ No;
- ❒ Yes

3.3.1 [If yes] Did you receive funding?

- ❒ No
- ❒ Yes

3.3.2 [If yes] To the best of your knowledge, please give us the start date of the funded project:

3.4. Considering other NIH research opportunities (e.g., Academic Industrial Partnerships, global small business research opportunities (e.g., SBIR), other global technology opportunities (e.g., Fogarty's mHealth program)), have you ever…(Please check all that apply):

- ❒ …applied for another NIH grant?
- ❒ …had another NIH grant funded?

3.4.1 [If yes, to any of the above] Please describe: _____

Section 4: Interest from Other Entities [Displayed only for PIs, co-PIs, co-Investigators, other key personnel. Taken from Q1.3 answers b, c, or d]

4.1 What level of interest have you had in the technology you're developing from the following outside entities?

	1 (None to Date)	2	3 (Some Interest)	4	5 (Extensive Interest)
Healthcare community in test location					
Healthcare community in other locations					
Non-clinical health care workers in test location					
Local community/ Patients					
Local health departments					
National government health department/ministry					
Local industry/ manufacturers					
Other researchers in the US					
Researchers based in test country, outside of test team					
US based industry/manufacturers					

	1 (None to Date)	2	3 (Some Interest)	4	5 (Extensive Interest)
NGOs					
Other: (Please describe)					

4.2 How much interest from industry have you found in the following areas?

	1 (None to Date)	2	3 (Some interest)	4	5 (Extensive Interest)
Technology fabrication					
Plan for commercial sustainability					
Distribution mechanism					
Equipment maintenance					
Consumable supplies					
Obtaining premarketing regulatory approvals					
Ensuring affordability of technology					
Other: (Please describe)					

4.3 Have you begun marketing the technology developed under the ACTs program?

- ❒ Yes
- ❒ No [Skip to 4.4]
- ❒ Don't know [Skip to 4.4]

4.3.1 Please describe the targeted market for the technology [text box]

4.4 Is the technology developed under the ACTs program actively being sold to consumers?

- ❒ No [Skip to 4.5]
- ❒ Yes

4.4.1 [If yes to 4.4] Who purchased the technology? [text box]

4.4.2 [If yes to 4.4] How many orders to date? _____

4.4.3 [If yes to 4.4] How many individual units have been purchased or ordered? _____

4.5 Do you think this technology could play a role in the U.S. healthcare system?

- ❒ No
- ❒ Yes

4.5.1 [If no to 4.5] Why not? [textbox]

4.5.2. [If yes to 4.5] How do you see this technology playing a role in the U.S. healthcare system? [textbox]

4.6 Please describe any barriers to bringing this technology to market:[textbox]

4.7 Please describe any facilitators to bringing this technology to market: [textbox]

Section 5: Training

5.1 What level of training do workers need to operate the technology?

- ❒ None, less than a high school level of education needed
- ❒ None, just a high school level education
- ❒ Minimal health care training, such as training provided by the clinic or researchers
- ❒ Nurse or physician needed to operate the technology
- ❒ Unknown

5.2 To the best of your knowledge, who has attended a training or a presentation about the technology? (Please select all that apply)

- ❒ LMIC clinical staff
- ❒ LMIC non-clinical health care workers (e.g., health educators, MOH staff and/or officials)
- ❒ LMIC medical students and/or faculty
- ❒ US-based medical students or faculty
- ❒ Other. Please describe _____

5.3 How many others (clinicians, health departments/ministries, businesses, etc.) have learned about and requested:

a. …Information about the technology

- ❒ None
- ❒ 1 to 2 other entities
- ❒ 3 to 4 other entities
- ❒ 5 or more other entities
    - [If answered ii-iv above] From which sector have individuals requested information about the technology? [textbox]

b. …The technology itself

- ❒ None
- ❒ 1 to 2 other entities
- ❒ 3 to 4 other entities
- ❒ 5 or more other entities
    - [If answered ii-iv above] From which sector have individuals requested information about the technology [textbox]

Section 6: Contributions to science (All respondents)

6.1 Please provide the number of presentations, publications, patent applications or patents *you personally* have achieved related to the ACTs project.

- ❒ Academic Presentations: _____
- ❒ Journal Publications: _____
- ❒ Book Chapters: _____
- ❒ Patent Applications: _____
- ❒ Patents: _____
- ❒ Other: _____

6.2 Would you say that your work in this project has encouraged or discouraged you to conduct more projects involving international collaborations?

- ❒ Discourage
- ❒ Encourage

6.2.1 [If encourage to 6.2] Please briefly explain why your ACTs program experience encouraged you to conduct more projects involving international collaboration? [Textbox]

6.2.2 [If discourage to 6.2] Please describe how your ACTs program experience discouraged you from conducting more projects involving international collaboration in the future. [Textbox]

Section 7: LMIC Researcher Section [Display if response to Q5 other than US]

7.1 Did working on this project open up new work or study opportunities for you?

- ❒ Yes [skip to 7.1.1]
- ❒ No [skip to 7.2]

7.1.1 [If yes] What type of new opportunities? (Please select all that apply)

- ❒ New research
- ❒ New streams of funding for your own research
- ❒ New training or education programs
  - [If yes to new training or education program], in what specialty: _____
  - [If yes to new training or education program], for which degree: _____
- ❒ New positions
  - [If yes to new position] where is your new position (Please give the name of the institution, the city, and state or country). [Text box]

- [If yes to new position] Would it be considered a promotion to a higher ranked position?

  ❒ Yes
  ❒ No

7.2 Based on this experience, what advice do you have for US-based researchers who wish to work with LMIC researchers?

Section 8: Additional Considerations

8.1 What is working well with your ACTs program project? [Text box]

8.2 What is not working well with this project? [Text box]

8.3 What surprising issues have you encountered with this project? [Text box]

8.4 What do you wish you had known before starting this research project that you know now? [Text box]

8.5 Is there anything else you would like ACTs program staff to know about the program or your specific project? [Text box]

Thank you very much for your time!

Appendix B.2 Tables with Survey Details

Table 1. Respondent Characteristics

	Percent of respondents
Year respondent began work on project	
2013	6.1
2014	18.2
2015	6.1
2016	36.4
2017	30.3
2018	3.0
Role on current ACTs funded project*	
Principal Investigator / Co- Principal Investigator	69.7
Co-Investigator	18.2
Researcher	9.1
Technical / Industrial partner	3.0
Business partner	3.0
Clinic staff	0.0
Other	9.1
Scientific/Research Specialty*	
Oncology	33.3
Other Clinical Specialty	24.2
Engineering	27.3
Public Health	18.2
Business/Technology Development	6.1
Other	15.2

*Respondents may select more than one response choice therefore the total of this category may be over 100%.

Note: Other reported project roles include research manager, research director/project management, and clinical research manager. Oncology sub-specialties include breast, radiation, molecular mechanisms of HPV induced cancers, surgery, women's cancers, surgical, gynecologic, hematology, and gastrointestinal. Other clinical specialties include OBGYN, medicine, molecular genetics, radiation oncology, diagnostic test development, and gastroenterology. Other scientific/research specialties include nursing, analytical chemistry, epidemiology, and pharmacy. Estimates are based on a total of 33 respondents, 32 who fully completed the survey and 1 respondent who completed 88% of the survey.

Table 2. Respondent's Grant Characteristics

	Frequency / Percent of respondents
ACT Grant (Number of respondents from each grant)	
CA189923 (ANDERSON); CA211551 (PORTER/SCAIFE); CA189883 (CREMER); CA202730 (HERRERO)	3
CA202637 (WEISSLEDER/CHABNER); CA211457 (MELTZER/WANG); CA189966 / EB019889 (LOVE); EB024965 (KINGHAM/ALATISE/WISHART); CA189910 (SCHMELER/RICHARDS-KORTUM)	2
CA211415 (ANDERSON/BRENNER); CA189901 (HASAN/CELLI); CA211232 (CHILKOTI/CHAO); CA239682 / EB022623 (LIANG); CA211310 (FORD); CA202723 (ERICKSON/MARTIN); CA202663 (VINSON/SMITH); CA202721 (BASU); CA202665 (COURT/BEADLE); CA211139 (CHIU); CA189908 (KUHN)	1
CA189965 (MURPHY)	0
RFA Number and Year	
CA13-015 (2014)	36.4
CA15-001 (2016)	30.3
CA15-024 (2017)	33.3
Country of main focus by continent	
Africa	30.3
Asia	36.4
Central / South America	30.3
North America	3.0
Main use of technology *	
Cancer Screening	60.6
Cancer Diagnosis	24.2
Cancer Treatment	12.1
Other	18.2
Steps towards commercialization currently working on*	
Regulatory submissions	21.2
Process validation	54.6
Phase II trial	15.2
Phase III trial	12.1
NGO interest in technology	12.1
Design validation	57.6
Commercial interest in technology	54.6
Applied for/received patent	24.2
Adding additional validation sites in new countries	15.2

*Respondents may select more than one response choice therefore the total of this category may be over 100%.

Note: Other reported main uses of technology include pre-cancer screening, cervical precancer lesion treatment, cancer prevention, and pre-cancer treatment.

Table 3. Respondents' Reported Number of Publications, Patents, Patent Application and Presentations, by Project

Number of Respondents	Total of Presentations	Total of Journal Publications	Total of Book Chapters	Total of Patent Applications	Total of Patents	Total of Other	Other Text
3	7	4	1	0	0	1	I am unsure about patents.
1	8	5	NA	1	NA	NA	
1	10	2	1	NA	NA	NA	
2	35	8	3	0	0	NA	
3	6	0	0	1	0	2	Conference presentations, Journal articles in preparation
2	2	2	0	0	0	NA	
2	35	15	3	3	1	1	
1	0	0	0	0	0	NA	
1	8	4	0	0	0	NA	
1	10	1	1	NA	NA	1	Digital Atlas for training
1	10	3	0	1	0	NA	
3	32	15	0	30	10	1	To be answered by manufacturer
1	10	NA	NA	NA	NA	NA	
1	2	0	0	1	1	NA	
1	11	2	0	0	0	NA	
1	5	3	0	2	NA	NA	
2	8	4	NA	1	0	NA	
3	14	5	0	4	0	NA	
1	5	3	0	1	0	NA	
2	9	2	1	6	1	NA	

Appendix B.3 Text Responses

1.2 Please select the month and year that you started working on the project.	
Response by Respondent	
Month	Year
September	2016
May	2016
May	2017
May	2017
July	2016
April	2017
June	2017
September	2013
September	2014
April	2017
August	2016
July	2016
May	2017
July	2016
September	2014
May	2017
August	2014
April	2018
June	2015
September	2016
December	2014
May	2016
December	2014
March	2016
June	2016
May	2017
January	2016
June	2015
May	2017
September	2014
January	2013
May	2017
February	2016

1.3 Which of the following best describes your role on your current ACTs program funded project? (Please select all that apply) - Other (please specify): - Text
Response by Respondent
Clinical Research Manager
Research director/project management
Research Manager

1.4_84 What is your scientific/research specialty? (Please select all that apply) - Oncology (sub-specialty): - Text
Response by Respondent
Gastrointestinal Oncology Translational Research
heme onc
Gyn oncology
Gynecologic Oncology
Surgical Oncology
surgical oncology
women's cancers
surgery
Molecular mechanisms of HPV induced cancers
Radiation Oncology
breast

1.4_85 What is your scientific/research specialty? (Please select all that apply) - Other Clinical Specialty (please specify): - Text
Response by Respondent
Radiation Oncology
Medicine/Gastroenterology
Diagnostic test developmet
OBGYN
Molecular enetics / Protein based in-vitro diagnostics
Medicine
OBGYN
Gynecologist

1.4_89 What is your scientific/research specialty? (Please select all that apply) - Other: (please specify): - Text
Response by Respondent
Pharmacy
Analytical Chemistry
Epidemiology
Analytical Chemistry
Nursinf

1.5a Please specify the country that is the main focus of the ACT project. - Other: (please specify): - Text
Response by Respondent
9 countries in Latin America
Nine Latin American countries
A total of twelve Latin American nations, foremost Columbia.

1.6 What is the main use of this technology? (Please select all that apply) - Other (please specify): - Text
Response by Respondent
Precancer treatment
precancer treatment
pre-cancer treatment
cancer prevention
cervical precancer lesion treatment
Pre cancer screening

2.2 During your ACTs program grant, were there any challenges to the collaboration between the US-based and LMIC-based personnel? - Yes (please describe): - Text
Response by Respondent
Sometimes language barriers make it difficult to effectively communicate despite excellent translators. Very helpful to have in-country study coordinators to help with both the language and cultural norms translations.
We had to switch country focus from […] and […] to […] and […]. The collaboration between teams is excellent though language and time zone challenges are present. The anticipated enrollment was a lot higher than actual enrollment which was another challenge.
Communication
[…] PI changed institutions during the course of the grant
we implemented Phase 1 of our project in the […] and encountered the following challenges: 1) lack of experience with rigorous study designs and with device trials (most experience with program implementation) 2) prolonged and complicated in-country review process 3) problems with […] financial system and being able to get funds to study team 4) overestimation of ability to enroll sufficient numbers of women who meet inclusion criteria
Level of understanding of clinical research expectations. Ethical board review issues
Some sites in […] did not have experience in clinical trials and were not being compliant with very basic GCP principles.
We ended up closing one site due to problems working with the team. They were unable to conduct the study as planned due to hospital bureaucracy.
Contracting between institutions.
Delay in the approval of the UH3 grant
I would say that there were very few challenges between our group and the LMIC collaborators from a technical point of view. We already had a very strong relationship (through […]) with our LMIC collaborator - who himself trained with […] at […] and new both the US and […] system. This was key to our success.

2.2 During your ACTs program grant, were there any challenges to the collaboration between the US-based and LMIC-based personnel? - Yes (please describe): - Text
Response by Respondent
What I have observed with some of the other teams is that those that have been less successful are those that did not truly have a strong partnership (beyond perhaps casual knowledge of each other to the point that a letter can be supplied for a proposal). This is perhaps an obvious statement, but I can see how the depth of a partnership could be difficult to parse at the proposal evaluation stage.
very slow response from the grant administration
The term "any challenges" is not really clear to me - in such international collaboration, there are always challenges in terms of physical communication and material shipping, but due to the fact that these challenges are naturally expected, they are perceived as a "normal" part of the project.
From our perspective, there is some difference in the expectation of general responsiveness. For example, within the US team, an email question or request is usually expected to be answered or addressed within one day, but the time can be quite variable with communications with the foreign site.
There have been challenges in terms of expectations on the scope of what will be done, although this was articulated very clearly at the outset and agreed upon.
Communication- 12-hour time zone differences Travel- visas for US entry Effective and timely transport of materials Budgets- timing and delays to fit NCI scheduling dates. Need to support budgets for travel to LMICs- it is ESSENTIAL for the success of the project. But, outstanding collaborators in […], committed time and efforts, great depth of knowledge both clinically, research, and practical.
Regulatory approvals took approximately 2 years to be completed. Infrastructure limitations often caused further delays.
Test platform was impounded by customs when traveling to […] for test kit demonstration.
We did not fully anticipate the difficulties in shipping materials to our collaborators in […] - our materials were confiscated in […] and held for 2 weeks until US team was returning home.
1. Shipping the prototypes. It takes significant effort to send the prototypes to the collaborators in India due to the custom clearance. 2. Funding transfer. In LMIC, it is preferred to get the funding first to start the research.

2.3 Using a scale from 1 to 5, where 1 means no influence and 5 means a lot of influence, please rate the extent to which the following factors influenced the ability of the US- based teams and collaborating country partners collaborate with each other on your ACT funded project. - Other (please describe): - Text
Response by Respondent
None I can think of
Haven’t been involved over the last year
lack of experience with rigorous studies-both in planning and execution
bureaucratic red tapes with various agencies

2.4 Please describe how the factors from the previous question, that you rated 4 and 5, influenced your ability to collaborate on the ACTs program grant.
Response by Respondent
I didn't rate any as a 4 or 5. We have a good system of weekly research calls and all the sites are included, so we are able to trouble shoot early. There have been several difficulties, as always, but collaboration has been good.
Lack of cancer awareness was a significant challenge to patient recruitment. Even patients who were identified with very suspicious lesions in preliminary screening camps were reluctant to come in for biopsy
impacted timely implementation of the project. The spotty internet connectivity in country also created additional burden to conduct regular coordinating and check in meetings
In country staff salaries were delayed for several months. IRBs responses were delayed. Staff lacked understanding of clinical Research experience and required extensive training
there was willingness and great collegiality from our colleagues in the […]. however, their lack of experience required a great deal of education and support and i think significantly impeded our progress in Phase 1 and led them to over-estimate the ability to enroll women who met inclusion criteria in Phase 2 (UH3). in terms of financial transfers, we were able to funnel funds thru […] country office to bypass the problem
Logistics (from US to the LMIC site) often delayed the deployment of devices, reagents, and other key instruments.
The selection of engaged partners was crucial in this ACT program grant. We meet regularly and have similar goals.
There were challenges with obtaining regulatory approval in each country/location we wanted to work. This delays the effort.
Import permits for the product required and difficult to obtain
These factors strongly affect the ability to physically exchange materials that are crucial to the substance of the project.
Just in general communication (language) and expectation of responsiveness.
regulatory processes in […] are difficult to navigate
There were many promises up front of institutional support which were slow to materialize and some are still pending.
The previous question was confusing. There were/are logistical challenges in transport of materials, for example, internet connectivity, electronics and software transfer. There were delays for local IRBs but they succeeded. However, the local institution, system, and infrastructure for the study are excellent.
Patient enrolment at […] is lower than we expected due to understaffing.
Shortages of adequate clinical equipment, staffing, and facilities delayed startup of the project.
Steep learning curve on how to move test platform through customs in […] (they i,pounded the test kit and associated hardware, which was returned on the trip back to the U.,S.) for meeting with […] collaborators to introduce the technology and get feedback on their persective on areas for improvement in its operation.
We had difficulties getting our materials into […], which affected our ability to work with our collaborators while we were on their site.
due to a political change in how funds could transfer to […] there was a time when funds took 6 months to get to LMIC investigators

2.5 In thinking about your collaborations on the ACTs program grant, is there any assistance that ACTs program staff could have provided to make the collaboration process smoother?
Response by Respondent
Haven't been involved over the last year - our device was built and handed off and no funding was allocated for us to continue to be involved. So many of these answers should be N/A, but that is not available on this survey.
Help with bringing one (or more) site PIs to the annual meeting. I think it really helps for them to see the process and what it entails.
The ACT program staff were great, they made themselves easily accessible and were always supportive. There were challenges getting appropriate regulatory numbers in place that are necessary for NIH fund dispersion. This caused delays. If there was a fast-track way to get DUNS, SAMS, And FWA in place it would be helpful.
No - we were fortunate to have a very strong partner in […]. I think our previous successful collaborations between the institutions prior to this project were key to our success
The collaboration on our project was very strong. ACTs program staff were always very helpful and supportive of our research goals and provided helpful feedback on regular calls and at the annual meeting.
it seems like a number of ACTs projects had some similar problems: local IRB bottlenecks and local study team lack of experience. it is hard to know how program staff could have addressed the former, given that it is very country specific; the two things that come to mind are making new PIs aware that this is common problem and potentially, keeping database of specific IRB requirements by country (if that is possible). we were in the first cohort of proposals funded; in future, linking new PIs who are working in a specific country with PIs who have been thru the process in that country might be useful. in terms of lack of experience of local study personnel, it might be helpful to develop a tool-kit or checklist or some other aids to help local staff get up to speed
More collaboration between the US team that were working similar projects. A robust platform for US teams to learn from each other
The ACTs program staff have been extremely supportive and provided appropriate and timely advice when necessary. The problems and challenges we faced were mostly local and in-country; inherently just a modality of how approvals are made in the country.
DEfinitely more information on how to transport the medical device across the border with the […], and the […] regulation
No, I think we were able to build a team to handle the collaboration process.
The NIH program staff have been very supportive.
N/A
Can't think of anything.
Assistance with IRB process in other countries/institutions, as available.
Reduce the delay between the completion of UH2 and approval of UH3
I think this would be difficult for ACT staff to help with - unless they had first hand knowledge of the players involved. One possible area would be developing more flexibility in the timing of the funding - knowing that IRBs are going to be difficult. In some cases now there is pressure to spend money quickly rather than wait for approvals at high quality sites.
No
Probably not, as there are overarching issues of international trade agreements and national custom procedure regulations
No. I think all the challenges are addressable and get better as a better understanding is being established between the teams.
not sure

2.5 In thinking about your collaborations on the ACTs program grant, is there any assistance that ACTs program staff could have provided to make the collaboration process smoother?
Response by Respondent
The ACT program may be able to serve as bit of leverage. Certainly the reports and renewal process served this purpose. Some more regular reporting and setting of expectations may be helpful.
Regulatory advice and support, in particular as we look toward FDA submissions and compliance.
I'm not sure the ACT staff could have helped with the […] infrastructure limitations.
NA
Maybe the addition of our transportation issues to "lessons leaned" document. It also, from our limited experience, always takes longer to reach a consensus with our intentional collaborators than we have originally envisioned.
We could benefit from logistics support from ACT staff with experience in shipping materials to these LMICs.
We have already received the strong support from ACTs program staff. No other assistance is needed for our research.
I can't think of one
no

3.1_2 While working on your current ACTs program grant, have you developed any other scientific collaborations with other ACTs program grantees? (Please select all that apply) - Yes, with some or all of the original ACT grant personnel on an offshoot project on the same technological innovation. Briefly describe: - Text
Response by Respondent
We have worked with the […] on issues with in […] general. Also collaborated with screening groups to incorporate treatment technology
Hooked up with a third party ([…]) which led to other activity outside the grant, and now applying for an additional grant using a different technology
With […]/[…]
Yes, we are proposing a new study to expand the capability of the technology with many of the same investigators.
for both original and new ACTs grant recipients working on cervical cancer screening technologies, we are working to put together a paper outlining common challenges and lessons learned
further collaborations with original group.
We have been working with […] team on … "…". We sent two devices to her team in […] to monitor the outcome of […] cancers. We have been discussing how to integrate two methods and devices together for detection and treatment of oral cancers.
we have started a collaboration with another ACT group to validate their device in […], the LMIC where our project is

3.1_3 While working on your current ACTs program grant, have you developed any other scientific collaborations with other ACTs program grantees? (Please select all that apply) - Yes, with new collaborators from other ACTs program grants but on the same technological innovation. Briefly describe: - Text
Response by Respondent
Hooked up with a third party ([…]) which led to other activity outside the grant, and now applying for an additional grant using a different technology

3.1_3 While working on your current ACTs program grant, have you developed any other scientific collaborations with other ACTs program grantees? (Please select all that apply) - Yes, with new collaborators from other ACTs program grants but on the same technological innovation. Briefly describe: - Text
Response by Respondent
Yes, we have begun working with the […] lab, whose technology for oral Ca imaging can be adapted to PDT treatment monitoring
Yes, we are proposing several new collaborations to expand the application of the technology and combine approaches.
for both original and new ACTs grant recipients working on cervical cancer screening technologies, we are working to put together a paper outlining common challenges and lessons learned
Discussion of collaboration with […] for autoplanning of his new treatment machine.
Have a direct collaboration with another ACT-funded group with one personnel located on-site. This is highly synergistic.

3.1_4 While working on your current ACTs program grant, have you developed any other scientific collaborations with other ACTs program grantees? (Please select all that apply) - Yes, on an entirely new technology unrelated to the ACTs program project. Briefly describe: - Text
Response by Respondent
Hooked up with a third party ([…]) which led to other activity outside the grant, and now applying for an additional grant using a different technology - a little of all the above

3.1.1_4 To the best of your knowledge, have any further grant applications been made to continue the work started by your original ACT grant? (Please select all that apply) Other NCI Grant (please specify which grant program): - Text
Response by Respondent
R01 Academic Industrial Partnership
NCI SBIR on closely related work using a different technology
AIP
U24

3.1.1_6 To the best of your knowledge, have any further grant applications been made to continue the work started by your original ACT grant? (Please select all that apply) Other federal agency (please specify grant program): - Text
Response by Respondent
USAID in […]

3.1.1_7 To the best of your knowledge, have any further grant applications been made to continue the work started by your original ACT grant? (Please select all that apply) Foundation or NGO (please specify): - Text
Response by Respondent
Rising Tide, Gateway for Cancer Research
Grant application to government of […]. Unsuccessful.

3.2_5 As a result of the ACTs program grant, have you developed new partnerships with researchers who were not on the original ACTs program grant? (Please select all that apply) - Yes, to work on another aspect of the technology developed under the original ACT grant project. Briefly describe: - Text
Response by Respondent
We went to observe the […] team and their technique of […]
[…] ([…] and MOH)
Yes, see earlier answer.
Established collaboration with a breast cancer group in […] to test the technology for […] clinical sample.
New collaborators in […] and […] on original RPA project.
We developed partnership with […] scientists to initiate microbiome and metabolite study through a supplementary grant
Our project does not include a treatment planning system which is a crucial component but out of scope. We have established a collaboration with another ACT-funded program to fill this need.
[…] ([…]), complementary technology for our study. Yes ([…]) on both head and neck HPV screening and vaccine monitoring. Yes ([…]) on HPV type distribution.
The […] and […] of our ACT project has been modified to develop a new point-of-care device for sexually transmitted infections (STIs).

3.2_6 As a result of the ACTs program grant, have you developed new partnerships with researchers who were not on the original ACTs program grant? (Please select all that apply) - Yes, it's an entirely new project Briefly describe: - Text
Response by Respondent
We are working with mobile ODT on a screening paradigm with AI
We did a Cryo system on first grant, now on to a new thermostat coag device and grant submission for Jan, 2020 date
The […] is being evaluated in several studies in different settings
We are working with my colleague […], at Department of Health Promotion Sciences to develop mobile screening program on cervical cancer in […].
Our ACT program has provided us with data and infrastructure to evaluate colorectal screening with multiple modalities. we have a new partnership with Prevent Cancer Foundation to support other types of crc screening in studies in […]

3.2.1_4 To the best of your knowledge, have any grant applications been made based on this new project? (Please select all that apply) - Other NCI Grant (please specify which grant program): - Text
Response by Respondent
AIP
R01
R01 -AIP
Not yet, January 2020

3.2.1_5 To the best of your knowledge, have any grant applications been made based on this new project? (Please select all that apply) - Other NIH Grant (please specify which grant program): - Text
Response by Respondent
The developed in our ATP project helps us developed a new R01 project from NIH/NIAID on point-of-care diagnosis of infectious diseases.of

Q3.2.1_7 To the best of your knowledge, have any grant applications been made based on this new project? (Please select all that apply) - Foundation or NGO (please specify): - Text
Response by Respondent
prevent cancer foundation
Lui & Wan Foundation
Rising Tide, Gateway

Q3.3_4 Other than the ACTs program grant, have you ever applied for and received funding for a grant or other funding mechanism related to global health technology research/development? Please include in your response NGO and non-US agency opportunities (e.g., Wellcome Trust, Bill and Melinda Gates Foundation). - Yes, I have applied and DID receive funding (please specify the approximate start date of the funded project): - Text
Response by Respondent
2016
PEER (USAID/NAS), Prevent Cancer Foundation (Washington DC)
Cancer Prevent
2014 Paul Allen Foundation; 2015 PATH, 2015 NRL
jan 2018 to dec 2019
USAID, Gates Foundation, Prevent Cancer Foundation
I've applied for and received numerous grants in this area. Primarily from the NIH.
April, 2019
1/1/2017
We received several SBIR grants on the development of parts of the technology in the time frame from 2004-2013, but not explicitly for the global health aspect. We also received funds from the NGO PATH through the BMGF for development from 2004-2008
Texas emerging technology fund, 2018
1-Jul-20
2017

3.4_1 Considering other NIH research opportunities: Academic Industrial Partnerships, Global small business research opportunities (e.g., SBIR) Other global technology opportunities (e.g., Fogarty's mHealth program) Have you ever applied to and/or had another NIH grant funded? (Please check all that apply): - Applied for another NIH grant (please describe): - Text
Response by Respondent
SBIR
SBIR with mobile ODT
See previous

3.4_1 Considering other NIH research opportunities: Academic Industrial Partnerships, Global small business research opportunities (e.g., SBIR) Other global technology opportunities (e.g., Fogarty's mHealth program) Have you ever applied to and/or had another NIH grant funded? (Please check all that apply): - Applied for another NIH grant (please describe): - Text
Response by Respondent
R01 application
AIP (pending) I have applied for BRPs, AIPs, PO1s
Grant Extension
Academic Industrial Partnerships
Academic Industrial Partnerships grant to evaluate AI in cervical cancer screening
R01: to conduct a study to evaluate triage techniques to be used on HPV positive women in order to detect precancerous cervical lesions, treat them and prevent cervical cancers
No
many
SBIR submitted, not funded. Are resubmitting.
R01 grants supporting basic and translational research in GI oncology.
Applied for an AIP grant, but not recommenced for funding.
R21
We have had a number of NIH grants funded. A few include R01AI111495; R33CA155586; U01CA151650; R21AI092231; and R21AI085476.
We submitted one Academic Industrial Partnerships proposal for oral cancer diagnosis with multimodal imaging in low resource setting (PAR-18-009)
D43

3.4_2 Considering other NIH research opportunities: Academic Industrial Partnerships, Global small business research opportunities (e.g., SBIR) Other global technology opportunities (e.g., Fogarty's mHealth program) Have you ever applied to and/or had another NIH grant funded? (Please check all that apply): - Had another NIH grant funded (please describe): - Text
Response by Respondent
R01 to further evaluate appropriate protocols for using thermal ablation
I have been part of funded BRPs, AIPs, PO1s
Other LMIC technologies were funded.
R01 for unrelated project
FeverPhone to do infectious diseases.
Several SBIR grants, as mentioned before; Phase 1, Phase II, and BRIDGE
many

3.4_2 Considering other NIH research opportunities: Academic Industrial Partnerships, Global small business research opportunities (e.g., SBIR) Other global technology opportunities (e.g., Fogarty's mHealth program) Have you ever applied to and/or had another NIH grant funded? (Please check all that apply): - Had another NIH grant funded (please describe): - Text
Response by Respondent
We have applied to and received an award from a Academic-Industry Partnership program, RFAAI17014: Partnerships for Development of Clinically Useful Diagnostics for Antimicrobial Resistant Bacteria (R01). NIH R01AI138978-01 "Technology development for point-of-care detection and antimicrobial susceptibility testing of Neisseria gonorrhea"
Cancer Prevent
i am an investigator on mHealth grant focused on ultrasound guided breast biopsy training in […] using handheld tablets

4.1_12 What level of interest have you had in the technology you're developing from the following outside entities? - Other (please specify): - Text
Response by Respondent
we have had many requests for […]
None

4.2_8 How much interest from industry have you found in the following areas? - Other (please specify): - Other (please specify): - Text
Response by Respondent
NA
I answered 1 because I do not know, our collaborator can answer
...these questions lack precision to be adequately answered; example: "obtaining premarketing regulatory approvals" - is it meant that an industry partner offers regulatory services, or that a potential distributor offers to register a product to then have right of distributions?
we have a commercial partner which received regulatory approval to use in their HQ country

4.3_1 Have you begun marketing the technology developed under the ACTs program? - Yes (please describe the targeted market): - Text
Response by Respondent
Radiation oncology public centers in low- and middle-income countries
LMICs
An investment group from Delaware has licensed IP from the […] for a start up company
LMIC
The manufacturer has tried to market to personal and professional contacts
licensing transfer of […] to […], based in […], who is commercially manufacturing the devices and will be marketing. they have just recently received requisite regulatory approvals in […]

4.4.1 Who purchased the technology?
Response by Respondent
other research projects
Different sites and NGOs in LMICs
A few private individuals.

4.5.1 How do you see this technology playing a role in the U.S. healthcare system?
Response by Respondent
For […] pre-cancer treatments if pathology not required. For ablation of bleeding ectropion.
As a non-surgical option for small early stage oral cancers
Private practitioners
Improving early detection for under-served groups
the […] will provide visual biopsy to replace colposcopy and cervical biopsy in women with abnormal screening test.
simpler and affordable cryotherapy technology application
Multiplexed single-cell analysis for targeted therapy
Rural areas
The ability to provide autocontours and autoplans for patients that need radiation therapy would help throughput in the US as well as improve the quality of the plans, especially in centers without disease-expert physicians.
To treat precancers
as a triage method for HPV positive women
In its degree of innovation, the technology is unique in that it directly detects the oncogenic agent, not just a risk factor or surrogate marker. Thus, the technology would improve health care related to detection of HPV induced cancers. Of course, the US healthcare system is in lesser need of innovation, as existing technology "does the job", and increase effectiveness of novel technology has to be balanced against the cost of changes in procedures and guidelines.
Use as triage for cervical precancer risk stratification
Enable point of care molecular diagnostics
point of care measurements
Some of the design features being developed may be useful in devices used in the US.
for head and neck cancer screening (not cervical); would need modification for POC screening.
Although rare in the United States, […] is extremely deadly, and early noninvasive diagnostic modalities could improve this high mortality.
Our technology can be used as a non-invasive (non-endoscopic-based) tool for diagnosis and screening of esophageal cancer that is currently not available.
It is an easy-to-use platform potentially deployable in the clinic as well as at the bedside.
This technology has the potential as a screening process for remote and/or limited resource areas.
The technology can be used in dental office for quick screening of oral cancer, particularly in low-resource settings. The same technique can be re-engineered for cervical cancer screening as well in US.
Reduce the cost of care in US
there is a large percentage of the population that does not participate in colorectal cancer screening. a point of care urine based device would help minimize this

4.5.2 Why don't you think the technology could play a role in the U.S. healthcare system?
Response by Respondent
Not used in the US only LMICs
US providers are generally not interested in […] technologies since excision procedures play such a large role here. Regulatory bodies would be a barrier. If ablation therapy were approved by ASCCP there could be a role for office procedures and use in low-resourse communities. Right now, there is a lot of resistance to use […] in the US.
LEEP has largely replaced cryotherapy for treatment of cervical dysplasia in the US; however, […] could be viable alternative to standard cryotherapy to extent that cryotherapy is still used. however, we have not pursued approval by the US FDA
Availability of HPV vaccine and established cervical cancer screening program
I suppose it could, but my sense is that the deficiencies in KS diagnosis that we are addressing are not as present in the US making market adoption difficult.

4.6 Please describe any barriers to bringing this technology to market.
Response by Respondent
In US: no pathology In LMIC: […]: expense of unit unless able to be mass produced. Weight of unit.
Price
The inventor wanted to have a larger order before doing injection molds since it is so expensive. He did get requests for about 100 orders but it wasn't enough for him to make a large batch.
Thermal ablation is cheaper and less bulky-- this may be a significant barrier for […]
US regulatory environment
Interest from industry to use in LMICs
Limited interest in multi-nationals to address markets in low-resource settings. Costs of distribution viewed as high.
Potential Barrier - bundling the device with the appropriate gas cylinder customized for in-country supply of CO2
We were fortunate in being able to find an interested and motivated commercial manufacturer. there were a number of steps they had to go thru to be able to manufacture devices and to receive regulatory approval. i think the primary barriers were identification of an appropriate commercial entity and negotiating the legal steps needed for licensing transfer. an additional barrier was setting a cost that would be competitive with existing devices
Limited funding or interests in the US for diagnostics
Sustainable funding support
Test needs to have sufficient performance to be viable as as cervical cancer screening test and secondly, the test needs to be affordable in LMICs.
Regulatory, HIPAA, data transfer rules
Market size vs requirements for getting regulator approval
In LMIC countries, barriers are not only the lack of technology, but often the lack of political will and infrastructure readiness to scale up. In LMIC settings, there is also competition by other urgent needs to be addressed. Lastly, there are cultural barriers that at time may affect the effectiveness of creating an effective business relationship.
Mostly manufacturing and regulatory processes that must be completed.
none at this time

4.6 Please describe any barriers to bringing this technology to market.
Response by Respondent
Regulatory approval (pending), clinical trials data.
cost to develop diagnostics for cancer screening. Novel biomarkers are not part of practice.
It is costly and time-consuming for the preparation of documentation including the sufficient results for regulatory approval.
Industrial partners are difficult to find, and esophageal cancer is not the most prevalent cancer in wealthy countries.
Garnering funding to complete test development and validation phase.
Need to complete the design and verification before we can address the market applications.
One barrier we found is that the device is a low-cost system, which means the profit for the manufacturer will be relatively low, reducing the interests from some potential equipment manufacturers.
Fabrication

4.7 Please describe any facilitators to bringing this technology to market.
Response by Respondent
[…] needs to be bought by a larger company. The inventor has been in discussions with many companies about making this happen.
NGO's Studies showing its efficacy
Multiple analytes and ease of use
'- The global effort towards eliminating cervical cancer and meeting the 2030 SDG current recommendations links screening to treatment of screen positives - The current device already is manufactured by a commercial entity which recently received regulatory approval for use in base country
[…] had long-standing relationships in […] and with […], a major manufacturer of IUDs. this personal relationship was very important. competitive pricing was critical
We've been working with people in the Business school to identify and set marketing strategies for the US, Asia and Africa markets.
Developing the test on a standard, low-cost and easy-to-use assay platform.
MD […] administration
WHO guidelines recently published
UNITAID grant to several countries to use the technology
Industry with existing footprint.
Ministries of health and national NGO, as well as global health organizations.
Through both established biomedical/clinical and small start up companies.
none
Local industry is highly motivated, local clinical champions as well.
Finding suitable industry partners would probably facilitate market translation.
For a start-up will help accelerate the process and bring in more resources for translating the technologies to the market.
Nothing to offer on this item until complete manufacturing assessments by start up company.
We have developed a strong relationship with a commercialization partner who has demonstrated success in this arena.

4.7 Please describe any facilitators to bringing this technology to market.
Response by Respondent
Our […] team has been discussing with […] government health office to promote oral cancer screening program.
Enthusiasm from the community

5.1_7 What level of training do workers need to operate the technology? - Other (please specify): - Text
Response by Respondent
High-school level education with 1/2 training on the system
Scientist
basic laboratory technique
Training via video instruction movie is possible.
The technology itself is very simple to train a non clinical person to use. The trainig that is needed is in making a decision to treat or to refer a screen positive results

5.2_7 To the best of your knowledge, who has attended a training or a presentation about the technology? (Please select all that apply) - Other (please specify): - Text
Response by Respondent
US based study staff
undergraduate students

5.3.1 From which sector have these individuals requested information about the technology?
Response by Respondent
Dental device manufacturers, financial investors
Academic and private hospitals and clinics
Health Ministry, University, and involved hospitals.
Clinical research labs
oncology
Healthcare
Providers of cervical cancer screening
healthcare providers in LMIC and HIC
health
Research at meeting
Local government and clinics
Clinical diagnostics
Academia and industry
ministry of health; private venture capital firms
Cancer prevention researchers and policy makers
Researchers- US, […],[…], and […].
Clinical researchers
Health care
Medical schools

5.3.1 From which sector have these individuals requested information about the technology?
Response by Respondent
National Ministries of Health, national stake holders in health care, private orgainzations
Government (regulatory), commercial
Don’t understand the Q
US government and LMIC health care facilities
health
global health working on cervical cancer prevention
Other academic institutions
Research staff

5.3.2 From which sector have these individuals requested the technology itself?
Response by Respondent
Dental device manufacturers, financial investors
Academic and private hospitals and clinics
University and involved hospitals.
Both academia and industry
oncology
Healthcare
Providers of cervical cancer screening
healthcare providers in LMIC and HIC
health
Ministry of health
Local government and clinics
Clinical health care market
Academia and industry
ministry of health
cancer prevention researchers
Same.
Clinical researchers
Health care
LMICs, Med schools
National Ministries of Health, national stake holders in health care, private orgainzations
Government (regulatory), commercial
Don’t understand the Q
US government and LMIC health care facilities
global health cervical cancer prevention
Other academic institutions and industry
Research staff and manufacturers

6.1_6 Please provide the number of presentations, publications, patent applications or patents you personally have achieved related to the ACTs project. - Other (please specify) - Text
Response by Respondent
Digital atlas for training
to be answered by manufacturer
I am unsure about patents
journal articles in preparation
conference presentations

6.2.1 Please briefly explain why your ACTs program experience encouraged you to conduct more projects involving international collaboration
Response by Respondent
We have visited local communities in remote regions in LMICs and felt the strong needs of cancer screening in those regions. The local health workers are extremely interested in working with us and provide as much support as they could for the study. In addition to oral cancer screening, the local health workers are very interested in using similar technologies for cervical cancer screening as well.
There is a need and an opportunity.
We achieved success with launching our research study in the LMIC, and I expect this study to make a substantial clinical impact. I would like to see further impacts in other countries based on similar strategies.
Understand better the challenges and rewards in conducting the international collaboration
there is such a huge need
LMIC have a great enthusiasm to get things done right
Developing a technology that has high relevance to the low resourced settings was very encouraging. The technology was quickly adopted by the providers due to its simplicity, affordability and safety.
very encouraging results and great collaborations.
Inspired
It showed that the sensors are be looking for a way to do this.
I have a better understanding of critical global health issues and new technological approaches to address them. Also, I understand different environments create different needs, even for the same disease. The existence of NIH funding opportunities also plays some roles.
Collaborating with colleagues in settings that are targeted for the commercialization of the technology provide insights into what works and what does not work early in the development process.
Positive experience and productive collaboration with LMIC team
the ACT program assisted us in building infrastructure for technology development in […]. also the community of investigators has been a valuable resource for additional avenues of research
We had a very productive collaboration that resulted in improved technology and excellent training opportunities for students and trainees from all participating institutions
Knowledge of realistic LMIC applications. Personal connections (meetings, etc) has led to two key collaborations (CDC, […]).
great opportuniti to develop research capacity and generate local data on public helath issues
I think it has been rewarding
Although many hurdles and unexpected issues, very satisfying to work in the global arena.
It was difficult to get the […] onboard with international collaboration. The past four years have been a steep learning curve but we have grown from the challenges and now have systems in place. This will make subsequent projects much easier.

6.2.1 Please briefly explain why your ACTs program experience encouraged you to conduct more projects involving international collaboration
Response by Respondent
The possibility to validate a promising test, developed in the US, to prevent cervical cancer using samples and data from women from different countries, where many women may benefit from the new test in the future
Working in the settings of need / in close collaboration with those settings leads to sensitizes about the urgent needs in these localities. Looking simply at the challenges to do international work in LMIC settings per-se is not encouraging.
This experience has proven to me that it is possible to do meaningful projects. It is not easy, to be sure, but if the right partnerships are in place it can be done.
Better idea
I have not conducted more projects involving international collaboration but am open to it based on the great experience we've had.
We have had excellent communications and working relationship with our international partners, and we receive great satisfaction in working toward making a real difference in the healthcare of the […] people.
despite the challenges we encountered, the support from the ACTs management has simply been outstanding and the ability to network (and sometimes commiserate) with other ACTs recipients enabled us to learn from each other and in some cases collaborate to solve certain problems. finally, the experience of developing and growing collaborations with international staff in focus countries feels very rewarding.
working with local staff and nurturing their interest in not only about solving problem of cervical cancer but as well as implementing/conducting research
Through our ACT program, we established a stronger partnership and expanded our collaboration to people in other disciplines such as infectious diseases with […] University in […]. We recently established a new collaboration with the Institute of Infectious Diseases (IDI) at […] for new projects on the point-of-care diagnosis of HIV and other infectious diseases.
Contributing to Global health

7.1.1_1 Please specify the specialty and degree of the new training or education program - Specialty
Response by Respondent
Radiation Oncology
Surgical Oncology
Ob/Gyn
OBGYN
community health

7.1.1_2 Please specify the specialty and degree of the new training or education program - Degree
Response by Respondent
MD, PhD
FWACS, FMCS, FACS
Training/Ed program involves providers and health promoters s in a LMIC clinic
MD
non degree

7.1.2 Where is the new position? (Please give the name of the institution, the city, and state or country):
Response by Respondent
There is NOT a new position, but there is the perception of added qualification and skill through the project related activities, which in turn COULD open a new work position.

7.1.3 Would it be considered a promotion to a higher ranked position?
Response by Respondent
No

7.2 Based on this experience, what advice do you have for US-based researchers who wish to work with LMIC researchers?
Response by Respondent
Need to understand the local culture and regulations.
Seek reliable and committed partners; visit regularly. Listen to actual problems. Do not inflict U.S. views of needs and priorities on LMIC researchers. They know their patients better than anyone else does.
Be persistent and patient, and do not give up on your LMIC partner projects, since these can be quite rewarding and make an important impact on world health.
Gain a better understanding of the cultural differences and differences in ways and timelines of communication.
keep trying, there is a real need in these LMIC areas
Do some investigation on regulations in the country of performance and make sure that your team will follow those regulations and the US ones.
To continue such support
Find good collaborators
Give more feasibility to LMIC workers.
Try to understand the needs and huddles of the LMIC researchers, which could be a lot different from those in the US.
While it is challenging to work across cultural and language barriers, as well as different time zones, it is a great learning opportunity that I can only recommend to anyone that wants to develop technologies & products for LMICs. There is no better way to learn about the challenges a technology or product will face in the environment where it will be deployed.
Find partners who are dedicated and truly excited about the project
the key is having a strong long-lasting collaborative plan
Be prepared to spend real time there; essential for success.
Work as equals and develop research capacity
I think the key thing is developing deep partnerships and recognizing that you need to speak to their needs/career aspirations not the other way around.
Be very clear with protocols Have an in-country coordinator Have frequent/regular check-ins
Everything takes much longer than you think it will. Always have a plan B. Weekly check in calls are important- make sure you can be flexible with your hours because multiple time zone work is not easy LMIC work is incredibly rewarding and important!

7.2 Based on this experience, what advice do you have for US-based researchers who wish to work with LMIC researchers?
Response by Respondent
It is important to involve all researchers in all scientific and logistics decisions. Essential to plan all logistics with enough time and have contingency plans for unexpected drawbacks.
To be very open minded and accepting with regard to difficulties the foreign collaborators may face. Such elements will slow down progress rate tremendously, and while a learning and improvement process should also be expected on the side of the LMIC collaborators, it is important to calculate this at an early time point into the program, because otherwise big disappointments and failed timelines may be a consequence.
Establish strong partnerships. That is the number one factor. Be present and listen to the needs. Be prepared to be extremely patient and focused on the long term goals.
Find a team that is motivated and dedicated to the project for the long haul.
Build your working relationship as early in the process as possible. Identify individuals that can help you in transporting materials and supplies to the LMIC and ensuring that the target entities actually receive them.
do your homework and choose collaborators carefully. developing and implementing some type of checklist would be helpful to assess baseline readiness of staff to implement research and country requirements for approvals and financial logistics. it is critical to assess ability to recruit individuals meeting the inclusion criteria
microfluidic (specifically, magnetofluidic) devices for […] sample preparation and rapid PCR detection for point-of-care detection of genetic and/or epigenetic markers for cancer, infectious diseases, and other diseases.
Not applicable

8.1 What is working well with your ACTs program project?
Response by Respondent
Good collaborations with global sites
Not sure, not really connected over the last year. We're just the technology developmental company and not doing the clinical study.
clinical testing of technology has been very successful with excellent outcomes. The collaboration has also been extremely rewarding and we are confident that we have started something that will continue to grow
Clinical study
Great collaboration to move the technology forward
the collaboration is strong
1 - Commercial Partner 2 - IRB Approval 3 - New partner to implement phase 3
1. we have found a commercial manufacturer and devices are ready for marketing 2. we had some unexpected findings initially in Phase 1, which caused delays and required re-working of the device and re-thinking outcome measures (i.e., […]) as valid surrogates for efficacy 3. after difficulties in recruitment for the second phase of our study, we have been able to identify an alternative country site, with significant research experience (Which also eased our in-country approval process) and a detailed implementation plan
Collarborarions
Enrollment
The collaboration with the LMIC team.

8.1 What is working well with your ACTs program project?
Response by Respondent
The overall program is going very well. I hope the funding mechanism continues.
Collaboration within the US team.
The collaborations with […]. The project approach and specific aims. The development of the system.
The completion of UH2 and the requisite target enrolment The communication between the LMIC researcher and the US based entity The support from the NIH liaison officer
The team, the technology, clinical trials
central coordination and interactions between grantees
The collaboration with multiple partners, with the company developing the test and the local investigators
Overall, the existence of the program in itself is a great asset and opportunity that is very welcomed and that greatly enhances chances of adeqaute technology development AND implementation. The meetings with all grantees are very useful towards sharing of experiences that stem from a shared common challenge, the LMIC work.
The end goal for use in LMICs of the technology helps to focus the team effort.
great guidance
Partnerships are excellent, particularly with the commercial partner in-country. Technical aspects have been going well. We have hit no fundamental roadblocks. I am excited about the new collaboration with another ACT program.
We really have outstanding collaborators at the LMIC site.
strong cross-disciplinary collaboration between clinicians, medical staff, medical scientists and engineers.
The interdisciplinary, international collaborative team members are working productively together.
We're making important strides in the technology, and all team members - both domestic and foreign - are enthusiastic and engaged.
1. Strong support from NIH. 2. Excellent collaboration with local researchers. 3. Strong support from the local communities.
Recruitment
the LMIC collaboration

8.2 What is not working well with your ACTs program project?
Response by Respondent
Ditto above
Enrollment has proven more difficult than anticipated
Patient recruitment was slower than we hoped for (see previous responses). In hindsight, expansion of eligibility to include high risk precancerous lesions may have yielded more rapid recruitment
Sustainability over the long term
it has been difficult to commercialize the technology
very little
1. the biggest problem has been slow recruitment in Phase 1 and inability to recruit in Phase 2 2. delays in local approvals in Phase 1 and logistical constraints in terms of financial transfers between the US and […]
Delayed start for the part three coupled with looming project end.
Recruitment
Getting to the point of commercialization.

8.2 What is not working well with your ACTs program project?
Response by Respondent
Nope
Struggle with the administrative tasks associated with the grant because as an industry participant we do not have any support as our colleagues from academia.
Logistical and administrative barriers.
The recruitment for UH3 is slower than expected
I think we are exceeding what I had expected. What is not working well in a sense is the amount of time it is taking for us to get IRB approval.
At the beginning was difficult to maintain the timeline proposed due to unforeseen delays, but this has improved with time
financial administration too slow and unresponsive
I do not have anything springing to mind, but I am only collaborator on this project.
Getting to understand better the culture, communication, and constraints of LMICs.
none
Institutional support at the clinical partner site is somewhat weak. Things are moving more slowly than I would like, frankly.
The majority of the work gets done when in person. The regulatory issues are still a process.
patient enrollment and sample collection are slower than we expected.
Shortages of clinical equipment and infrastructure sometimes delay or obstruct study progress.
Logistics, including obtaining well characterized human samples to test the platform.
Shipping of the devices to LMICs. For our project, we need to ship ~100 devices to […]. It takes a long time to get the custom clearance.
Machine design
The technology development can be difficult to perform on such a tight timeline required by the UG3

8.3 What surprising issues have you encountered with this project?
Response by Respondent
About the change in the project after it was started
Enrollment is much harder than I would have thought. There are many regulatory and site-specific issues that were not originally anticipated.
Resistance of some members of the US research community to the assay
the lack of interest on the part of multi-nationals in the market in LMICs
1) insight into translating an idea into a product is an iterative process and, in hindsight, could have been a journey made easier with a manufacturer or a commercial partner working at the very start 2) Physics of freezing and its impact on living tissues is more complex than what we previously understood
Lack of properly trained staff
the length of time it took to get things off the ground the lack of experience of senior academic personnel in our country partner with the requirements of rigorous research
the challenges of identifying women with high grade cervical dysplasia in a country where access to screening and to evaluation of abnormal screening is limited
Longer IRB process in the US vs in the LMIC.
Nothing in particular
We had some delays in IRB approval, but we addressed those well and the experience is valuable for us to design future studies.
Nothing comes to mind.
Variability in collaborator effort and engagement.

8.3 What surprising issues have you encountered with this project?
Response by Respondent
none
The challenges with finances going across borders.
Science / clinical work always has "surprise" to offer in that something happens that was not seen before on a technical performance level. In this particular setting, it is the more extensive use of clinical samples which might have resulted as outcome in detection of activities that lead to more cross-reactivity in test outcome than it was seen before.
The variety of products being developed and validated that if proven efficient may improve global health by preventing different cancers or offering accessible treatment
How some seemingly simple questions can take a long time to answer, and some seemingly harder processes can take a shorter time than expected, which might be related to the fact that administrative processes are not very transparent.
none
Regulatory system in-country has been a surprise. Thankfully we have a good team to help with this.
A fire in the LMIC lab would have wiped out our biorepository, except for luck- the samples were moved the day before. The electricity is variable; the humidity impacts the components. Customs delays for reagents that cannot be purchased directly in […].
Many healthcare elements that we take for granted (e.g., health insurance) are not a given in LMICs.
NA
We had not properly recognized the problems with the changes in sample viscosity.
In the remote regions ([…]), we found that ~8% of young people between the age of 15-19 years have pre-cancerous lesions.
New metabolites discovery
one of our co-PI died which affected our work at the technology development site

8.4 What do you wish you had known before starting this research project that you know now?
Response by Respondent
Everything takes longer than expected (which I guess I knew before too)
The changes during the grant time
How to find the right commercialization partner prior to starting the project and have worked in partnership throughout the study
We might have been better off to select a local partner for commercialization
Better understanding of LMIC. Staffing. More training on document submission to NIH. More resources for questions
see above! i think primarily is a more realistic understanding of timelines needed and considering these in terms of strategies to keep things moving forward. a lot of prompting and support needed for local team
see item 1 above
IRB approval for international collaborations could take a much longer time than expected.
Nothing comes to mind
Logistical issues.
None
Not so much with this one, but with others - how important an existing true partnership is.

8.4 What do you wish you had known before starting this research project that you know now?
Response by Respondent
Nothing particular coming to mind.
Processes and mechanisms are not well established in LMICs, and exactly what they are can be unpredictable.
regulatory hurdles
I wish I would have known more about the crucial need to establish good partnerships. I knew this in my head but now I know it in my gut.
Carefully explore all possible LMIC partner options to choose the best one.
Logistics, logistics, logistics!
We had worked with the local researchers before the project started, so we had a good preparation before the project.
Assay for the hand held device
nothing

8.5 Is there anything else you would like ACTs program staff to know about the program or your specific project?
Response by Respondent
Don’t have any comment - not connected hardly at all in the last year
Thank you for this opportunity!
The gap between the first 2 years and the last 3 years was problematic and set the project back. Otherwise NCI has been exceedingly helpful. Annual meetings were quite informative and useful.
Thanks for the support (funding and collaboration)
i appreciate the incredible support given and the belief in our device. although we are behind and now in a no-cost extension, we believe we now have a clear path forward and continue to believe that this device will be another valuable tool in the armamentarium to prevent cervical cancer
More Collaboration between projects for exchange of ideas. Not only at the PI level but for other staff such as coordinators
we believe that the device has a great potential to support the elimination of cervical cancer in LMIC. I thank the ACT program staff for all their assistance.
The program has been excellent and the staff has been very supportive of the project. I hope the funding mechanism continues and provides opportunities to develop more new technologies for global health.
No
We would like a path forward for continued development. Given immense progress, we would like to continue the work. There is no clear way for additional funding support for further development. That said, it is an amazing program, and we would like to thank the NCI and ACT program staff for their support and assistance. We hope it will continue for new investigators (and have an extension mechanism for existing ones).
No
I think this is a strong program one that I am glad you you are planning to continue (as I understand it). VERY confidentially I would relay that I think the first and second cohort of this program were very strong. Perhaps I'm biased but the third cohort did appear to be significantly weaker and my interpretation of this was that the partnerships between the US and LMIC partners were not well established in advance of the program. Again I don't see the whole program but this was my take from the annual meetings at least.
Big "Thank You" to all the staff for their excellence in work they are doing!

8.5 Is there anything else you would like ACTs program staff to know about the program or your specific project?
Response by Respondent
Not at this moment.
This experience, so far, has been wonderful. I believe we are going to make an important impact. Thank you for your support.
I can't think of anything else.
NA
We think the UG3 phase should have been planned for longer duration to work out all the challenges we encountered.
The local communities and government are interested in oral cancer screening program we are promoting. We may include additional study sites. Thanks a lot for the great support from ACTs program staff.
its the best grant program I've worked with inside/outside the NIH.
None

APPENDIX C: REPORT OF CASE STUDY FINDINGS (SUBTASK 3C)

Appendix C.1: Interview Instrument

CGH ACTs Program Evaluation
Case Study Interview Guide
FINAL 1/2/20

Introduction: Hello – Thank you for taking the time to help us out today. My name is […] and I work for Westat, which is located in Rockville, MD. I want to start with a little background on what we'll be doing today.

Westat conducts evaluations and research on many different topics, under contract with many different organizations. Currently, we are working with the National Cancer Institute's Center for Global Health (CGH) Affordable Cancer Technologies Program (ACTs Program) to interview a number of people, such as yourself, with direct involvement in ACTs Program grants. The goal of these interviews is to help us better understand the activities you're doing as part of the grant, as well as the context of those activities. These interviews are NOT intended to evaluate individual grantees or projects, but rather to help us get a picture of and improve the overall ACTs Program.

What is involved: This call will take no more than 1 hour. Participation in this interview is voluntary. You can skip any question and stop at any point during our call. There are no right or wrong answers, and we really appreciate your honest responses. Please feel free to interrupt with questions at any point, or ask me to rephrase or clarify a question.

Any comments you make in this interview will not be attributed to you in our report. However, since CGH staff have selected your grant for participation in the case study component of this evaluation, NCI is likely aware of your participation and it is possible that they'll be able to identify you as one of the individuals making the comments described in our report.

Do you have any questions before we get started?

Consent: Do I have your permission to conduct this interview?

Do I have your permission to audio record this conversation? We're recording to make our report preparation easier and as a backup for our note-taking. NCI will not receive the recordings or transcripts of these interviews.

[INTERVIEWER: IF PERMISSION GRANTED, START RECORDER AND GET VERBAL PERMISSION TO CONDUCT INTERVIEW AND RECORD AGAIN]

I have now started my recorder. It is [DATE AND TIME]. I'd like to reconfirm that I have your permission to conduct this interview and that I have your permission to record. Is that correct?

INTRODUCTION

1. Can you please tell me your current title and institutional affiliation?

2. Please provide a very brief overview of your work funded by the ACTs Program.

    PROBE: What are your responsibilities on this ACTs Program grant?
    PROBE: Who else works on this grant with you? Who are the key individuals we should be talking to?
    PROBE: Who are your key collaborators at the [LMIC/US]?

CONTRIBUTION AND IMPACTS OF THE ACTS PROGRAM GRANT

I'd like to first ask a few questions about the outputs and accomplishments of your ACTs Program grant so far.

3. In what ways do you think that your ACTs-funded research fills gaps in global oncology research?

4. What do you consider to be the most significant impacts and successes of your ACTs-funded research?

[INTERVIEWER: ASK SUBQUESTIONS 4A-4E UNLESS THEY WERE ADDRESSED IN RESPONSE TO Q4.]

4a. What interventions, protocols, devices, and/or assays have you developed?

4b. What technological innovations have resulted from this work?

4c. How has the work conducted with your ACTs grant helped you grow as a scientist, i.e. what have you learned that you did not know before?

4d. What publications have resulted from this research? Could you provide a list? What other publications, presentations, etc, are in the works?

    Probe: Are members of the LMIC teams getting involved in these publications and presentations?

4e. Has your research contributed to the training of other scientists? If yes, please explain how it has contributed to this training.

- Roughly how many scientists would you say have been trained? In the US? In the LMIC?

- Was there a training infrastructure in place when you were getting started at the LMIC? Has there been any change in the training infrastructure at the LMICs as a result of this research project?

4f. How has this research contributed to the improvement of healthcare delivery at your testing sites thus far?

4g. When getting started in this research, what outcomes [innovations, technologies, publication, trainings, patents, or others] had you hoped for? Which took place, and which have not?

5. Looking back, is there anything you would have done differently to improve your outcomes (such as those discussed above)?

6. What are your thoughts about the applicability of your work in other parts of the healthcare continuum, i.e. other diseases, other healthcare settings, other populations, etc?

7. What are your thoughts on the applicability of this work outside of [the LMIC where it's being tested/your country]?

   PROBE: Do you feel this work could be used in the US? In other countries? If so, how could it be used?

8. What are the major challenges you've encountered in your ACTs-funded work?

   PROBE: Challenges with the science of the research conducted?
   PROBE: Challenges pertaining to conducting work in your study sites? (e.g., forming partnerships, staffing grants, recruiting patients, cultural barriers, institutional barriers, etc.)
   PROBE: Have you had any difficulties obtaining regulatory permissions?
   PROBE: To what extent have you been able to generate industry interest thus far?
   PROBE: Have you found funding to be sufficient?

[*INTERVIEWER: TRY TO ELICIT EXAMPLES FOR EACH OF THE CHALLENGES DESCRIBED*]

9. How did you address the challenges you encountered?

   PROBE: Which challenges, if any, have you not yet been able to overcome? Do you know why that is?

10. Knowing more about the challenges mentioned above now, what would you have done differently?

11. Can you think of ways that NCI as your funding authority could have done more to help you overcome the challenges described above?

COLLABORATION/PARTNERSHIPS

I'd like to ask a few questions about the US-LMIC partnerships developed to support the research conducted under your grant.

12. How did you initiate your US-LMIC partnerships for the ACTs Program grant?

- Was there a partnership in place already before the grant application? If so, can you describe what it looked like? I.e. Did your institution have already any ties to the respective LMIC institution?
- [*If partnership was formed specifically for the conduct of this work*] Can you describe how the partnership came to be? Was it a lengthy process? Any specific hurdles you would like to mention?
- To what extent do you feel your US based team was ready to partner with the chosen LMIC team? *[if needed, explain: readiness in this case relates to both scientific and institutional know-how]*

13. Can you briefly describe the roles filled by the US team vs. the LMIC team?

14. What types of challenges have you experienced in the course of your partnership?

    PROBE: Challenges in maintaining the partnership? I.e. Institutional, political, cultural, financial, personal, knowledge/training based, etc.

[*INTERVIEWER: TRY TO ELICIT EXAMPLES FOR EACH OF THE CHALLENGES DESCRIBED*]

15. How did you address these partnership challenges?

16. What lessons have you learned regarding establishing a successful partnership between a US institution and the international sites participating in this research?

    PROBE: What lessons have you learned about working globally that you've been able to take back to your work in [the US/your country]?

17. What types of supports – from NCI or from the US and LMIC institutions involved - would further promote the success of US-LMIC partnerships?

18. Overall, how has this collaboration contributed to your research and development efforts?

19. What unexpected results have come about from these partnerships? By "unexpected results," we mean accomplishments or other outcomes that you did not foresee or anticipate when you began this work.

ACTs PROGRAM IMPROVEMENTS

Next, I'd like to discuss your perspective on potential changes or improvements to the ACTs Program.

20. What additional support or resources do you need for your ACTs-funded research?

    PROBE: Who do you think could provide that support?
    PROBE: Do you think the existence of a coordinating center may be helpful?

21. What changes would you suggest for the ACTs Program moving forward?

WRAP-UP

22. Is there anything else you'd like to say about the ACTs Program, beyond the topics we already discussed today?

[INTERVIEWER: CONFIRM LIST OF OTHER INTERVIEWEES FOR THIS GRANT AT THIS POINT IN THE INTERVIEW]

Thank you for your time and your comments! Your input is valuable.