Department of Health & Social Care

UK Vaccine Network Project Annual Review 2020/21

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Contents

Abbreviation list

Abbreviation	Term
BBSRC	Biotechnology and Biological Sciences Research Council
CEPI	Coalition for Epidemic Preparedness Innovations
CSA	Chief Scientific Advisor
CCF	NIHR Central Commissioning Faculty
CCHF	Crimean Congo Haemorrhagic Fever
EPSRC	Engineering and Physical Sciences Research Council
GIAA	Government Internal Audit Authority
LMIC	Low and Middle Income Countries
MERS	Middle East respiratory syndrome
NETSCC	NIHR Evaluation, Trials and Studies Coordinating Centre
NIHR	National Institute for Health and Care Research
ODA	Official Development Assistance
R&D	Research and Development
ToC	Theory of Change
IUK	Innovate UK
UKVN	UK Vaccine Network

1. Summary and overview

Project Title: UK Vaccine Network

Project Value (full life): £134m

Review period: 1 April 2020 - 31 March 2021

Project's Start Date: 21 October 2016

Project's End Date: 31 March 2022 **(with a few projects extended to 2023)**

Summary of Project Performance

Year	2019	2020	2021
Project Score			B
Risk rating	Amber/Green	Amber/Green	Amber/Green (Medium Low)

1.1 Outline of project

The UK Vaccine Network (UKVN) Project is funded through Official Development Assistance (ODA) by the Department of Health and Social Care (DHSC). It aims to improve health security in low- and middle-income countries (LMICs) by supporting the research and development (R&D) of vaccines and vaccine technologies to combat diseases with epidemic potential, focusing on diseases that primarily impact LMICs.

An investment strategy for the UKVN Project was developed using advice from the UKVN expert group, a group of experts from academia, industry, government, and philanthropic organisations, chaired by DHSC's then Chief Scientific Adviser (CSA), now Chief Medical Officer, Professor Chris Whitty. The UKVN expert group was established in 2015 and identified 12 priority pathogens with epidemic potential in LMICs, on which efforts should initially be focused[1], alongside 'Disease X'. The term "Disease X" was adopted by the World Health Organization and suggests an international epidemic could result from a pathogen currently unknown to cause human disease. The expert group has continued to meet annually and works to understand wider policy issues around vaccine development

[1] The priority pathogens are: Chikungunya, Crimean Congo Haemorrhagic Fever (CCHF), Ebola, Hantavirus, Lassa Fever, Marburg, Middle Eastern Respiratory Syndrome (MERS), Nipah, Plague (Yersinia pestis), Q fever (Coxiella burnetii), Rift Valley Fever and Zika.

and manufacturing. The group has produced and published tools to aid research and policy decisions.

Seven research competitions were designed and established on the advice of the UKVN expert group. These competitions were run through experienced cross-government delivery partners, who now manage the funded research projects. The delivery partners are: Innovate UK (IUK, who manage 3 research competitions), Biotechnology and Biological Sciences Research Council (BBSRC), Engineering and Physical Sciences Research Council (EPSRC) and 2 bodies of the National Institute for Health Research (NIHR) – the NIHR Evaluation, Trials and Studies Coordinating Centre (NETSCC) and the Central Commissioning Facility (CCF).

The UKVN portfolio is comprised of 78 R&D projects, focusing on pre-clinical and early clinical development of vaccines for the UKVN's 12 priority pathogens, as well technologies for vaccine manufacture and distribution, and associated epidemiological research. It was originally anticipated that all projects would complete by March 2021. While many have achieved this, the COVID-19 pandemic has meant a number required extensions to meet their original objectives. These extensions were granted where appropriate; the new overall endpoint for the current phase of the UKVN Project is March 2022 (with a few extended till March 2023).

1.2 Summary of progress

This section includes a summary of progress and a supportive narrative for the overall score. At the beginning of this reporting period, it was expected 20/21 would be the final year of the current phase of UKVN. The impact of the COVID-19 pandemic was not fully understood and whilst it was clear that delivery of some of the funded R&D projects would be affected, the extended impact of the pandemic could not have been anticipated.

However, by September 2020 it was clear that a significant proportion of projects would not be able to complete as planned due to several reasons. Firstly, several projects were unable to continue funding staff, facilities, and capabilities during lockdown, meaning they had insufficient funds to meet their original objectives. Furthermore, some projects repurposed work packages to COVID-19 work (following DHSC assessment and approval). Both these reasons resulted in researchers requesting for additional time in 2021/22 and additional budget to complete. Lastly, due to the impact of the pandemic on the R&D sector, some projects were unable to be completed within the 2020/21 financial year, which requested additional time in the next (2021/22) financial year to fulfil their objectives. This required movement of some expenditure from 2020/21 to 2021/22, but no increase in overall project budget.

The delays and repurposing of funding due to the pandemic, resulting in a change to the project's endpoint, meant that some of the milestones set for the year against the

indicators in the project logframe were not achievable or applicable. Reduced capacity within the UKVN Project team, including the then Project Lead and Project Manager being redeployed to COVID-19 activity for significant parts of the first half of the year, limited the team's capacity and their ability to undertake some activities and implement all recommendations from the last annual review. Despite these factors, the UKVN Project performed very strongly through an exceptionally challenging year. Whilst some projects have been delayed, all have continued to make progress, with many already completing original objectives and delivering valuable results and impacts.

The UKVN Project now has multiple success stories to evidence its value and support the case for funding the next phase which is detailed in Section 4 Project Performance.

Given the UKVN Project did not conclude its current phase in the reporting year as originally planned, and that the competing priorities of the pandemic meant that the project logframe had not been updated to provide a framework for evaluating progress considering this changed context, an overall score of a B has been awarded for this reporting period. This indicates that it 'moderately failed to meet expectations' and reflects the B score awarded for the output 1, which is the most heavily weighted output in the logframe.

However, in considering the risk rating for the project overall, which reflects the risk of the project not being successful in its current phase, a 'green' rating has been applied. This means it is considered highly unlikely that the UKVN Project will not deliver value for money and significant contributions towards outcome and impact (as defined in its Theory of Change) by its new endpoint for the current phase of March 2022. This scoring approach also does not fully reflect the impact of UKVN funding in supporting the response to COVID-19.

1.3 Progress against recommendations

This section includes a progress against recommendations from the last review. It should be emphasised that due to the end of this phase of UKVN being extended to March 2022, several recommendations have not been achieved however, will be prioritised in the next reporting period and final year.

Project Management

1. "The impacts recorded for the types of projects and types of organisations supported in the 2016-2020 period should be reviewed in order to design a programme that ensures optimal participation from different research agencies, including small to medium-sized enterprises (SMEs) and organisations in LMICs."

Not achieved: a structured review has not been conducted in the reporting period; however, this was deliberate, reflecting the change to the project's endpoint, delaying the

need to design the next phase of the project. A review of impacts would be most appropriate to complete when the research projects conclude.

2. “UKVN working group outputs have not been presented at international meetings and this is something that should be taken forward in the 2020/21 communications strategy.”

Not achieved: Partially completed: working group outputs were not presented at any meetings, largely because the number of international research forums decreased due to COVID-19, and because the outputs are owned by the working group members, so it is not necessarily the prerogative of the UKVN team to share these. However, these outputs have been shared across other forums, e.g. through the UKRI-hosted website and publications in academic journals. International traffic to the website hosting the tools produced by the working groups increased during the pandemic, indicating their potential value to researchers.

Examples of published material:

- Vaccine Development - Decision Making Guide [Internet]. Vaccinedevelopment.org.uk. [cited 30 May 2022].

- Vaccine Development Process Map [Internet]. Vaccinedevelopment.org.uk. 2020 [cited 30 May 2022].

3. "LMIC collaborations should be a pre-requisite of a proportion of UKVN funding in the future.”

Not achieved: due to the change to the project endpoint and the delay in designing future funding, the work to ensure LMIC collaborations in future funded activity did not take place during the reporting period, however this remains an ambition that will be considered in the design of the next phase of the project (underway in reporting period 2021/22).

4. “UKVN case studies should be published.”

Partially completed: several case studies (included in annex A) were produced, with the intention that the material could be modified and drawn upon for both external communications and internal evaluation purposes, however as yet these the majority of these have not been used for external publications. A case study was published in the UK Covid 19 Vaccines Delivery Plan in January 2021.

5. “Increase UKVN team resilience by building capacity for agile working across the Preparedness and the wider GHS team. An increased team capacity should also be considered as part of the design of the future project, including joint posts with the GHS partner R&D project, Global AMR Innovation Fund (GAMRIF)".

Completed: Recruitment was undertaken for a Project Officer post that would support both GAMRIF and UKVN, however it was decided that UKVN would be better supported by the addition of a full-time Project Officer post and recruitment was initiated for this. The UKVN and GAMRIF teams continue to work closely and meet regularly to share lessons and provide support.

6. “UKVN Project team and delivery partners to continue to embed safeguarding considerations in their ways of working. To assist this, project staff should watch UKCDR's webinar on 'Preventing Harm in Research: Safeguarding in International Development' to increase their understanding of this issue.”

Partially achieved: the UKVN Project Manager and the GHS Preparedness (part time UKVN) Project Officer attended Bond Safeguarding training with other DHSC staff in December 2020. However, the UK Collaborative on Development Research (UKCDR) webinar has not been viewed by new staff, and conversations with delivery partners about incorporating safeguarding expectations into their Memorandums of Understanding with DHSC are still ongoing.

Finance

7. "With the UKVN funded projects nearing their completion, it is recommended that full financial reconciliations are undertaken by EPSRC and BBSRC to ensure that payment schedules can be revised as appropriate in line with project expenditure and updated forecasts.”

Partially achieved: given the delayed UKVN Project endpoint, a decision was taken to do a full reconciliation when funded projects are concluded or just before. However, smaller project-level reconciliations have been undertaken by BBSRC and EPSRC.

8. "A recommendation from the Fraud Risk Assessment completed by the DHSC Anti-Fraud Unit is to introduce an invoice spot-checking process. This will be followed up with delivery partners and implemented in 2020/21.”

Not achieved: A GHS portfolio wide spot-check process was undertaken in 2020/21 with plans to implement specific a UKVN programme level process in 2021/22.

Theory of Chance (ToC)

9. “Assumption 8 should be updated to reflect the likelihood of a phase 2-ready vaccine being affected by not only the number of vaccine candidates in the pipeline but the type and range of vaccine platform technologies they are based on.”

Not achieved: due to limited capacity and staffing changes the ToC was not updated in the reporting period, however this will be a priority for future.

10. “An additional assumption should be added to reflect the requirement for sufficient manufacturing capacity to produce the quantity of doses required for deployment during an epidemic.”

Not achieved: due to limited capacity and staffing changes the ToC was not updated in the reporting period, however this will be a priority for future.

External Engagement

11. “The UKVN project should seek to expand its reach and recognition based on an effective community of practice. A review or opinion piece in an academic journal would raise awareness of the project amongst the research community.”

Not achieved: this task was going to be undertaken by the Project Manager in post at the start of the reporting year, who had an appropriate academic background. Due to their leaving the team early in the year it was not completed, and the team do not anticipate obtaining the skill sets necessary to undertake this in the future.

Monitoring, Evaluation and Learning

12. "A recommendation from the Publish What You Fund assessment (December 2019) was to prioritise improving the quality and amount of performance data, particularly results or shared learning.”

Not achieved: work is ongoing across the GHS Programme to ensure better consistency and quality in publishing for transparency, the Project Team are engaging with the Programme Management Office on this. As noted above, in recommendation 4, project results and learning will be shared through case studies which were compiled this reporting period going forward.

13. "All recommendations from the interim evaluation should be reviewed and, where appropriate, implemented in the current programme or incorporated into future Project design.”

Achieved: a management response detailing whether DHSC accepts, partially accepts or rejects the different recommendations, and the actions to be taken, has been published alongside the evaluation. Appropriate recommendations have been actioned; will be actioned in the 21/22 financial year; or will be incorporated into future project designs.

14. “Lessons learned from the UKVN event held in February 2020 should be considered during the design of the next stage of the UKVN project.”

Partially achieved: Lessons learnt were considered when considering the next phase of the project early in the reporting period when a multiyear spending review was expected, however the confirmation of a one-year spending review and delay of the current project endpoint meant that work on designing the next phase was delayed. This is something the UKVN are prioritising for 21/22.

1.4 Major lessons and recommendations

This section includes major lessons and recommendations for the year ahead, along with the not achieved and partially achieved recommendations above, the following will be a priority for the next reporting year:

1. The UK Vaccine Network Expert Group should be reconvened to identify if any updates are required to the policy tools the group developed, given changes in vaccine landscape and COVID-19's impact.

2. As projects are closing by March 2022, tweets, publications, and communication content should be planned to be published after end of projects. The UKVN project team should also consider developing a UKVN website to host long form content.

3. A process should be implemented for documenting and sharing lessons learnt across delivery partners, researchers and internally as projects are closing.

4. Scoping and planning for an impact evaluation should occur for end of current UKVN phase.

5. The UKVN log frame should be updated to reflect the post-COVID-19 vaccine research landscape, with focus on updating milestones to ensure they are quantifiable and reflect expectations ahead of next reporting period.

2. Theory of Change

2.1 Summary of changes

This section includes a summary of changes to the project's Theory of Change.

The Theory of Change (ToC) model for the UKVN (Annex B), which covers both the UKVN Project and the policy work of the UKVN expert group, was not updated during the reporting period

All the outcomes remain relevant, but 2 of them stand out as particularly prescient in light of the UKVN Project's influence on COVID-19 vaccine development, 'new technologies accelerate vaccine response to an unknown pathogen' and 'UK R&D community is ready and able to support future public health emergencies.

The broader impacts defined in the ToC are aligned with those in the GHS Programme's Theory of Change, covering 'prevention and reduction of the likelihood of health emergencies' and 'rapid and effective response' – the significance of the latter is also highlighted by the UKVN's contribution to the pandemic response.

2.2 Project's progress

The UKVN Project logframe defines a single outcome of ‘new technologies and vaccine candidates for epidemic diseases are advanced’. Considering the additional year now added to its current phase, the UKVN Project is on track to make a significant contribution to this in its new final year.

The first indicator for the outcome is described as ‘vaccine pipelines for pathogens on the UKVN priority list are diverse, with products at all stages of the development process’. With a significant number of projects focused on the priority pathogens already complete, and more on track to complete in the next year, it is clear that UKVN funding is diversifying the pipelines for these diseases in the development stages it is focused on (late pre-clinical and early clinical, identified as an area of market failure prior to the outset of the project). It will take more time for this to have a downstream influence on increasing the diversity of vaccine candidates in later stages of the pipeline, and this will also be dependent on follow-on funding from other organisations.

Another indicator for the outcome was ‘technologies and tools to support the deployment of vaccine candidates in outbreak-affected countries are advanced and informed by LMIC collaboration’. Progress towards this can clearly been seen in the completion of projects in the Epidemiology for Vaccinology strand and the continued success of the 2 vaccine manufacturing hubs, with several significant LMIC collaborations supporting these. For example, the Emergency and Epidemic Data kit (EDK, more detail in Annex B) was instrumental during the 2018-2020 Ebola outbreak. The EDK removed the need to handle an estimated 15 million pieces of paper and saved hundreds of thousands of data-clerk/analyst hours. It played a critical part in the roll-out of a breakthrough Ebola vaccine.

The expected long-term impact for the UKVN Project described in the logframe is ‘global community is able to prevent and reduce the severity of outbreaks through availability of vaccine candidates and associated technologies that can be readily deployed under emergency situations’. Given the timeframes associated with vaccine development it will take some time before the contribution of the UKVN Project to this impact can be fully evaluated, however the aforementioned progress towards indicators 1 and 2 show this work has the potential to progress ‘the global community’s ability to prevent and reduce the severity of outbreaks through availability of vaccine candidates and associated technologies’. Additionally, the COVID-19 pandemic has clearly highlighted how vulnerable the global community is to disease outbreaks, and the UKVN Project’s contribution to the development of vaccine solutions for this new threat (both through the rapid reorientation of some of its portfolio of funded projects and through the adaptation of technologies developed for other pathogens) can be taken as an indication of its value in addressing a broader range of epidemic and pandemic threats.

2.3 Changes to the LogFrame

The project logframe was reviewed when the last annual review was conducted in summer 2020. The only changes made were to some of the indicators for output 1, explained in section 3.1.2 below. While it would have been beneficial to review again later in the reporting period, the ongoing impact of the pandemic and the granting of extensions into 2021/22, alongside limited capacity and staff changes within the UKVN Project team, meant this was not possible. As a result, the milestones set for the indicators in the logframe do not reflect the fact that the 2020/21 reporting period is the penultimate, rather than final, year in this phase of the project.

On reviewing the logframe for the purposes of the current annual review, with the support of the GHS Programme MEL lead, the project team have also recognised a number of broader shortcomings in its design. These are explained in more detail in the sections below that relate to each output, but the key issues to be remedied are the quantifying of milestones to allow accurate reporting and updating logframe to reflect one-year extension by setting new final year milestones for 21/22. Another weakness is that the logframe is not appropriately designed to assess impact for this stage of the UKVN. The logframe was developed at the start of the UKVN when the project was being set up and the indicators were designed to reflect progress against this stage. As a result, the indicators for later years lack detail and were not effectively designed to support evaluation of the project's endpoint.

Moving forward, there is a strong argument for aligning the logframe more closely to the Theory of Change. However, given that 2021/22 will be the final year of the current phase, it may not be practical to heavily revise the logframe structure in this period, however at a minimum the output on project management should be removed and realistic measurable milestones set for indicators for the other outputs ahead of the next Annual Review. For the future phase of the UKVN it would be advisable to design a new logframe at the outset, reflecting the outputs, outcomes and impact set out in the Theory of Change.

3. Detailed output scoring

3.1

High quality research that aims to:

- Feed the vaccine development pipeline for 12 priority pathogens and Disease X
- Test new platforms and technologies to accelerate vaccine development (including for Disease X)

- Produce processes and products to support vaccine manufacture and delivery in LMICs

- Produce and test epidemiological models for optimal vaccine deployment for UKVN priority pathogens

Output number: 1

Output score: A

Impact weighting (%): 60

Weighting revised since last AR? No

Risk rating: Green

Risk revised since last AR? No

Indicator(s)	Milestone for the review	Progress
1.1 Competitions that cover these four research areas are run successfully.	Achieved	Achieved prior to reporting year
1.2 Number of Projects active and completed.	'≥70 projects contracted (cumulative), c.60 of which complete	Partially achieved
1.3 UKVN funded projects generate outputs	'Wide range of high quality outputs generated'	Achieved
1.4 UK research from across academia and SMEs is accessed to support Project aims.	≥ 25% active projects are from SMEs	Achieved prior to reporting year

3.1.1 Supporting narrative

This output relates specifically to progress in research and development funded by the UKVN Project, across the focus areas of vaccine development (early-stage clinical development and the testing of platforms and technologies), manufacturing and delivery solutions, and epidemiology.

At the end of the reporting period a cumulative total of 42 projects had completed out of a total of 78 funded since the outset of the UKVN Project. Of those 7 were completed during this reporting period specifically. While this is less than the milestone figure set for the year, considering the impact of COVID-19 on projects (due to project and staff reorientation to COVID-19 and research facility closures), and the fact that extensions have been put in place for the remaining projects to complete in 2021/22, these statistics represent strong progress.

Indicators 1.1 and 1.4 were both achieved in prior reporting years. In the 19/20 AR, indicator 1.4 was under review and it was decided that it has already been achieved. Across the whole portfolio of projects commissioned (both active and completed) by the UKVN, 29% were initially from SMEs. Therefore, the UKVN Project has already achieved this indicator. This does not mean that >25% of active projects are from SMEs, as the Project is reaching the end of its current phase and the majority of projects from SMEs have now closed. We argue this indicator is still achieved, as this reflects the involvement of SMEs in the whole UKVN Project.

Indicator 1.3, 'UKVN projects generate outputs', refers to the combination of academic publications and other recorded research outputs well as confirmed follow-on funding. This indicator did not have a quantifiable milestone set for the reporting period. However, 14 externally published, peer-reviewed publications were put out by projects, which is reasonable considering the number of projects that have completed (most publications would be made when a project reaches its conclusion). Additionally, a number of other 'non-academic' outputs (including publications of UKVN working group outputs, interviews, presentations and articles on project) were recorded, which is significant given the barriers imposed by the pandemic (not being able to attend conferences etc). The UKVN Project team have received details of multiple projects receiving follow-on funding, such as the novel chimpanzee adenovirus MERS vaccine developed by Oxford University, which received £42 million follow on funding from CEPI (see further examples under section 4.3). This is notable as follow-on funding is not normally achievable until after a project has finished, and due to COVID-19 the majority of UKVN projects are still running. Furthermore, it is now recognised that it may take longer than originally anticipated for information on follow-on funding to be confirmed, and in some cases it can be difficult to obtain information after projects have completed and researchers no longer have an active relationship with delivery partners. Additionally, with the pandemic stretching available funding and the sector's attention focused on COVID-19, opportunities for follow-on funding may be more limited in the short term.

Considering all indicators have all been achieved or partially achieved, and as demonstrable progress is not fully captured by the indicators, an overall score of A has been given for this output. This reflects the strong progress against these indicators during a challenging period due to the impacts of the pandemic. As project extensions are now in

place a number of these indicators have not been fully achieved in this reporting period but are expected to be achieved before the current phase of the UKVN ends in March 2022.

3.1.2 Changes to the output

The project's logframe was reviewed when the previous Annual Review was conducted in summer 2020. During this review, a decision was made to combine the 3 separate indicators, covering academic publications, 'non-academic outputs', and follow-on funding, into one single indicator of 'UKVN-funded projects generate outputs'. One reason for this was to make evaluation of progress less weighted towards academic publications, as it was recognised that other research outputs can be just as valuable, if not more so. However, no quantifiable milestones were set for this new indicator, merely a generic descriptor of 'wide range of high-quality outputs generated', and this is now recognised as a weakness as it does not allow progress against expectations to be tracked since what constitutes a "range" has not been quantified. Another weakness is that the logframe is not appropriately designed to assess impact for this stage of the UKVN. The logframe was developed at the start of the UKVN when the project was being set up and the indicators were designed to reflect progress against this stage. As a result, the indicators for later years lack detail and were not effectively designed to support evaluation of the project's endpoint. Due to the limited capacity of the team, the logframe was not reviewed again during the reporting period and consequently the milestones were not updated to reflect the fact that 2020/21 would no longer be the final year of the project, since (as a result of COVID-19's impact on projects, due to project reorientation to COVID-19 and research facility closures), an extension was granted to projects to complete in 2021/22. Aside from setting new final year milestones for 2021/22, the next logframe review's description for output 1.3 should be more specific and should include quantifiable milestones which reflects achievement expectations.

3.1.3 Recommendations

A clear recommendation is to update the logframe and set new final year milestones for year 2021/22.

3.2

Clear UK vaccine investment strategy contributes to global leadership in this space and supports development of a clear process for end-to-end vaccine product development for epidemic diseases.

Output number: 2

Output score: B

Impact weighting (%): 30

Weighting revised since last AR? No

Risk rating: Amber/Green

Risk revised since last AR? No

Indicator(s)	Milestone for the review	Progress
2.1 Use of UKVN policy tools by international stakeholders.	UKVN sub-meeting with other GHS projects, relevant DFID programmes and key stakeholders to identify routes to use for UKVN project outputs and gaps in programming to address through updated strategy. Statistics from website show 10% increase in visits from 2019 level. Evaluation demonstrates that the UKVN has influenced the international community through its outputs and has stayed relevant to changing international environment.	Partially Achieved
2.2 UKVN Project funded research supports the development of collaborations between LMIC and UK researchers and organisations.	≥50% of the international collaborations supported by the portfolio are successful in receiving funding to extend partnership	Not achieved
2.3 Findings of UKVN Project funded research are disseminated to non-academic audiences, including public health practitioners and the public.	≥ 24 tweets/retweets ≥ 4 case studies on website ≥ 3 press releases of project outcomes (DHSC-led or supported)	Partially achieved

Indicator(s)	Milestone for the review	Progress
	≥ 2 presentations of UKVN outcomes at stakeholder community meetings. Findings of impact evaluation summarised and uploaded to the UKVN website.	
2.4 UKVN strategy clear and communicated to research community and other stakeholders, including organisations that support development and deployment of vaccines.	Impact evaluation demonstrates how UKVN project contributes to and complements wider landscape to ensure end-to-end vaccine development for epidemic diseases.	Postponed

3.2.1 Supporting narrative

This output is intended to reflect the UKVN Project's broader contribution to the UK's leadership in the vaccine development space and related policy, and it also overlaps with the strategic direction-setting and development of policy tools by the UKVN expert group.

Under Indicator 2.1, the milestone on 'use of policy products produced by UKVN expert working groups by international stakeholders' was partially achieved. Opportunities to present these tools at international meetings were limited by the COVID-19 pandemic. However, the UKRI-hosted webpage containing the UKVN policy tools had an increase by threefold during the pandemic. Since January 2020 over 4,000 new users have accessed the site, indicating that this this milestone is likely to have been achieved.

Under indicator 2.2, covering international collaborations, the milestone regarding follow-on funding was not achieved. However, as with many types of follow-on funding, it is recognised that this is a result which takes time to materialise. Furthermore, it is anticipated that as more projects reach completion in the next reporting period, this milestone will be achieved. As only half of UKVN funded projects have completed, many are not eligible for follow-on funding yet. Further relating to this indicator, several projects which were reoriented to COVID-19-focused activity during the pandemic formed LMIC collaborations which may positively contribute to this indicator when completed.

For indicator 2.3, covering the dissemination of findings to non-academic audiences, several quantifiable milestones were set, but these were not met during this reporting period. This is due to the project team's limited capacity which meant that this area of activity was deprioritised. During this reporting period, 14 tweets using the hashtag

#UKVaccineNetwork have been posted on the DHSC Global Health Security Twitter Account. Also, 3 case studies have been produced (in Annex A), but these have not yet been used for external communications. At a research project level, opportunities for disseminating findings, such as community meetings in LMICs and in-person conferences, have been restricted due to COVID-19.

For indicator 2.4, covering the communication of the UKVN strategy to the research community and other stakeholders, the milestone was the completion of an effective impact evaluation. This has been delayed, primarily because the project was extended for a year but also due to the limited capacity of the project team to plan and procure an evaluation, and because the interim evaluation was completed in summer 2020.

Based upon the progress against the indicators, an overall score of B has been given for this output. While this implies that progress against the output has not fully met expectations for this reporting period, it should be acknowledged that the output and its indicators were not effectively designed to evaluate the project's progress and were not reflective of the project's new extended timelines and the progress made to support this stage of the project's cycle. Furthermore, during this reporting period, resources were reprioritised to support the government's response to COVID-19, which was also not reflected in the output indicators.

3.2.2 Changes to the output

On reviewing the logframe for the purposes of the current Annual Review and considering the challenges presented during the reporting period, the project team now recognise that there are shortcomings to the indicators under this output, as highlighted above. For this reason, it is recommended that the current logframe is reviewed ahead of the next reporting period to ensure it is fit for purpose and indicators are appropriately selected to evaluate the project.

3.2.3 Recommendations

Reconvene Expert Group to identify whether any updates are required to the policy tools, given the significant changes to the vaccine landscape, in particular the advances made during the COVID-19 pandemic.

Recommendation for 2.3 – As projects are closing in March 2022, more tweets, publications and communication content should be planned.

Recommendation for 2.4 – UKVN strategy for a new phase of investment should be communicated to key stakeholders including the UKVN Expert Group, CEPI and the relevant research community.

Scoping for an end of project evaluation should be carried out to consider the best approach to evaluating the impact of UKVN 1.0.

3.3

Effective management, governance and oversight of the UKVN Project.

Output number: 3

Output score: N/A

Impact weighting (%): 10

Weighting revised since last AR? N/A

Risk rating: N/A

Risk revised since last AR? N/A

Indicator(s)	Milestone for the review	Progress
3.1 Project budget is fully committed and investments are VfM.	£25m 20/21 budget spent ≥5 Case studies of projects produced to demonstrate impact and VfM of spend.	Partially Achieved

Indicator(s)	Milestone for the review	Progress
	Impact evaluation shows that project achieved aims, including VfM.	
3.2 Project delivery approach allows competitions to be delivered to timelines and delivery risks are identified and managed.	All competitions delivered. Quarterly Project Delivery Boards and delivery partner performance management process show effective risk management	Achieved

3.3.1 Supporting narrative

This output was included in the original logframe to support monitoring of project management. However, it is now recognised that ‘effective management, governance and oversight’ is not a relevant output for inclusion in a logframe, rather it is a process that contributes to the effective delivery of the project. While it is important to monitor and evaluate this, the logframe is not the appropriate tool for doing so. For this reason, no score has been given for output 3 in this annual review.

For indicator 3.1, this has been partially achieved as the project did spend the allocated budget but 3 case studies were produced rather than 5. Due to the decision not to conduct an impact evaluation at this stage of the UKVN lifecycle, the full impact of the project investment cannot be assessed.

3.3.2 Changes to the output

The logframe was reviewed when the last Annual Review was conducted in summer 2020, however no changes were made to this output. Moving forward, this output will be removed from the logframe.

3.3.3 Recommendations

Project management recommendations are covered elsewhere in this annual review, found in reference to the items appropriate project management will assist in delivering

4. Project performance not captured by outputs

1. Repurposing of funding to support ODA-eligible work on COVID-19

In Spring 2020 the UKVN project team undertook a COVID-19 impact assessment to identify any UKVN-funded projects that could support the response to COVID-19. As a result, a number of projects requested scope changes to re-direct their activity to ODA-eligible work addressing the COVID-19 pandemic, subject to approval by the UKVN project team and respective delivery partner. This rapid but limited repurposing of funds allowed researchers to test the feasibility of repurposing their epidemic vaccine platforms to COVID19. A number of these projects were successful in gaining further COVID19 vaccine development funding based on the initial work funded by UKVN. A total of £2,343,705 in funding was repurposed. The Head of the UKVN Project was also redeployed to DFID to support work on COVID-19 vaccine development and LMIC access to vaccines.

2. UKVN contribution to rapid COVID19 candidate vaccine development

Oxford University's ChAdOx1 vaccine platform

The UKVN grant of £1.87m supported the preclinical development and phase 1 clinical trials of the ChAdOx1 MERS vaccine. The MERS vaccine targeted the spike protein and successfully completed phase 1 clinical trials in 2019.

In communications on the success of their COVID-19 vaccine, which has been distributed to 178 countries with over 1.3 billion doses deployed, the Oxford group highlighted the important role the work on the MERS vaccine played in allowing them to rapidly switch to working on COVID19, a related coronavirus.

Imperial's saRNA platform

The UKVN have provided funding to support the development of Imperial's saRNA platform since 2017, with a grant focused on the use of this platform to develop a trivalent Ebola, Lassa and Marburg vaccine.

The success of the Moderna and Pfizer/BioNTech show the huge potential that vaccines based on an RNA platform can have.

Future Vaccine Manufacturing Research hubs

Since 2017 the UKVN has funded 2 research hubs focusing on improving vaccine platform technology to allow rapid vaccine development against 'disease X' and associated research to improve vaccine manufacturing processes.

The hubs are based at UCL and Imperial and have both contributed expertise to the Oxford and Imperial COVID-19 vaccine efforts, notably the process for rapid scale up of production of the Oxford-AstraZeneca COVID-19 vaccine.

5. Risk

5.1 Overall risk rating

Overall risk rating: green

At the end of the reporting period the UKVN Project overall risk rating is assessed as green, since the likelihood of it not being successful is considered very low. While the pandemic resulted in delays and challenges, these have been effectively managed over the course of the reporting period and the approval of extensions now means all research projects are on-track to achieve their original objectives, and new, COVID-19 related objectives. The only foreseeable reason for work to fall off track would be a significant worsening of the COVID-19 situation, with associated restrictions and pressure on resources; however this currently looks unlikely. Even if some individual research projects failed to deliver effectively, the overall impact would be low as many have completed already or are now close to completion; the portfolio approach of the UKVN Project ensures that meaningful results will still be delivered, even if not all projects succeed.

5.2 Overview of project risk

At the beginning of the reporting period, the most salient risks were around the impact of COVID; delays or uncertainty on confirmation of future funding; and lack of recognition of the work of the UKVN Project. The project team have actively maintained the risk register throughout the year and reviewed risks in quarterly meetings, as well as consulting with the Project Board for advice and updates on key risks every quarter. Two risks did develop into live issues during the year, but these were effectively resolved with minimal impact. The risk landscape has evolved considerably over the course of the year, not least because of the evolving trajectory of the pandemic and associated restrictions. Below are details of the most significant risks to be managed during the year and their current status.

1. Public and political support for UKVN damaged by media allegations of poor value for money or unclear results

Risk description:

At the start of the reporting period the project team were aware of the need to do more work on communications, promoting the project across government, to the scientific community and to the public – to prevent the media and public not being aware of the

value of our programme, increase external engagement, and support bids for future funding. Limited capacity within the project team and limitations of long-form content platforms for publishing comms made it difficult to engage at the desired level of communications activity, and this continued to be the case in 2020/21. However, the spotlight on vaccines and their development, and the direct link between UKVN-funded work and the Oxford/AstraZeneca COVID-19 vaccine, decreased the likelihood of the UKVN's work being undervalued in the media, and improved the UKVN's ability to defend itself against it.

Mitigation strategy:

Work to create a bank of key case studies (Annex A), detailing a selection of success stories from within the portfolio, was completed in 2020/21. These case studies are intended to be drawn upon and adapted for different purposes, including reporting and external communications. Continuing to keep these case studies up to date, adding new ones to the bank, and exploring more opportunities for putting the stories out externally, will help mitigate the risk of bad press. The planned recruitment of a new Project Officer will also increase the capacity of the project team to work on communications.

Residual risk rating: Amber/green

2. Misuse of ODA funds

Risk description:

The Project team were aware of the risk that funding would be spent on work that is not ODA eligible, as research staff working on individual projects might not understand the criteria for ODA eligibility

Mitigation strategy:

The UKVN Project team and delivery partners will continue to communicate clearly with each other and researchers around ODA-eligibility requirements and to carefully scrutinise requests for changes in project scope. If another situation occurred where, like at the start of the pandemic, there was a strong argument for projects across the portfolio to pivot their work, steps would be taken to reclarify understanding of ODA-criteria with researchers at the outset. More detail in financial quality section below.

Residual risk rating: Green

3. Impact of COVID-19 causes delays to delivery of UKVN funded projects, or results in an inability to delivery entire workstreams.

4. 4. HMG /DHSC response to COVID-19 outbreak requires additional work from UKVN team and/or temporary redeployment of UKVN team members.

Risk description:

The significance of the risks related to COVID-19 were apparent at the start of the reporting period, however the extent and duration of restrictions arising from the pandemic could not have been predicted at that point. The impact and likelihood of these risks increased through the year as restrictions continued and a high proportion of projects were unable to complete before their anticipated endpoints. This was either due to having to pause work due to lockdowns restricting access to their workspaces, due to resources (e.g. laboratory consumables) not being available as they were being used for COVID research, or due to their original objectives being put on hold due to repurposing their work towards COVID. Within the UKVN Project team, capacity was limited due to the Project Lead being loaned to the Department for International Development from March to August 2020 to support their work on the COVID response. By the end of the reporting period the COVID-related risks had lessened, as project extensions had been improved, as there were no further calls for staff redeployment, and as the overall COVID situation had stabilised. These risks maintain the potential to increase if the COVID situation worsens again.

Mitigation strategy:

Approval to extend the UKVN Project into 2021/22 and the subsequent granting of extensions to projects requiring more time or money to complete has effectively mitigated this risk. Plans to recruit a new Project Officer to the UKVN Project team will increase resilience if staff are redeployed again.

Residual risk rating: Green

5. 5. Delays and limitations to funding decisions and approvals.

Risk description:

At the beginning of the reporting period the UKVN Project team were anticipating a multi-year Spending Review and planning work for the next phase of the project (including seeking strategic advice from the UKVN expert group, which was not able to meet during 2020/21). The UKVN has submitted a successful SR21 bid and received funding allocation till FY 24/25.

Residual risk rating: Amber/Green

6. Project management

This section reviews delivery and commercial considerations

6.1 Delivery against planned timeframe

The reporting year 2020/21 was originally envisaged to be the final year in the current phase of the UKVN Project. However, as mentioned above, the continuation of the COVID-19 pandemic has meant that 27 projects reported that they would be unable to meet their original objectives in the planned timeframe.

As explained earlier in this review, extensions have been granted to allow projects more time and money to complete their objectives, and a successful bid in the one-year Spending Review has allowed the overall endpoint of the first phase of the UKVN Project to be pushed back to March 2022. This delay is not expected to impact the quality of project outputs, and considering that meaningful results for LMICs were always expected to be realised in the longer-term given the nature of the vaccine development process, it also does not detract from broader UKVN Project outcomes. It should also be noted that the project extensions have required only a £3.5m (3%) uplift to the original business case, and that additional work relating to COVID-19 has also been delivered in the reporting period. There was underspend against the budget available for the reporting period, as research projects tend to have larger project spends towards the end of their research, which is now in 21/22. However, arrangements made to award this ODA funding to the Coalition for Epidemic Preparedness Innovations (CEPI), an organisation with objectives closely aligned with those of the UKVN Project.

The fact that the need for extensions only became apparent during this reporting year, and that many projects in the portfolio still completed before the original endpoint, suggests that the original planned timeframe for the UKVN Project was appropriate. It is reasonable to assume that, without the unforeseeable and extended disruption caused by the pandemic, the current phase would have successfully completed by March 2021 as planned.

6.2 Performance of partnerships

The UKVN team continue to utilise a scorecard review system to regularly engage with each delivery partner. The aim of these meetings is to assess the working relationship between DHSC and the partner, and to identify risks and issues as well as any areas for improvement. The scorecard meetings have been effective in achieving consistent communication and a regular avenue for escalation of issues. They also provide a forum

for delivery partners to raise areas of improvements for DHSC to be a more effective partner.

All delivery partners kept their MoU obligations during this reporting period, with all partners scoring Green and Amber/Green on their performance during the last scorecard meetings of this period. For NIHR-NETSCC, partnerships have been positive with representatives expressing they were impressed that DHSC colleagues managed to provide the same level of support and guidance as usual throughout the pandemic, despite their increased workload. Conversely, EPSRC reflected that due to challenges with the pandemic, responses by DHSC have been delayed at times but understood how pressed the team were. The COVID-19 pandemic led to significant work increases for BBSRC and DHSC, impacting communication channels, including around project monitoring information after the BBSRC project lead changed. However, key financial information flows remained. The relationship between IUK and DHSC is positive overall, with a good level of communication between organisations and appropriate project management processes.

Representatives from each delivery partner also meet with DHSC at the quarterly Project Delivery Board meetings. These meetings are not a formal governance mechanism, but an opportunity to discuss key updates, and overarching risks and issues from across the project. They offer a useful opportunity for the delivery partners to get together as a group, promoting alignment and a sense of working together towards shared objectives. It also allows a forum for delivery partners to share learnings from their respective portfolios.

Due to the pandemic, all the meetings were conducted virtually during the reporting period, whereas previously they had been held face-to-face. While this has proved largely effective, it may be worth considering holding occasional meetings or events with partners face-to-face in future (depending on COVID-19 restrictions), to facilitate stronger relationship building.

An audit of the UKVN Project by the Government Internal Audit Agency (GIAA) in autumn 2020 made 2 findings that relate specifically to DHSC's relations with delivery partners. The first was that "DHSC should ensure delivery partners are receiving comprehensive guidance on best practice in preventing fraud and misuse of public funds", and the second was that "DHSC should seek explicit confirmation from delivery partners that they have completed all necessary assurance work, and that any issues identified have been escalated to DHSC where necessary". The UKVN Project team responded to this by updating Memoranda of Understanding (MoUs) with Delivery Partners to ensure guidance around issues such as fraud and safeguarding are up to date.

A key recommendation for the future would be to provide Delivery Partners and researchers with an overview of fraud and safeguarding processes through in-person training ahead of starting new work.

7. Financial performance

7.1 Value for Money

Economy

The UKVN invests in an inherently high-risk research area hence why taking a portfolio approach with a larger number of smaller awards across multiple diseases and multiple candidates per priority pathogen, rather than investing larger sums in single vaccine candidates, has been confirmed by the range of successful results across all priority areas.

DHSC is a key funder of CEPI, allowing the UKVN Project Lead to sit on the (advisory) CEPI Investors Council, and maintain a good understanding of CEPI priorities. The potential of UKVN investments has also been enhanced by developing a close relationship with CEPI, a key source of potential follow-on funding for UKVN-funded projects which in turn will allow the long-term outcomes of UKVN being realised as UKVN research can progress along the vaccine development pipeline and be ready for use when an outbreak occurs

Efficiency

While COVID-19 has meant that some projects require more time or money to complete, this is balanced by the fact that additional meaningful outputs have been delivered through COVID-19 repurposing. From a management perspective, the model of having the research projects managed by specialist delivery partners from across government has remained an efficient one. For example, it has ensured continuity of management arrangements despite capacity limitations and staffing changes within the central UKVN Project team during the 2020/21 reporting period. It has also ensured the projects are managed by experts in the research topic, allowing the UKVN staff to focus on non-specialist management and strategic issues.

Effectiveness

Most UKVN investment is in the stage of pre-clinical and early-stage clinical development, strengthening the vaccine pipeline at a point at which projects traditionally founder for lack of investment. This means that full effectiveness of the project may not be evident for some years. However, the number of projects that have already completed and delivered meaningful outputs illustrates the value of the awards made through the original funding

competitions. The contribution of long term UKVN investment to the rapid development of candidate vaccines for COVID-19 is further evidence of the value of long-term investment in development of vaccines targeting pathogens of epidemic potential and the scope for this investment to support rapid development of vaccines against novel pathogens.

Equity

UKVN investment aims to support the development of vaccines that will primarily benefit those in LMICs, with the intention that these vaccines will ultimately be available to all those who need them in these countries. However, there are limitations to the project's control over these outcomes. The current approach to funding early-stage development means that the UKVN Project cannot guarantee that the later-stage development, manufacture, and distribution will (if the candidate is taken forward by other funders) be utilised in a way that supports equitable access. This is a challenging area but something that could be explored in future contracting arrangements. In addition to funding early-stage development, the UKVN project makes an additional contribution to LMIC vaccine access through the vaccine manufacturing hubs, which specifically addressing challenges related to the roll-out of vaccines in LMIC settings. In addition, projects funded through the 'Epidemiology for Vaccinology' competition use epidemiological modelling to understand how best to deploy vaccines for maximum impact, and anthropological research is being conducted to understand how to effectively engage local communities in vaccine deployment during outbreaks.

7.2 Quality of financial management

Despite the challenges due to the pandemic, UKVN has demonstrated responsible financial management.

UKVN were able to be effectively repurpose funding to support HMG's response to the COVID-19 pandemic and address risk related to ODA misuse. During the pandemic, work related to COVID-19 could be ODA-eligible (at the time of the repurposing), however it would need to be evident that the primary beneficiaries were LMIC populations. COVID-19 activity for global public good, or activity that would primarily benefit the UK population, would not be ODA-eligible. The risk materialised into a live issue during the reporting period, when it emerged that a number of projects had inadvertently used their funding for COVID-19 work that was not ODA-eligible. The financial exposure was relatively low (less than £1 million) and the UKVN Project team worked with delivery partners to quickly resolve the issue, ensuring that alternative funding was secured to cover the non-eligible spend, so no ODA funds were misused. The issue has now been downgraded back to a risk, and it is thought that the likelihood of it occurring again is low as relevant lessons have been learnt by the UKVN Project team and delivery partners.

UKVN delivery partners are responsible in paying funds to research projects on a quarterly basis, invoicing DHSC promptly and providing accurate reforecasting information to DHSC on a quarterly basis. During this reporting period, the ability of delivery partners to achieve this has varied.

For IUK's systems, internal processes and funding model have limited their ability to provide accurate forecasting information. IUK have acknowledged the issue and have identified steps needed to address this in collaboration with the UKVN Project Team.

For NIHR NETSCC managed projects that did complete in 2020/21, there continue to be 2 final expenditure reports outstanding to confirm final spend. DHSC is hoping to close off these accruals as soon as possible.

For NIHR CCF, there are similarly 2 payments outstanding from 2020/21 for ongoing projects. NIHR CCF have investigated why these payments were not released/requested, with a view to resolving this by end September 2021.

8. Monitoring Evaluation and Learning

8.1 Evaluation

An interim evaluation of the UKVN Project was conducted by a researcher from Manchester Metropolitan University. This began in January 2020 and was completed in July 2020.

Its primary finding that the UKVN project provided financial support to address 12 pathogens that cause epidemics in low- and middle-income countries, enabling researchers to begin building vaccine development infrastructure and candidates. Alongside outlining the key benefits of the project, this assessment highlighted several key challenges faced by the UKVN project. The evaluation of these challenges and opportunities resulted in a variety of valuable insights for DHSC to reflect upon, including recommendations for the wider UKVN project and the work it undertakes with its delivery partners. The most relevant recommendations included reporting templates of projects to be standardised across all delivery partners and UKVN communications strategies to be reviewed and strengthened to promote engagement and discussions between researchers, the UKVN Project, UK Research and Innovation (UKRI) and other external stakeholders.

DHSC were satisfied with the methodological rigour of the evaluation and were pleased to engage with the evaluator throughout this process. Many of the report's findings and recommendations will prove beneficial in the final year of the current phase of the project or will influence potential future project iterations. However, given the breadth of

viewpoints taken into consideration, some recommendations did not directly relate to the scope of this project. DHSC's full response to the evaluation recommendations, included those that were rejected or partially accepted, can be found in the published management response.

8.2 Monitoring

Due to staff resourcing issues generated by the pandemic, there was not a significant focus on monitoring activities during the reporting period. Field visits and other in-person activities were not possible. Stakeholders and partners were also very stretched by the COVID response, which limited their ability to engage in monitoring activities.

The logframe was reviewed after the 2019/20 annual review, with no significant changes to the structure or the milestones, however no further revisions to the logframe were made after it became apparent that 2020/21 would not be the final year of the project as originally planned. This made it challenging to assess progress for the purposes of the current annual review.

As noted above, a recommendation moving forward would be to review the logframe ahead of the next annual review to ensure it is fit for purpose to assess the progress for the final stage of this current iteration of UKVN. Furthermore, for the new phase of UKVN, at the start of every reporting period, and periodically throughout the project, the logframe should be reviewed. This would enable the logframe to be used as a more effective tool for both monitoring progress during the period and evaluating it in the annual review.

In addition to the staffing limitations with the UKVN Project team, the post of Monitoring, Evaluation and Learning Lead within the GHS Programme was vacant until September 2020. Having this post filled means the UKVN Project can now access direct support and guidance around MEL best practice and will also ensure consistency with other projects across the GHS Programme.

8.3 Learning

Proactive activity on learning processes were not a focus in 2020/21 due to the limited capacity of the team. A finding from the audit conducted by the GIAA was that "lessons learnt from implementing partners and delivery partners should be communicated across the project". As a result, the UKVN will implement a new process for documenting and sharing lessons learnt across delivery partners, researchers, and internally.

Going forward key lessons will be collected from delivery partners, and through them, the researchers, during quarterly scorecard meetings. DHSC will then collate, anonymise and disseminate this information back to delivery partners during UKVN Delivery Board meetings. Delivery Partners are requested to circulate the DHSC-compiled lessons learnt

to their researchers, where they feel this is appropriate to allow sharing of learning across projects. Researchers will continue to escalate recommendations/feedback/ lessons learnt to the UKVN via delivery partners.

Annex A: Case studies

Case Study: Advanced development of a safe and effective Rift Valley Fever vaccine for livestock' – George Warimwe

Prof Warimwe has pioneered a vaccine development approach that exploits synergies in human and livestock immunology to accelerate development of vaccines that can be used in both animals in humans. Using this approach, Prof Warimwe developed a Rift Valley Fever vaccine (ChAdOx1 RVF) that can be used in both humans and animals. With funding from the UKVN, Prof Warimwe is working with partners in the UK and East Africa to further develop ChAdOx1 RVF for licensure.

Rift Valley Fever is endemic in many parts of Africa and the Arabian Peninsula and is caused by a virus that infects livestock such as sheep, goats, cattle and camels. Since the year 2000 there have been 9 major outbreaks of Rift Valley Fever. The largest known historical outbreak was in Egypt in 1977-1978, with an estimated 200,000 people infected and at least 594 deaths. No licensed vaccines are currently available for human use, and while licensed veterinary vaccines are available, they have major drawbacks. Most vaccines are currently designed separately for animals and humans, which increases development time and cost.

However, the new RVF vaccine, ChAdOx1 RVF has been designed to protect both susceptible animals and humans from the disease. Scientists from the Pirbright Institute have worked with Oxford's Jenner Institute and other collaborators to demonstrate the vaccine's safety in pregnant goats and sheep within specialist high containment facilities. Based on the results of this safety trial, the UKVN has funded 2 parallel projects that are being delivered by the University of Oxford, Pirbright Institute and partners in East Africa.

Recent studies on the ChAdOx1 RVF vaccine have shown that sheep and goats immunised with a single dose of the vaccine remained healthy and suffered no pregnancy losses after exposure to a severe strain of RVF virus. It has demonstrated that the new vaccine does not share the drawbacks of currently available RVF vaccines. It also generates a rapid immune response and allows diagnostic tests to differentiate between infected and vaccinated animals.

These properties make the vaccine well suited for tackling outbreak situations and protecting livestock, and if its use limits the circulation of RVF virus amongst animals then consequently transmission to humans will also be reduced. Manufacture of the ChAdOx1 RVF vaccine is readily scalable at low cost, and unlike currently licensed vaccines, does not require specialised high containment facilities.

The livestock studies have provided vital information that will support the parallel project and aid the development of ChAdOx1 RVF for potential human use. If these phase I clinical trials indicate that ChAdOx1 RVF is safe and elicits robust immune responses in humans as it does in animals, broader trials would then be required to obtain further data on safety and determine effectiveness. It could be the first vaccine ever developed that can be deployed against the same virus in both animals and humans. The potential benefit to people living in LMICs affected by RFV is therefore threefold: their livestock can be protected from a highly damaging disease, the vaccination of livestock will reduce cases of transmission to humans, and human vaccination of those at risk will provide further protection.

Case Study: Future Vaccine Manufacturing Research (FVMR) Hub – Robin Shattock

The Future Vaccine Manufacturing Research (FVMR) Hub aims to guide and assist vaccine manufacturers within LMICs, alongside working to develop innovative new solutions for vaccine manufacturing and distribution that will directly benefit LMIC populations. It is funded through UKVN, managed by the Engineering and Physical Sciences Research Council (EPSRC) and led by Imperial College London, who collaborate with other academic institutions, small to medium enterprises (SMEs) in the UK, and partners within LMICs, including the Developing Countries Vaccine Manufacturing network (DCVMN).

Vaccines are powerful weapons in the fight against outbreaks of infectious disease, however the time and cost involved in developing and manufacturing them by conventional methods severely limits how effectively they can be deployed, particularly in LMICs, where outbreaks are more common and challenges in the distribution process can further impair response efforts. The high costs of manufacturing using these conventional methods also presents a significant barrier to a rapid and effective response in LMICs, as does the lack of suitable facilities and technology to produce the vaccines within the countries themselves. The cost and logistics of getting vaccines to the people who need them is another difficulty, both when dealing with outbreaks of new and emerging diseases and in the ongoing efforts to combat endemic diseases in LMICs. Conventional vaccines need to be kept between 2 and 8 °C (standard temperature for a refrigerator), and the need for refrigerated storage and distribution is a major obstacle to getting them where they are needed in LMICs, where outbreaks often occur in remote areas and under extreme climate

conditions, and where 24 million children currently die every year in rural areas because they do not have access to appropriate vaccinations. The FVMR Hub seeks to exploit the latest advances in biotechnology to enable the rapid response that is required to combat emerging outbreaks.

The team at Imperial College London has successfully utilised the saRNA vaccine platform already developed under UKVN funding to progress one of the UK's leading COVID-19 vaccine candidates. They have gone from the SARS-CoV-2 gene sequence to early stage human clinical trials within 6 months, a feat that would have been impossible using traditional vaccine technologies. In addition to the direct work under the Hub on the saRNA platform, funding was also provided through the UKVN to Robin Shattock and Imperial College London for a project aimed at preclinical and early clinical development of a saRNA vaccine against Ebola, Marburg and Lassa (EML-VAC, https://gtr.ukri.org/projects?ref=971617), and progress made on this project laid the groundwork for rapid adaptation of the platform to COVID-19 vaccine development. Continued development of the platform has the potential to offer a safe and effective vaccination response to the three originally targeted diseases as well as COVID-19, plus the adaptability to combat other manifestations of 'Disease X' (caused by unknown pathogens) in the future.

The UKVN-funded development of the saRNA vaccine platform, through the FVMR Hub and the EML-VAC project, has led to Imperial College London securing further funding through a partnership with the Coalition for Epidemic Preparedness Innovations (CEPI). This project included further support to develop the saRNA vaccine platform against Ebola, Lassa and Influenza. Through this partnership, CEPI aims to develop vaccines against new and unknown pathogens ("Disease X") within 16 weeks from identification of antigen to product release for clinical trials. If successful, this platform could transform regional and global preparedness against outbreaks of Disease X, enabling rapid production of large volumes of effective “single-shot” vaccines (i.e. providing protection against infection with only one injection) or 'cocktail' vaccines (effective against different pathogens) in a matter of weeks.

The UKVN is now funding a clinical trial that will be delivered by Imperial College London in collaboration with the Uganda Virus Research Institute (UVRI). This will be based in Uganda and complement UK-based trials of the saRNA vaccine. This COVID-19 work builds on the existing FVMR Hub partnership between Imperial College London and UVRI that has been strengthened since the Hub was established in 2017. The long-term aim of this collaboration is to pilot the distributed manufacturing approach of saRNA vaccines. This capability could eventually provide a means for vaccines to be rapidly produced close to the source of disease outbreaks.

Case Study: Emergency and Epidemic Data Kit – Chrissy Roberts

Dr Chrissy Roberts is the lead scientist of the London School of Hygiene and Tropical Medicine (LSHTM) Global Health Analytics team and principal investigator of the Emergency and Epidemic Data Kit (EDK). The project is funded through UKVN and managed by the National Institute for Health Research, Central Commissioning Centre. The EDK project aims to address this deficiency and improve the way data is collected, aggregated, analysed and reported to key stakeholders during humanitarian emergencies and infectious disease outbreaks.

Outbreaks of infectious diseases and other health emergencies require urgent interventions to prevent their effects from worsening and to limit the extent to which they can continue to spread. Collection and management of data is an essential part of such interventions. It is necessary to collect high volumes of data in the field within a very short timeframe, to analyse that data and then communicate the findings to people who can use them to make important decisions.

The traditional approach would be to record everything in the field using paper, which makes getting the data to where it is needed a slow process with a high risk of records being lost or damaged, as well as significant administration work required to coordinate the paper records and transcribe them digitally. The use of electronic devices to replace paper-based systems clearly has many advantages, however for them to be used effectively a consistent and accessible platform is required, and one that can be quickly adapted and deployed to meet the needs of different emergency situations. Since health emergencies often occur in areas which lack infrastructure, a practical electronic solution needs to be able to work off-grid and in inhospitable settings including outbreak and conflict zones.

For some time, the London School of Hygiene and Tropical Medicine has been assisting staff, students and collaborators with the use of electronic devices and a suite of apps called the Open Data Kit (ODK), which has replaced the need for paper data collection in the field for over a hundred research projects across the world. The EDK project team have sought to adapt and develop the existing platform being used for the research projects so it can meet the requirements of data collection in emergency response situations. They have made the ODK system even more effective, adding extra apps, software and protocols, making geographical mapping much faster, and adding web-surveys and other data collection methods to the list of ways data can be gathered. More processes have been automated so that data and results are delivered much faster.

The EDK suite of tools allows for rapid linking of clinical, environmental and geospatial data in one secure data portal, and the project has worked on facilitating automated and

real-time analysis of data, which will further contribute to the ability to respond rapidly and appropriately in the changing landscape of an emergency situation. The team has brought together the expertise of clinicians, epidemiologists, and software specialists to create innovative solutions that are fit-for-purpose in the field, and they have refined and developed their products based on real experience. They work with partners, like the UK Public Health Rapid Support Team (UK-PHRST, another project funded by ODA through DHSC) who make field deployments in response to health emergencies in ODA-eligible countries, progressively evaluating and optimising their data tools through real experience of their use in the field. Working together with partners from the DRC National Institute for Biomedical Research, CEPI, DFID, Epicentre, MSF, UK-PHRST, Wellcome Trust, WHO and Janssen Vaccines & Prevention B. V., the team have provided data systems and expertise during a major clinical effectiveness and safety trial of a two-dose preventive Ebola vaccine in the Democratic Republic of the Congo (DRC).

Following a request from the World Health Organization, the EDK team provided data collection, management and coordination systems, as well as analytical support, to many of the interventions surrounding the 2018-2020 outbreak of Ebola Virus in the Democratic Republic of the Congo. During the outbreak, the EDK removed the need to handle an estimated 15 million pieces of paper and saved hundreds of thousands of data-clerk/analyst hours. It played a critical part in the roll-out of a breakthrough Ebola vaccine. This vaccine was an experimental and unlicensed product, and therefore it was essential to follow-up recipients after the vaccination as part of the efforts to evaluate the vaccine's safety and effectiveness. Heightened monitoring activities such as these are linked to vast quantities of data which must be processed and analysed in near-real-time. Given the scale of the Ebola outbreak and the vaccination effort (over 260,000 individuals received the vaccine) this would have proved near impossible to co-ordinate with paper data collection. Data collected during the vaccination programme evinced that the new vaccine is safe and highly effective, and its use during the outbreak is estimated to have prevented many thousands of cases of infection. The data gathered underpinned successful applications for global licenses for the VSV-ZEBOV-GP vaccine, which is now marketed internationally by Merck as 'Ervebo'.

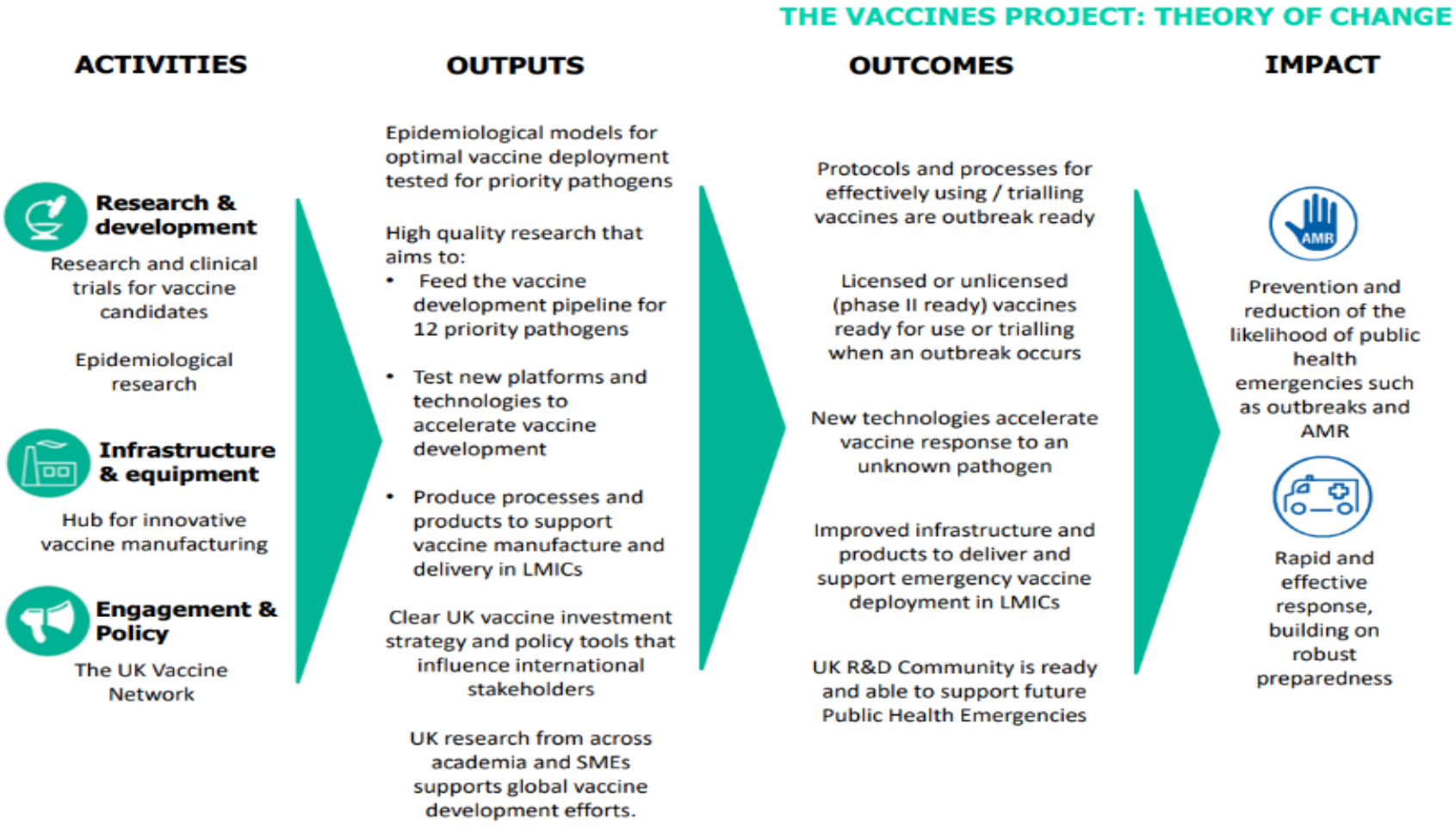
The team have recently been working with WHO to develop a database of non-clinical interventions for COVID-19, which they hope will provide a reference point for the timeline of outbreaks in different countries. The analytical tools and the skills of the EDK team have also enabled them to conduct a variety of key studies to inform the COVID response effort, including studies on inferring the number of cases from recently reported deaths, the effectiveness of airport screening, and the feasibility of controlling outbreaks by isolating cases and contacts.

LSHTM has recently been awarded a 500,000 Euro grant, based around the use of tools developed through the EDK project. The COVID Surveillance Intensification in Ghana Network project will use the EDK data tools to create an enhanced surveillance network for

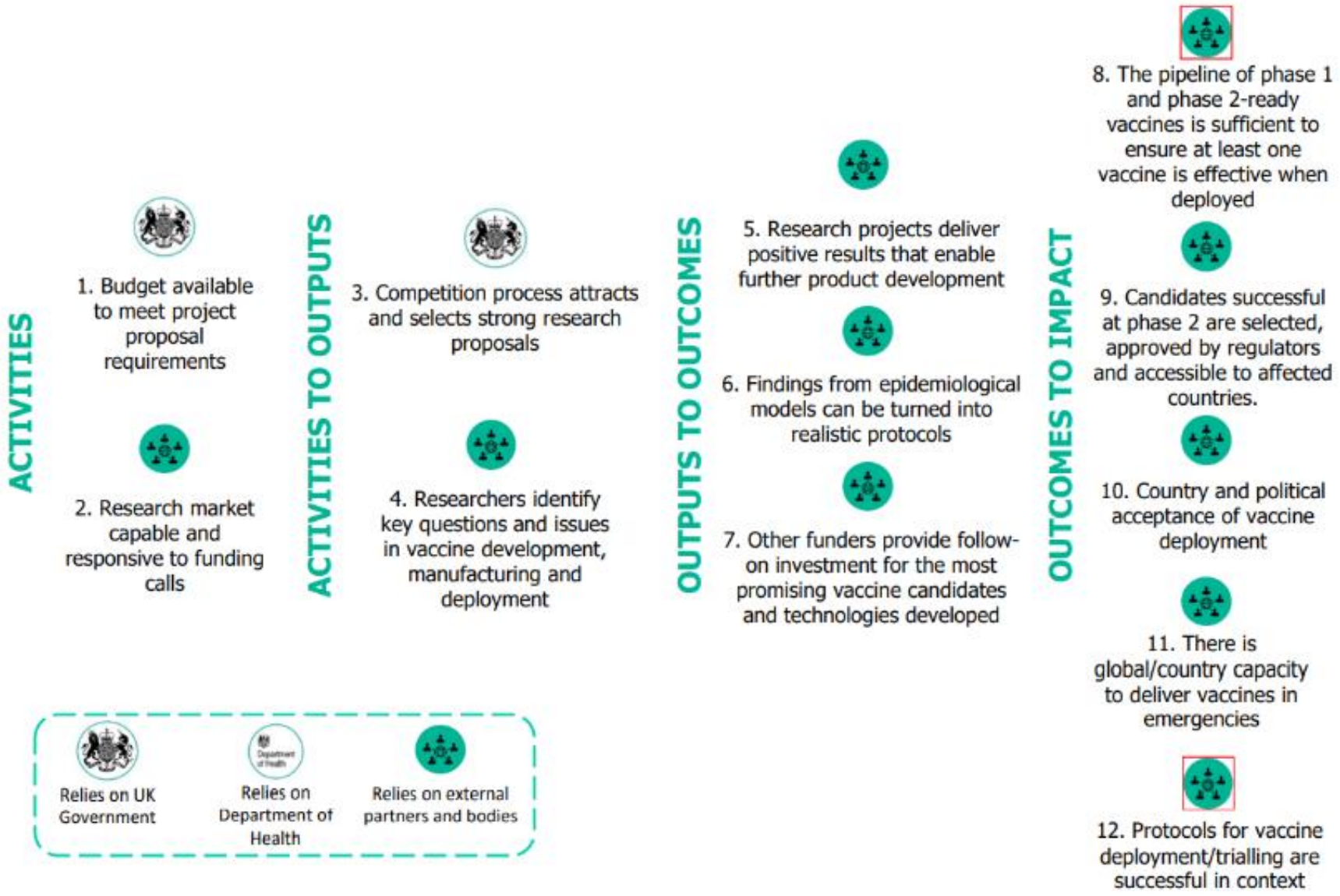
COVID-19 in Ghana. In collaboration with the Ghana Health Service and the University of Ghana, the LSHTM team will develop and deploy tools and linked reporting systems throughout the surveillance network, feeding data in real-time into mathematical models, helping to build scientific understanding of the disease and its spread in Ghana and enhancing the ability to respond effectively. The team is also involved in NIHR funded research that aims to understand the unique risks faced by tightly knit ethnic and cultural minority groups during the COVID-19 pandemic.

The project team are continuing to work with a variety of partners to further develop tools for the surveillance and control of a number of other key diseases affecting people in LMICs countries

Annex B: Theory of Change (ToC)



THE VACCINES PROJECT: THEORY OF CHANGE ASSUMPTIONS



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