

## Executive Summary

### Immunization Implementation Research Priority Setting

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#### 1. Background

Despite significant achievements over the last decade to strengthen national immunization programmes, and significant donor support to introduce new vaccines in resource-limited countries, major challenges remain in reaching and maintaining high vaccine coverage in several countries or regions<sup>1</sup>. Many of the challenges contributing to this are known to be related to health systems and immunization program management issues as well as socio-cultural factors that impede the delivery or scale up of cost-effective immunization interventions<sup>2,3</sup>. Implementation research to understand these and other barriers and bottlenecks is increasingly recognized as a critical tool to improve the delivery of immunization services and uptake of new vaccines as well as the effective use of new immunization technologies. As such, implementation research is an integral component of the work of WHO's Department of Immunization, Vaccines & Biologicals, (IVB). Against this background, in 2012, IVB initiated an activity in consultation with its key partners to develop priorities for a global immunization implementation research agenda.

The overall goal was to create an enabling environment for all stakeholders to participate actively in supporting implementation research that has the potential to drive immunization policy and maximize the impact of vaccines and immunization, and to help define and implement a collaborative process to facilitate efforts at country level aimed at generating relevant and credible evidence to support decision-making for national immunization programmes.

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<sup>1</sup> WHO-UNICEF estimates: In 2012, 22.6 million children < 1 year of age did not receive DTP3 vaccine worldwide and 1.5 million children died from diseases preventable by vaccines currently recommended by WHO.

([http://www.who.int/immunization\\_monitoring/Global\\_Immunization\\_Data\\_v2.pdf](http://www.who.int/immunization_monitoring/Global_Immunization_Data_v2.pdf))

<sup>2</sup> [http://www.who.int/immunization/sage/CDC\\_UNVACC\\_REPORT\\_FINAL\\_v2.pdf](http://www.who.int/immunization/sage/CDC_UNVACC_REPORT_FINAL_v2.pdf)

<sup>3</sup> Swiss Tropical and Public Health Institute. Gender and Immunization (Report to WHO), 2010

An ad hoc working group was established to guide IVB in the priority setting exercise. The scope of **research needs** covered was quite broad and included initial submissions of broad topics and specific research questions. For consistency, all such research needs considered were framed as questions for review. However, the process to evaluate priorities among these “research questions” was not aimed at making decisions to fund or support specific research studies and did not include the more detailed review of research proposals that would be required for that purpose.

Other related components, aimed at ensuring a dynamic and ongoing global implementation research agenda, were proposed and were to be informed by the outcomes of the prioritization exercise: (a) mapping of global research activities and monitoring of progress in the field; (b) assessing the quality, relevance and potential policy implications from emerging implementation research; (c) to build scientific consensus around useful implementation research outputs, and develop best practices and guidelines in accordance with WHO’s normative role; and (d) to support implementation research capacity in countries and regions in collaboration with partners.

The methodology and preliminary findings of the prioritization exercise were reported to WHO’s Immunization and Vaccine-Related Implementation Research Advisory Committee (IVIR-AC) which provided further guidance to the work. In addition, the working group took note of the critical work by the Decade of Vaccines (DoV) Collaboration Research and Development Working Group which defined an implementation research framework that could serve to evaluate the application of results from this prioritization exercise.<sup>4</sup>

## **2. Methods**

### **2.1 Ad hoc working group**

The working group comprised 41 immunization experts (chaired by Dr John Clemens) who represented a broad range of expertise; public health, academic and research backgrounds; perspectives from all 6 WHO Regions and representation from both high and low resource settings. Working group members were selected based on their expertise and did not represent their affiliated organization or agency other than the WHO Regional staff. The composition of the final working group is detailed in Annex 1.

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<sup>4</sup> Arora NK et al. The need for targeted implementation research to improve coverage of basic vaccines and introduction of new vaccines. *Vaccine* 2013;31S: B129-36.

As one of its first tasks, the working group developed a conceptual framework which defined the focus of its work to be: research to improve coverage of recommended vaccines and to facilitate introduction of new, licensed or near-to-licensing vaccines; research to understand the barriers and bottlenecks against improving vaccine coverage and uptake, and to identify and test attractive strategies to overcome such barriers; research that addresses low and middle income countries (LMIC) with a specific emphasis on low performing and low resource settings; research with a broad scope (i.e., as applicable as possible to immunization or vaccines in general rather than vaccine-specific); and research that can be completed in less than a five-year timeframe (once the priorities are finalized and disseminated in the public domain). In addition, it was decided that the research needs to be considered should be relevant to one or more guiding principles relating to equity, integration, innovation and partnerships. The group also defined eight domains under which research needs would be grouped as listed below.

<b>Domain A: Health and Immunization Systems</b>	<ul style="list-style-type: none"> <li>• Financing, human resource, infrastructure, immunization services, governance</li> </ul>
<b>Domain B: Social determinants of vaccination &amp; Communication</b>	<ul style="list-style-type: none"> <li>• Gender, vulnerable population, socio-economic factors, geographic distribution (including urban/rural, hard-to-reach groups etc.), power/social hierarchy, community engagement, knowledge, attitude and behavior, communication and advocacy</li> </ul>
<b>Domain C: Vaccine product profile</b>	<ul style="list-style-type: none"> <li>• Vaccine effectiveness, vaccine presentations, delivery devices/technologies, vaccine safety including perceptions about safety</li> </ul>
<b>Domain D: Vaccination and Coverage</b>	<ul style="list-style-type: none"> <li>• Policy, introduction decisions, schedules, immunization strategies, immunization practices, vaccine refusal and drop-out</li> </ul>
<b>Domain E: Cold chain and logistics management</b>	<ul style="list-style-type: none"> <li>• Cold chain space, equipment and related technology, vaccine and dry stores management, waste management</li> </ul>
<b>Domain F: Programme Management</b>	<ul style="list-style-type: none"> <li>• Performance/programme monitoring, capacity building, supervisory practices, job aids, checklists</li> </ul>
<b>Domain G: Programme monitoring and Impact assessment</b>	<ul style="list-style-type: none"> <li>• Surveillance standards and practices, economic impact, disease burden reduction, use of monitoring data for decision making</li> </ul>
<b>Domain H: Research capacity and application</b>	<ul style="list-style-type: none"> <li>• Research capacity strengthening, linking research to policy and practice</li> </ul>

## **2.2. Identifying the candidate research questions**

Potential research questions and topics were identified through a widespread consultation with technical staff of IVB; WHO Regional Immunization Advisers, and through the latter with national immunization programme managers; vaccine and immunization experts and through selected regional and global meetings in 2012<sup>5</sup>. Additional potential implementation research needs were identified through reviews of several key documents, including reports of the WHO Strategic Advisory Group of Experts (SAGE) meetings from 2007 to 2011; technical reports to SAGE and WHO on the analysis of specific issues<sup>6</sup>; the Global Vaccine Action Plan; reports of the Global Vaccine Research Forum meeting (2011); national research priorities of 23 selected countries<sup>7</sup>, technical reports of immunization programme reviews (such as EPI reviews, post-introduction evaluation of new vaccines, vaccine management assessments) and Project Optimize activities.

An initial list of 404 potential research needs (questions and broad topics) was obtained from the multiple sources described above. All research needs were framed as research questions from which, following a series of review steps undertaken by the working group and with inputs of the relevant IVB technical staff, a final list of candidate questions to be rated was compiled. Questions were included to be rated if they were consistent with the conceptual framework and guiding principles and it was felt that results of the proposed research could potentially strengthen immunization programmes at the country level. Suggested research questions specific to a vaccine for which a more detailed research agenda existed (e.g. polio eradication), or with an agenda setting process ongoing (e.g. for measles and rubella), and those considered to have been adequately addressed by previous research or for which ongoing work was identified (for example under Project Optimize) were excluded. Where necessary, questions were edited to ensure both clarity and consistency in terminology, harmonization among the domains and elimination of duplicates in the master list. A final list of 84 candidate research questions was subjected to the systematic rating method described below. The eight domains within which questions were grouped were defined after the process to solicit potential research questions had started and no specific efforts were made to achieve a balance in the final number of questions per

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<sup>5</sup> Targeted meetings in 2012 included the South-East Asia Immunization Technical Advisory Group meeting (29-30 March), the Africa Advisory Committee on Health Research Meeting (27-28 April), the Global NUVI meeting (15-17 May), and the WHO/AFRO Task Force on Immunization (TFI) meeting (21-22 June).

<sup>6</sup> Epidemiology of the unvaccinated child, Impact of new vaccine introduction and Gender and immunization.

<sup>7</sup> 23 national health research prioritization reports, accessed from the Health Research Web initiative of the Council on Health Research for Development (<http://www.healthresearchweb.org/>) were reviewed to identify Immunization-related research issues.

domain (ranging from 5 to 19).

### **2.3 Prioritization criteria**

At its June 2012 meeting, the working group considered several systematic prioritization criteria and methods: the Essential National Health Research (ENHR) method<sup>8</sup>; Child Health and Nutrition Research Initiative (CHNRI) method<sup>9</sup>; 3D Combined Approach Matrix method<sup>10</sup>; and Delphi and nominal group techniques. The group decided on an approach using absolute ranking (based on an aggregate score for each question) as the most appropriate and feasible for the number of questions under consideration in this exercise.

The ENHR method was selected to be adapted for use in this exercise. The method is based on four fundamental questions to assess the suitability of a proposed research question: *Appropriateness* (Should we do it?); *Relevance* (Why should we do it?); *Chances of success* (Can we do it?); and *Impact of the research outcomes* (What benefit will be achieved?). A final set of nine prioritization criteria adapted from the ENHR criteria was used, each with three response levels of “no”, “not sure” and “yes” which were assigned nominal values of 0, 0.5 and 1 respectively (Annex 2). A response of “don’t know” (meaning the rater felt that he/she was not sufficiently well informed to assess the research question on a particular criterion) was allowed but treated as missing data and omitted from the calculation of scores.

### **2.4 Method for weighting of criteria and rating of questions**

A web-based tool for multi-criteria decision-making<sup>11</sup> was selected for use (after a pilot test<sup>12</sup>) in a 2-step process involving (a) weighting of the prioritization criteria based on raters’ value judgments about the relative importance of the criteria and (b) rating of the candidate questions from which a weighted aggregate score was calculated from each rater’s responses to the nine criteria. The weighting of criteria and question rating were carried out between 23 May to 20 August 2013.

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<sup>8</sup> COHRED. A Manual for Research Priority Setting using ENHR Strategy, COHRED document 2000.3, March 2000

<sup>9</sup> CHNRI. A New Approach for Systematic Priority Setting In Child Health Research Investment

<sup>10</sup> Global Forum for Health Research. The 3D Combined Approach Matrix: An improved tool for setting priorities in research for health, 2009.

<sup>11</sup> Hansen P and Ombler F. A new method for scoring multi-attribute value models using pairwise rankings of alternatives. *Journal of Multi-Criteria Decision Analysis*. 2008; 15: 87-107.

<sup>12</sup> The tool was tested with a pilot group including six WHO staff and two external experts who completed the decision survey to weight the criteria and rated all candidate research questions.

In the first step, all experts in the working group were invited to complete a “decision survey”, in which a scoring system, called the *Potentially All Pairwise Rankings of All Possible Alternatives (PAPRIKA) method*, was used to derive each rater’s *preference values* (i.e., weights) for the pre-defined criteria according to their stated preferences when presented with a series of paired criteria (with differing responses) at a time to be ranked on importance. In the PAPRIKA method, each time the expert ranks a pair, all undominated pairs implicitly ranked as corollaries are identified and discarded. In this way the PAPRIKA method limits the number of pairwise rankings to a small fraction of all potential pairs and the process is repeated until potentially all undominated pairs are ranked. From the explicitly ranked pairs, preference values for each criterion are obtained via linear programming and expressed as a percentage. Each criterion's relative importance (i.e., weight), relative to the other criteria, is represented by the value of its highest ranked level (“yes” response). For a question to achieve a 100% rating it would need a “yes” response on all nine criteria. Similarly, a question would be rated worst if it received a “no” response on every criterion. The mean preference values of the group therefore represent the relative importance of the nine criteria to the group.

In the second step of the exercise, the rating of questions was designed to address two potential challenges that were earlier identified, and confirmed as important through the pilot test, namely how to ensure that an individual rater had the relevant expertise to provide valid responses for questions across multiple areas of immunization, and the need to limit the rating exercise to a reasonable and feasible duration that would not hinder the response rate. To address those concerns, each rater was requested to identify their top four areas of expertise according to the domains by which questions were grouped,. Raters were then matched to rate questions in specific domains (on average 3-4 domains) corresponding to their areas of expertise. Raters were kept blinded to the weights calculated for the criteria.

## **2.5 Analysis of scores**

Each rater’s responses to the nine prioritization criteria for each question were weighted (by *mean preference values* from the PAPRIKA method) and a mean of the weighted individual scores for each criterion was calculated as a criterion-specific score for that criterion. Each research question therefore received nine criterion-specific scores. The nine criterion-specific scores were then summed to give an

aggregate score for the question (ranging between 0 to 100%<sup>13</sup>) by which research questions in each domain were ranked in decreasing order.

### **3. Results**

#### **3.1 Response rate**

Of the 41 experts who were invited to participate in the prioritization exercise, 28 completed the weighting of the criteria (68% response rate) while 29 completed the rating of their assigned research questions (71% response rate). All non-respondents on the question rating survey (and those experts who had started but not completed) received up to five reminders through a combination of emails and phone calls. The distribution of respondents by WHO Region was approximately representative of the distribution in the working group (AMR 24%, SEAR 22%, EUR 20%, AFR 12%, EMR 12%, and WPR 10%), however with slightly lower response rate from the African Region (with only 4% and 7% of experts completing the weighting and rating respectively).

Five experts who completed weighting of the criteria did not complete the rating of questions. Conversely, six of those who completed rating of the questions did not contribute to the criteria weights. Overall, four experts did not respond to either the weighting or the question rating. There was no systematic process to document reasons for delayed or non-response, however lack of time and/or other competing commitments were reported by several non-respondents or respondents who completed the exercise with significant delay (after an initial start).

#### **3.2 Criteria weights**

Annex 2 shows the weights (by mean preference values) assigned by the group to the response levels for each of the nine criteria. Not unexpectedly, criterion 1.2 (ethical conduct of the study) was deemed to be the most important relative to the other criteria (i.e., highest weight on a “yes” response). Criterion 3.2 (availability of endpoints/results in <5 years) was judged to have the lowest relative importance.

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<sup>13</sup> To score 100%, a question had to have a “yes” response on each of the nine criteria.

### 3.3 Rating of the research questions

The number of experts who completed the rating per domain ranged from 9 to 19. However, the completion rate varied in relation to the number of experts assigned to each domain. For example, while there was comparatively more expertise on the working group in programme management (Domain F with 60% completion rate), and in health and immunization systems (Domain A, 64% completion) not all the eligible experts in those domains contributed to the final ranking. The top 5 ranked questions per domain, based on weighted aggregate scores, is presented in Table 1<sup>14</sup> (and the full list of ranked questions in each domain is available in Annex 3).

While one of the goals of this exercise was to focus on research questions that are broadly applicable rather than vaccine-specific ones, a few exceptions were made for the latter. Five of the six vaccine-specific questions included were rated in the bottom third of their respective domains, which could suggest that the panel of raters may not have been sufficiently well informed to assess those vaccine-specific questions on the given criteria. It is also possible, but difficult to confirm, that the *a priori* decision to exclude vaccine-specific questions could have biased raters against such questions.

There were missing data (i.e., “don’t know” responses) in all domains with the exception of Domain F (in which none of the questions generated a “don’t know” response to any of the criteria). However, in general there was no tendency for questions with a higher proportion of missing data (across all nine criteria for all raters combined) to rank lower on the final aggregate score. For example, in domains with the highest frequency of missing data (>20% of all possible responses to the criteria for all questions by all domain raters), questions with relatively higher or lower proportions of missing data were equally distributed in the ranking order. Comments provided by raters (optional) suggested that lack of clarity or the rater’s judgment that it was “not a research question” were frequent reasons for missing data.

## 4. Discussion

In this exercise, a pool of “research questions” was gathered from multiple sources in an effort to identify potential research needs for addressing barriers to improving vaccine coverage for existing

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<sup>14</sup> In different analyses, aggregate scores were weighted by (a) working group mean preference values (averaged across responses given by all experts who completed the decision survey) and (b) domain mean preference values (averaged across responses given by only those experts who were assigned to rate the given domain according to their expertise). The rankings were identical with limited changes in overall ranking and the results in this report are based on the working group weights only.



recommended vaccines or uptake of newly licensed or soon-to-be licensed vaccines. The questions were categorized *post hoc* into eight domains as presented in the report. Given that questions were ranked within each domain, the results are not useful for making choices between research needs in one area versus another (e.g., health systems versus social determinants of vaccine acceptance and uptake). The ranking of all questions in each domain provides a reference list of the relative importance assigned to the identified research needs by this group of experts. Given the close range of scores it would be difficult with these data to identify, for example in funding decisions, a true set of “lowest ranked” research needs that should not receive support. It is possible that a larger group or a different group of raters could result in a different rank order of research needs. Furthermore, different stakeholder groups that may use such a list are likely to have different priorities and apply additional factors in selecting among these research needs.

The ENHR criteria proved to be adaptable to the prioritization of immunization implementation research needs. In addition, the PAPRIKA method served as a useful tool for a transparent decision-making process in that it enabled empiric weighting of our prioritization criteria according to judgments by the actual raters and yielded weights that exhibited face validity. Importantly, changing the weights applied to the criteria from the overall weights to those derived by raters in a specific domain did not result in significant changes in the overall ranking. Limitations of this prioritization exercise include relatively small numbers of raters per domain, less than optimal completion rate (in part this is likely attributable to the prolonged duration of the exercise) and potential biases in selecting (through the multiple stages of review) the final list of candidate research questions for systematic rating.

IVIR-AC guidance was sought on the robustness of the overall methods used and the analytical approach. IVIR-AC was supportive of the effort to make priority setting for immunization implementation research needs more systematic and found the analytical approach to be appropriate. The committee also found that the method is attractive in that it is based on an accepted decision theory framework and tapped the authority of relevant experts while also simplifying complex multiple comparisons to binary choices in the weighting process. Nonetheless, the committee cautioned that the outcomes of this prioritization should not be used as the sole measure for decision-making on implementation research needs given the importance of contextual factors to implementation research and the variability of such factors in different settings. Dissemination to and inputs from a range of stakeholders (public health communities,

researchers, donors and policymakers at national, regional and global levels) – all of whom may have different priorities - will be beneficial in defining the application of the results from this exercise.

Implementation research needs in immunization have been identified and categorized in different dimensions by the DOV R&D Working Group<sup>15</sup> and other groups. It will be particularly interesting to review the research needs identified through this exercise against five implementation research domains developed by the DOV R&D Working Group: Bringing immunization closer to the community; Demand for vaccination; Services at fixed sites; Program management, and Policy and governance. The latter also provide a useful framework for monitoring the outcomes of this prioritization exercise in terms of the broader acceptance of the research needs identified as well as the number and outcomes of future research activities conducted.

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<sup>15</sup> See footnote 4

**Table 1: Top 5 ranking research questions per domain – aggregate score (based on number of raters in the given domain) weighted by working group mean preference values**

*Note: The full ranking for all questions per domain is available in the complete report.*

<b>Domain A (Health and Immunization Systems) – 15 questions</b>			
<b>Short title</b>	<b>Proposed research questions</b>	<b>Rank</b>	<b>Aggregate score (n=9 raters)</b>
A13: Unvacc_ delivery strategies	What are the specific barriers to immunization among children not reached by immunization services and what are the service delivery strategies (including specific package of services) to respond effectively to those barriers?	1st	95.1%
A04: HCP competence/KA	How do the level of professional competence, knowledge and attitudes of vaccinators (e.g., trained nurses vs. 'lay' health workers) impact on the quality of vaccination services, vaccine acceptance, vaccination coverage, and occurrence and management of AEFIs etc.?	2nd	91.6%
A03: Sustainability barriers	What are the barriers to sustained financing for routine immunization in low and middle income countries and what are the successful financing and advocacy mechanisms both internal (i.e., governmental) and external (i.e., donors) for countries in different categories (GAVI-supported vrs. non-GAVI etc.) in terms of long term sustainability?	3rd	89.9%
A06: PPPs_service quality	What public-private partnerships (and specific interventions) can be developed and leveraged to improve the quality of routine immunization services and to increase vaccination coverage?	4th	88.9%
A01: Sustainability tools	What are the optimum tools to assess and sustain vaccine purchases and operational costs after donor funding ends?	5th	87.8%
<b>Domain B (Social determinants of vaccination &amp; Communication) – 8 questions</b>			
<b>Short title</b>	<b>Proposed research questions</b>	<b>Rank</b>	<b>Aggregate score (n=12 raters)</b>
B1: High risk communities	What are the profiles of high risk communities (such as gender, vulnerable populations, socio-economic factors etc), how do these profiles influence vaccine uptake, and what are the best strategies to identify and vaccinate such groups?	1st	91.0%
B5: Low public demand	What are the factors that influence levels of demand for immunization (context, vaccine and vaccination specific issues, individual and social group influences)?	2nd	88.3%
B7: Media education/training	What is the impact of education/training of the media in enhancing (a) community knowledge and perceptions about vaccination, and (b) greater media accountability in reporting immunization-related issues?	3rd	87.4%
B4: HCP capacity on trust issues	Do policymakers, doctors, nurses, and other frontline workers have adequate relevant (as per their responsibilities) tools, knowledge, and capacity to address trust issues in order to increase (or maintain already high levels of) vaccine uptake?	4th	87.3%
B8: Strategies_vacc hesitancy	What strategies are effective (with the public, health care workers, health system) to address vaccine hesitancy?	5th	84.7%
<b>Domain C (Vaccine product profile) – 6 questions</b>			
<b>Short title</b>	<b>Proposed research questions</b>	<b>Rank</b>	<b>Aggregate score (n=14 raters)</b>
C4: LLD feasibility_safety	What is the feasibility of establishing (regional) dynamic, large-linked databases for use in assessing vaccine safety concerns?	1st	87.6%
C1: Perceptions_impact	How do perceptions about vaccine effectiveness and safety influence vaccine introduction and coverage, and what are the most effective strategies to address negative inaccurate perceptions in order to improve coverage?	2nd	83.9%

C6: Quality AEFI systems	What are the most effective strategies for management of AEFIs and to have high quality AEFI surveillance systems?	3rd	83.1%
C5: Needle-free routes LMIC	What are the effectiveness, efficiency, appropriateness and potential risks of novel needle-free routes of vaccine administration (e.g., sublingual, jet injectors, micro-needle patches) in low- and middle-income countries and what is the impact of their use on reducing injection waste?	4th	81.3%
C3: Vaccine presentations_impact	What is the impact of different vaccine presentations (e.g., single dose vs. multiple dose or combo vs. non-combo vaccines) on vaccine wastage, costs, acceptability and vaccine introduction and coverage?	5th	75.8%
<b>Domain D (Vaccination and Coverage) – 12 questions</b>			
Short title	Proposed research questions	Rank	Aggregate score (n=19 raters)
D09: Vacc cov_special populations	How should vaccination services be adapted to increase coverage of specific populations e.g. in context of HPV (different target group); cholera vaccines (home intake of the second dose distributed when the first dose is administered under supervision); private sector availability of some oral vaccines (e.g., cholera, typhoid); or marginalised population (slums, migrants, etc.) ?	1st	93.0%
D06: IntegratSed Vacc programs	Does integration of childhood and adolescent immunization programmes with other health programmes improve vaccination coverage and if so, which other health programmes (e.g., Primary Health Care, PMTCT) provide the most effective models for integration (e.g., what is the optimal package of services and the cost-effectiveness of different packages, and what additional resources are needed to achieve successful and sustainable integration)?	2nd	89.1%
D01: Unvacc_active measures	How effective are active measures to supplement routine EPI in capturing children at risk of non-vaccination and/or poor compliance?	3rd	88.3%
D07: Health/immunization cards	How can child health cards and child immunization cards (or equivalent) be designed and used as cost-effective monitoring tools to track service delivery (i.e. linked with registers and tracking systems) and improve vaccination coverage, and as communication tools for caregivers?	4th	87.4%
D03: Survey methods	How can survey methods be standardized to reduce heterogeneity between vaccination coverage estimates from different surveys and/or system reports, and to improve accuracy and timeliness of coverage data at all levels?	5th	85.3%
<b>Domain E (Cold chain and logistics management) – 10 questions</b>			
Short title	Proposed research questions	Rank	Aggregate score (n=10)
E10: Integrated logistics mxmnt	What would be an effective 'common operating platform' for integrated logistics management of all public health activities at district level, including the validation of a trained logistics manager to lead the activity?	1st	89.3%
E02: Solar refrigerators	What is the performance in use and the reliability of solar refrigerators in health facilities without electricity and why have repair/maintenance systems worked or failed?	2nd	88.1%
E07: Controlled Room Ambient	What is the potential impact of equipping medicines supply chains with storage at Controlled Room Ambient (+15/+25C) on future vaccine storage (i.e., to enable vaccine storage out of the cold chain)?	3rd	86.9%
E05: Centralized destruction	How can sharps collection systems be best integrated within vaccine delivery systems, in environmentally acceptable, practical and affordable ways, and using centralized destruction technologies?	4th	83.7%
E03: Passive transport containers	Which technologies and practices will provide the necessary protection against heat and freezing for vaccine carried in passive transport containers and what is likely to be the burden of introduction?	5th	83.1%

Domain F (Programme Management) – 9 questions			
Short title	Proposed research questions	Rank	Aggregate score (n=12 raters)
F5: Tools_missed opportunities	What tools are needed for health workers to effectively assess and correct missed opportunities for children whose immunization has been delayed or whose schedules have been interrupted?	1st	91.4%
F6: Minimum supervisory criteria	What are the supervisory capacities and practices in different countries/settings, and what is the minimum set of criteria for supervisory workforce planning and supervisory practices in immunization programmes?	2nd	89.1%
F1: Minimum enabling elements	What is the minimum set of “enabling elements” required for a successful immunization programme, and what indicators can be best used to monitor the quality of immunization services and immunization programme management?	3rd	88.1%
F3: Barriers_RED	What are the barriers to implementation of the RED (Reaching Every District) strategy in low performing countries?	4th	86.8%
F8: Strategies_REC	What are the implementation and management strategies, and the outcomes/impact of the ‘Reaching every Community’ strategy (in countries where this is implemented)?	5th	83.8%
Domain G (Programme monitoring and Impact assessment) – 19 questions			
Short title	Proposed research questions	Rank	Aggregate score (n=18 raters)
G02: Estimating target population	Can improvements be made to methods for estimating the size of the target populations, at national and subnational levels?	1st	90.4%
G01: Technologies_data recording	How can new or innovative information and communication technologies be used to improve the recording and reporting as well as the use of immunization data?	2nd	89.6%
G04: Sub-national data	Can better tools be developed to facilitate the use of sub-national (district level) immunization data (stock, surveillance and coverage) to take timely action to improve programme performance?	3rd	85.9%
G10: Rapid methods_sensitivity	Can rapid methods be developed to assess reporting sensitivity of VPDs in national health management information systems?	4th	85.5%
G11: Rapid methods_BOD	In countries with inadequate surveillance capacity, can rapid assessment methods be developed to estimate burden of disease using data from hospital records or national health management information systems?	5th	85.5%
Domain H (Research related issues) – 5 questions			
Short title	Proposed research questions	Rank	Aggregate score (n=15 raters)
H5: NITAGs	How frequently is evidence-based information used to support NITAG (or other equivalent national) recommendations? What are the barriers and challenges to the effective functioning of NITAGs and how can they be addressed to strengthen NITAGs and vaccine policy-making at country level?	1st	87.3%
H1: Strategies_IMR capacity	What strategies can be used to strengthen vaccine implementation research capacity in countries and the translation of research to policy?	2nd	82.4%
H2: IMR capacity_Policy	To what extent is in-country research critical in driving immunization policy? How is it influenced by presence or absence of local research capacity/institutions and their relationships with policy makers and local/national advisory bodies such as NITAGs?	3rd	80.6%
H4: Requirements_Governance	What are the technical cooperation and research capacity requirements to facilitate establishment of immunization governance mechanisms?	4th	77.4%
H3: ICC roles	What role can interagency coordinating committees play in improving immunization financing, governance and partnership?	5th	66.7%

**Annex 1: Composition of the Ad Hoc Working Group on Immunization Implementation Research**

The table lists the technical experts on the ad hoc working group as well as each member's affiliation (at the start of the prioritization exercise) and selected areas of expertise for rating the research questions.

Name	Affiliation	"Top areas" of immunization expertise selected (Domains assigned for rating)
Abdoulreza Esteghamati	Tehran University of Medical Sciences, Iran	Health and Immunization Systems, Social determinants of vaccination & Communication, Cold chain and logistics management, Programme Management, Research capacity and application
Andrew J. Hall	London School of Hygiene and Tropical Medicine	Vaccine product profile, Vaccination and Coverage, Research capacity and application
Asad Ali	The Aga Khan University, Pakistan	Vaccine product profile, Vaccination and Coverage, Programme monitoring and Impact assessment, Research capacity and application
Auguste Ambendet	WHO AFRO	Health and Immunization Systems, Programme Management, Programme monitoring and Impact assessment, Research capacity and application
Adalid Zamora	National Immunization Technical Advisory Group for Immunization, Bolivia	Social determinants of vaccination & Communication, Cold chain and logistics management, Programme Management, Programme monitoring and Impact assessment
Carolina Danovaro	PAHO	Vaccination and Coverage, Programme Management, Programme monitoring and Impact assessment, Research capacity and application
Christian Schaetti	Swiss Tropical & Public Health Institute	Health and Immunization Systems, Social determinants of vaccination & Communication, Vaccine product profile, Vaccination and Coverage, Research capacity and application
Dicky Akanmori	WHO AFRO	Social determinants of vaccination & Communication, Vaccination and Coverage, Programme Management, Programme monitoring and Impact assessment
David Durrheim	University of Newcastle, Australia	Vaccination and Coverage, Programme monitoring and Impact assessment, Research capacity and application
David Sack	Johns Hopkins Bloomberg School of Public Health	Social determinants of vaccination & Communication, Vaccine product profile, Vaccination and Coverage, Programme monitoring and Impact assessment
Fussum Daniel	WHO AFRO	Health and Immunization Systems, Programme Management, Programme monitoring and Impact assessment
Gabriela Montorzi	Council on Health Research for Development	Research capacity and application
Helen Oh	Changi General Hospital, Singapore	Social determinants of vaccination & Communication, Vaccine product profile, Vaccination and Coverage, Cold chain and logistics management
Irtaza Chaudhri	WHO EMRO	Social determinants of vaccination & Communication, Cold

		chain and logistics management, Programme Management, Programme monitoring and Impact assessment
John Clemens (Chair)	UCLA (subsequently icddr,b, Bangladesh)	Vaccine product profile, Programme monitoring and Impact assessment
John Grundy	Nossal Institute for Global Health	Health and Immunization Systems, Social determinants of vaccination & Communication, Programme Management, Research capacity and application
John Lloyd	Independent consultant	Vaccine product profile, Vaccination and Coverage, Cold chain and logistics management, Programme Management,
Lee Jong-Koo	Seoul National University College of Medicine	Health and Immunization Systems' Vaccine product profile, Vaccination and Coverage, Programme Management
Lauri Markowitz	US CDC	Vaccine product profile, Vaccination and Coverage, Programme monitoring and Impact assessment, Research capacity and application
Manoj K. Das	INCLIN Trust International	Social determinants of vaccination & Communication, Vaccine product profile, Vaccination and Coverage, Cold chain and logistics management
Myriam Henkens	Médecins Sans Frontières	Vaccine product profile, Vaccination and Coverage, Cold chain and logistics management, Programme monitoring and Impact assessment
Mark LaForce	Independent consultant	Social determinants of vaccination & Communication, Vaccine product profile, Vaccination and Coverage, Cold chain and logistics management, Research capacity and application
Nihal Abeysinghe	WHO SEARO	Health and Immunization Systems, Vaccine product profile' Programme monitoring and Impact assessment
Niyazi Cakmak	WHO EURO	Health and Immunization Systems, Social determinants of vaccination & Communication, Vaccination and Coverage, Programme Management
Nonhlanhla Dlamini	Department of Health, South Africa	Social determinants of vaccination & Communication, Vaccination and Coverage, Cold chain and logistics management, Programme Management
Nehemie Mbakuliyemo	WHO AFRO	Health and Immunization Systems, Social determinants of vaccination & Communication, Vaccination and Coverage, Programme Management
Pritaporn Kingkaew	Health Intervention and Technology Assessment Program, Department of Health, Thailand	Social determinants of vaccination & Communication, Vaccine product profile, Programme monitoring and Impact assessment, Research capacity and application
Pem Namgyal	WHO SEARO	Health and Immunization Systems, Vaccine product profile, Vaccination and Coverage, Programme Management
Paba Paliawdana	Ministry of Healthcare and Nutrition, Sri Lanka	Health and Immunization Systems' Programme Management, Programme monitoring and Impact assessment

Rajendra Bohara	WHO SEARO	Social determinants of vaccination & Communication, Vaccine product profile, Vaccination and Coverage, Programme monitoring and Impact assessment
Rana Hajjeh	US CDC	Vaccination and Coverage, Programme monitoring and Impact assessment, Research capacity and application
Robert Steinglass	Maternal and Child Health Integrated Program, USA	Health and Immunization Systems, Social determinants of vaccination & Communication, Cold chain and logistics management, Programme Management
Renato Valenzuela	National Autonomous University of Honduras	
Shams Al Arifeen	International Centre for Diarrhoeal Disease Research, (icddr,b)	Health and Immunization Systems, Vaccination and Coverage, Programme monitoring and Impact assessment
Salah Al Awaidy	Ministry of Health and Social Welfare, Oman	Health and Immunization Systems' Cold chain and logistics management, Programme monitoring and Impact assessment, Research capacity and application
Shahin Huseynov	WHO EURO	Vaccination and Coverage, Programme Management, Programme monitoring and Impact assessment
Sudath Peiris	Ministry of Healthcare and Nutrition, Sri Lanka	Vaccine product profile, Vaccination and Coverage, Cold chain and logistics management, Programme Management, Research capacity and application
Theresa Diaz	UNICEF	Social determinants of vaccination & Communication, Vaccination and Coverage, Programme monitoring and Impact assessment, Research capacity and application
Vusala Allahverdiyeva	WHO EURO	Vaccination and Coverage, Cold chain and logistics management, Programme Management, Programme monitoring and Impact assessment
Yot Teerawattananon	Health Intervention and Technology Assessment Program, Department of Health, Thailand	Social determinants of vaccination & Communication, Programme Management, Programme monitoring and Impact assessment, Research capacity and application
Zulfiqar Ahmed Bhutta	The Aga Khan University, Pakistan	



**Annex 2: Prioritization criteria**

Each criterion was assigned the following response levels:

**Yes/No:** The rater is *sufficiently informed* to assess and score the research question as “Yes” or “No”

**Not sure (Maybe):** The rater is *sufficiently informed* to assess and score the research question, but *cannot decide* “Yes” or “No”

**Don’t know:** The rater feels that s/he is *not well informed* to assess the research question on the criterion. In these cases, raters were instructed to leave the response as *blank* (“not rated” in the online surveys). Don’t know responses were treated as missing data and removed from the calculation of scores (see sections 2.4 and 2.5).

Description of category	Specific criteria	Weights assigned to response levels
<b>1. Appropriateness</b>  The purpose of this category is to determine if the proposed research is well suited to the target population and if it duplicates past studies or addresses knowledge that is known already.  The key question is “Should we do it?”	1.1. Would you say there is a significant knowledge gap on this issue to be addressed by research?	Yes = 12.0% Not sure = 6.7% No = 0%
	1.2. Do you think that a study to answer the proposed research question can be conducted in an ethical fashion?	Yes = 14.9% Not sure = 9.1% No = 0%
<b>2. Relevance</b>  The purpose of this category is to make sure that the proposed research is of the right kind for the right people, is pertinent to the health problems and immunization issues of the population/community and also addresses the equity issues.  The key question is “Why should we do it?”	2.1. Would you say that the size and/or severity of the problem being addressed by the proposed research is significant?  <i>(An indicator of significance of the size and severity of the problem may be any of these: burden of the disease, disability, years of potential life lost, disability-adjusted life years, economic burden, social burden, contribution to low coverage, difficulties in introducing new vaccines, etc.)</i>	Yes = 9.9% Not sure = 5.1% No = 0%
	2.2. Do you think the proposed research can respond to the population needs and national or global health policies or goals?	Yes = 12.2% Not sure = 7.3% No = 0%

	<p>2.3. Do you think the proposed research can contribute to greater equity in immunization?  <i>(Indicator of equity may be on any, or a combination, of these factors: socio-demographic, economic, health service access/delivery, gender, etc.)</i></p>	<p>Yes = 11.9%  Not sure = 6.6%  No = 0%</p>
<p><b>3. Chances of success</b></p> <p>The purpose of this category is to evaluate the possibility and feasibility of undertaking the proposed research considering the resources (technical, financial) available and timeframe.</p> <p>The proposed research is to be evaluated within the specific context (low and middle income countries) and a time frame of 5 years.</p> <p>The key question is “Can we do it?”</p>	<p>3.1. Is it possible to design a study to appropriately answer the proposed research within the specific context and time frame (as defined above)?</p>	<p>Yes = 9.2%  Not sure = 5.4%  No = 0%</p>
	<p>3.2. Do you think the endpoints of the proposed research are likely to be achieved, i.e., results will be available, within the specific context and time frame (as defined above)?</p>	<p>Yes = 6.8%  Not sure = 4.2%  No = 0%</p>
<p><b>4. Impact of the research outcome(s)</b></p> <p>The purpose of this category is to estimate the benefit of using or implementing the proposed research results by assessing their potential merit and usefulness.</p> <p>The key question is “What benefit will be achieved?”</p>	<p>4.1. Do you think that the proposed research is likely to produce knowledge that will lead to affordable and sustainable interventions and/or policies?</p>	<p>Yes = 11.0%  Not sure = 6.2%  No = 0%</p>
	<p>4.2. Do you think that the proposed research is likely to produce knowledge that will lead to any or all of the following: improved coverage, improved quality of immunization services, improved new vaccine introduction, or improved policy/decision-making?</p>	<p>Yes = 12.3%  Not sure = 6.2%  No = 0%</p>

**Annex 3: Full list of ranked questions in each domain in Tables 3A1 to 3H2****Table 3A1: Ranking of research questions in Domain A (Health and Immunization Systems) – aggregate score weighted by Working Group mean preference values**

Short title	Proposed research questions	Rank	Aggregate score (n=9)
A13: Unvacc_delivery strategies	What are the specific barriers to immunization among children not reached by immunization services and what are the service delivery strategies (including specific package of services) to respond effectively to those barriers?	1st	95.1%
A04: HCP competence/KA	How do the level of professional competence, knowledge and attitudes of vaccinators (e.g., trained nurses vs. 'lay' health workers) impact on the quality of vaccination services, vaccine acceptance, vaccination coverage, and occurrence and management of AEFIs etc.?	2nd	91.6%
A03: Sustainability barriers	What are the barriers to sustained financing for routine immunization in low and middle income countries and what are the successful financing and advocacy mechanisms both internal (i.e., governmental) and external (i.e., donors) for countries in different categories (GAVI-supported vrs. non-GAVI etc.) in terms of long term sustainability?	3rd	89.9%
A06: PPPs_service quality	What public-private partnerships (and specific interventions) can be developed and leveraged to improve the quality of routine immunization services and to increase vaccination coverage?	4th	88.9%
A01: Sustainability tools	What are the optimum tools to assess and sustain vaccine purchases and operational costs after donor funding ends?	5th	87.8%
A08: ADC_routine	To what extent do accelerated disease control initiatives strengthen or weaken routine immunization services, and what are the opportunities and threats to strengthening routine immunization?	6th	87.2%
A07: Private sector_routine	What private sector models for routine vaccination are available, and what are their advantages/disadvantages?	7th	86.6%
A05: HCP accountability/performance	How can accountability and performance of the health workforce be improved to ensure delivery of high quality services in immunization programmes?	8th	84.6%
A10: Routine in urban	How can immunization services be most effectively organized and delivered in urban areas (as opposed to the rural model on which EPI was designed) in different countries/country settings?	9th	84.1%
A11: Admin reforms	What is the positive and negative impact of administrative reforms in countries that result in decentralization of immunization programme responsibility to lower administrative levels (e.g., provincial, district etc.)?	10th	80.6%
A09: Tools_routine	Which tools are most effective to assist in the planning of routine immunization services considering the available infrastructure and target population in a given setting?	11th	79.4%
A02: Post-GAVI govt budgets	What have been the financial consequences on government budgets after introduction of new vaccines using GAVI support?	12th	79.2%
A14: Vacc centres_staffing/hours	What are the optimum staffing needs and operating hours of immunization centers in order to achieve maximum vaccination coverage rates in the community?	13th	79.0%
A15: Multi-antigen campaigns	What is the feasibility and what are the expected outcomes for injectable multi-antigen vaccine campaigns targeting various age groups (e.g., a campaign with TT/Td targeting women of child-bearing age during polio and measles SIAs)?	14th	79.0%
A12: Pre-service training HCPs	What information on vaccines and vaccination implementation is currently included in the pre-service training of medical doctors and nurses, and is there a need for a standard package to be developed?	15th	75.8%

**Table 3B1: Ranking of research questions in Domain B (Social determinants of vaccination & Communication) – aggregate score weighted by Working Group mean preference values**

Short title	Proposed research questions	Rank	Aggregate score (n=12)
B1: High risk communities	What are the profiles of high risk communities (such as gender, vulnerable populations, socio-economic factors etc), how do these profiles influence vaccine uptake, and what are the best strategies to identify and vaccinate such groups?	1st	91.0%
B5: Low public demand	What are the factors that influence levels of demand for immunization (context, vaccine and vaccination specific issues, individual and social group influences)?	2nd	88.3%
B7: Media education/training	What is the impact of education/training of the media in enhancing (a) community knowledge and perceptions about vaccination, and (b) greater media accountability in reporting immunization-related issues?	3rd	87.4%
B4: HCP capacity on trust issues	Do policymakers, doctors, nurses, and other frontline workers have adequate relevant (as per their responsibilities) tools, knowledge, and capacity to address trust issues in order to increase (or maintain already high levels of) vaccine uptake?	4th	87.3%
B8: Strategies_vacc hesitancy	What strategies are effective (with the public, health care workers, health system) to address vaccine hesitancy?	5th	84.7%
B6: Vaccinator/vaccinee interactions	What tools and systems and health worker training will improve and sustain the quality of the interaction between vaccinators and parents/caregivers or adolescent/adult vaccinees in order to enhance satisfaction and reduce drop-out?	6th	83.6%
B2: Women's/community groups	What are the roles of women's associations or community-based groups in the improvement and sustainability of immunization programmes?	7th	82.0%
B3: Strategies_communication	Can a standard reference protocol be developed to compare the impact of alternative advocacy, social mobilization, and communication strategies on increasing vaccine uptake in a given community to determine the most effective strategies in given communities/contexts?	8th	77.8%

**Table 3C1: Ranking of research questions in Domain C (Vaccine product profile) – aggregate score weighted by Working Group mean preference values**

Short title	Proposed research questions	Rank	Aggregate score (n=14)
C4: LLD feasibility_safety	What is the feasibility of establishing (regional) dynamic, large-linked databases for use in assessing vaccine safety concerns?	1st	87.6%
C1: Perceptions_impact	How do perceptions about vaccine effectiveness and safety influence vaccine introduction and coverage, and what are the most effective strategies to address negative inaccurate perceptions in order to improve coverage?	2nd	83.9%
C6: Quality AEFI systems	What are the most effective strategies for management of AEFIs and to have high quality AEFI surveillance systems?	3rd	83.1%
C5: Needle-free routes LMIC	What are the effectiveness, efficiency, appropriateness and potential risks of novel needle-free routes of vaccine administration (e.g., sublingual, jet injectors, micro-needle patches) in low- and middle-income countries and what is the impact of their use on reducing injection waste?	4th	81.3%
C3: Vaccine presentations_impact	What is the impact of different vaccine presentations (e.g., single dose vs. multiple dose or combo vs. non-combo vaccines) on vaccine wastage, costs, acceptability and vaccine introduction and coverage?	5th	75.8%
C2: Anti-vaccination_impact	What is the prevalence and impact of anti-vaccination organizations or activities on vaccine introduction and coverage?	6th	71.0%

**Table 3D1: Ranking of research questions in Domain D (Vaccination and Coverage) - aggregate score weighted by Working Group mean preference values**

Short title	Proposed research questions	Rank	Aggregate score (n=19)
D09: Vacc cov_special populations	How should vaccination services be adapted to increase coverage of specific populations e.g. in context of HPV (different target group); cholera vaccines (home intake of the second dose distributed when the first dose is administered under supervision); private sector availability of some oral vaccines (e.g., cholera, typhoid); or marginalised population (slums, migrants, etc.) ?	1st	93.0%
D06: IntegratSed Vacc programs	Does integration of childhood and adolescent immunization programmes with other health programmes improve vaccination coverage and if so, which other health programmes (e.g., Primary Health Care, PMTCT) provide the most effective models for integration (e.g., what is the optimal package of services and the cost-effectiveness of different packages, and what additional resources are needed to achieve successful and sustainable integration)?	2nd	89.1%
D01: Unvacc_active measures	How effective are active measures to supplement routine EPI in capturing children at risk of non-vaccination and/or poor compliance?	3rd	88.3%
D07: Health/immunization cards	How can child health cards and child immunization cards (or equivalent) be designed and used as cost-effective monitoring tools to track service delivery (i.e. linked with registers and tracking systems) and improve vaccination coverage, and as communication tools for caregivers?	4th	87.4%
D03: Survey methods	How can survey methods be standardized to reduce heterogeneity between vaccination coverage estimates from different surveys and/or system reports, and to improve accuracy and timeliness of coverage data at all levels?	5th	85.3%
D04: Life-course approach	What are the most effective policies and practices for a life-course approach to immunization beyond childhood (i.e., from adolescent to adults to the elderly) in low- and middle-income countries?	6th	85.1%
D10: Barriers_"better" vacc cov	What are the barriers to improving vaccination coverage in countries with "good" coverage (e.g., around 70%) to achieve 85% -90% coverage levels?	7th	84.4%
D11: NUVI vrs routine	What are the best approaches (e.g., specific strategies, tools, technical or other support) to help countries in prioritizing introduction of new vaccines while at the same time maintaining or improving vaccination coverage of existing vaccines in the national immunization programme.	8th	84.0%
D08: Impact SIAs_Routine	What is the impact (potential benefits or risks) of SIAs and Child Health Days on routine vaccination coverage?	9th	82.7%
D12: Integrated approaches_buy-in	How can integrated approaches to diarrhoea, pneumonia, cervical cancer, vector-borne disease (malaria, dengue) control be made more effective and acceptable to country decision-makers?	10th	77.8%
D05: CHW_advocacy	How effective are community health workers in promoting immunization in their communities?	11th	74.7%
D02: Routine vrs mass campaigns	What are the feasibility, advantages and disadvantages of routine versus mass immunization approaches for vaccines for which both options are viable (e.g., cholera, typhoid)?	12th	74.3%
D13: Flu_pregnancy	What is the feasibility of delivering seasonal influenza vaccine to pregnant women?	13th	72.1%

**Table 3E1: Ranking of research questions in Domain E (Cold chain and logistics management) - aggregate score weighted by Working Group mean preference values**

Short title	Proposed research questions	Rank	Aggregate score (n=10)
E10: Integrated logistics mxmnt	What would be an effective 'common operating platform' for integrated logistics management of all public health activities at district level, including the validation of a trained logistics manager to lead the activity?	1st	89.3%
E02: Solar refrigerators	What is the performance in use and the reliability of solar refrigerators in health facilities without electricity and why have repair/maintenance systems worked or failed?	2nd	88.1%
E07: Controlled Room Ambient	What is the potential impact of equipping medicines supply chains with storage at Controlled Room Ambient (+15/+25C) on future vaccine storage (i.e., to enable vaccine storage out of the cold chain)?	3rd	86.9%
E05: Centralized destruction	How can sharps collection systems be best integrated within vaccine delivery systems, in environmentally acceptable, practical and affordable ways, and using centralized destruction technologies?	4th	83.7%
E03: Passive transport containers	Which technologies and practices will provide the necessary protection against heat and freezing for vaccine carried in passive transport containers and what is likely to be the burden of introduction?	5th	83.1%
E04: Vaccine delivery to POC	What are the managerial benefits and economics of delivering vaccines to the point of use with supervision versus vaccine collection systems, and how do they contribute to reducing incidents of stock control failure?	6th	82.9%
E09: Single dose_Small sessions	What is the cost and impact on coverage of using single dose presentations (in conjunction with multidose vaccines) where sessions are small or casual immunizations are extensively used?	7th	81.7%
E06: Decentralized destruction	How effective is the use of syringe melting, shredding and crushing technologies as an environmentally acceptable, practical and affordable approach to disposal of used sharps and vaccine containers, and to facilitate de-centralised destruction and disposal in remote areas?	8th	81.6%
E08: Cooling reconstituted vaccine	What technologies can be developed to cool re-constituted vaccine at the point of use when the lyophilized vaccine is taken beyond the cold chain?	9th	74.9%
E01: Mobile technologies	What are the benefits and challenges of using mobile communication technologies with appropriate applications to transmit vaccine orders and to report remaining stocks and consumption to achieve more timely, complete and accurate vaccine distribution?	10th	74.3%

**Table 3F1: Ranking of research questions in Domain F (Programme Management) - aggregate score weighted by Working Group mean preference values**

Short title	Proposed research questions	Rank	Aggregate score (n=12)
F5: Tools_missed opportunities	What tools are needed for health workers to effectively assess and correct missed opportunities for children whose immunization has been delayed or whose schedules have been interrupted?	1st	91.4%
F6: Minimum supervisory criteria	What are the supervisory capacities and practices in different countries/settings, and what is the minimum set of criteria for supervisory workforce planning and supervisory practices in immunization programmes?	2nd	89.1%
F1: Minimum enabling elements	What is the minimum set of “enabling elements” required for a successful immunization programme, and what indicators can be best used to monitor the quality of immunization services and immunization programme management?	3rd	88.1%
F3: Barriers_RED	What are the barriers to implementation of the RED (Reaching Every District) strategy in low performing countries?	4th	86.8%
F8: Strategies_REC	What are the implementation and management strategies, and the outcomes/impact of the ‘Reaching every Community’ strategy (in countries where this is implemented)?	5th	83.8%
F2: Technologies_program mxmnt	How effective is the use of innovative IT technologies, software or other tools for programme management (incl. monitoring and supervision) and what is their impact on improving the quality of immunization programmes and vaccination coverage?	6th	82.6%
F7: Gaps_EPI Manager	What are the existing gaps in the skills and knowledge of a typical EPI Programme Manager in the context of the multiple antigens delivered in national immunization programmes, and what core training content is needed for EPI Programme Managers to address those gaps?	7th	81.3%
F4: VaccCov_program mxmnt	How can vaccination coverage data be used at different levels (e.g. district, regional, national ) to improve performance management?	8th	80.3%
F9: Checklists	Are checklists a useful tool to improve immunization services? Can improved checklists be devised and pre-tested for this purpose?	9th	79.7%



**Table 3G1: Ranking of research questions in Domain G (Programme monitoring and Impact assessment) - aggregate score weighted by Working Group mean preference values**

Short title	Proposed research questions	Rank	Aggregate score (n=18)
G02: Estimating target population	Can improvements be made to methods for estimating the size of the target populations, at national and subnational levels?	1st	90.4%
G01: Technologies_data recording	How can new or innovative information and communication technologies be used to improve the recording and reporting as well as the use of immunization data?	2nd	89.6%
G04: Sub-national data	Can better tools be developed to facilitate the use of sub-national (district level) immunization data (stock, surveillance and coverage) to take timely action to improve programme performance?	3rd	85.9%
G10: Rapid methods_sensitivity	Can rapid methods be developed to assess reporting sensitivity of VPDs in national health management information systems?	4th	85.5%
G11: Rapid methods_BOD	In countries with inadequate surveillance capacity, can rapid assessment methods be developed to estimate burden of disease using data from hospital records or national health management information systems?	5th	85.5%
G18: BOD/VacImpact_post-childhood+C90	What is the suitability of existing surveillance platforms for measuring disease burden and monitoring vaccine impact in adolescents and adults?	6th	83.5%
G09: Surveillance platforms enhanced	How may existing surveillance platforms be enhanced/adapted to conduct surveillance across the life-course and in special high-risk populations to describe the epidemiology of VPDs (including those caused by organisms targeted by the original EPI vaccines e.g. pertussis, diphtheria)? When can such surveillance platforms for different VPDs be reasonably well combined and when would this not be preferable?	7th	82.4%
G17: Broader economic impact	Can methods be developed for estimating the broader economic impact of immunization, looking beyond the traditional cost-benefit analysis to also consider broad return on investments in immunization?	8th	81.5%
G16: Rapid tools_impact morbidity	Can simple, rapid tools be developed for use in resource-poor populations to quantify the health and economic impact of immunization on long-term morbidity from vaccine preventable diseases (e.g. CRS, meningitis sequelae etc.)?	9th	81.1%
G14: Pneumo hosp data	Under what conditions and how may we use pneumonia hospitalization data to monitor the impact of vaccines targeting pneumonia pathogens?	10th	80.3%
G13: Surveillance indicators	Can indicators be established for surveillance systems to assess the completeness and quality of surveillance ( i.e. such as the non-polio AFP rate for polio surveillance)?	11th	80.3%
G07: POC diagnostics	Can point-of-care-diagnostics be developed that are more suited for use in resource-poor countries to improve the quality of laboratory confirmation?	12th	78.8%
G19: Biomarkers	What are the appropriate methods (and guidelines) for collecting, analyzing, and interpreting data on biomarkers and their potential use for validating vaccination coverage or assessing population immunity to specific antigens?	13th	76.9%
G15: Pneumo carriage	Can nasopharyngeal carriage of pneumococci be used as a surrogate for documenting the impact of PCV?	14th	75.6%
G03: Home-based records	What factors influence the availability of home-based immunization and health records and what measures may be taken to improve availability?	15th	73.6%
G08: Strain typing	Can simplified tests for strain typing be developed that can be performed in laboratories in low and middle-income countries?	16th	72.8%
G06: Clinical specimens	Can methods be developed to facilitate the collection and transport of clinical specimens to the laboratory, while maintaining the viability of the causal pathogens?	17th	69.8%
G05: Serosurveys 4 coverage	How may sero-surveys be used to validate vaccination coverage estimates?	18th	68.8%
G12: Surveillance data_Cold chain	Are surveillance data a reliable means of monitoring cold chain problems in countries with high vaccination coverage?	19th	64.9%

**Table 3H1: Ranking of research questions in Domain H (Research related issues) – aggregate score weighted by Working Group mean preference values**

Short title	Proposed research questions	Rank	Aggregate score (n=15)
H5: NITAGs	How frequently is evidence-based information used to support NITAG (or other equivalent national) recommendations? What are the barriers and challenges to the effective functioning of NITAGs and how can they be addressed to strengthen NITAGs and vaccine policy-making at country level?	1st	87.3%
H1: Strategies_IMR capacity	What strategies can be used to strengthen vaccine implementation research capacity in countries and the translation of research to policy?	2nd	82.4%
H2: IMR capacity_Policy	To what extent is in-country research critical in driving immunization policy? How is it influenced by presence or absence of local research capacity/institutions and their relationships with policy makers and local/national advisory bodies such as NITAGs?	3rd	80.6%
H4: Requirements_Governance	What are the technical cooperation and research capacity requirements to facilitate establishment of immunization governance mechanisms?	4th	77.4%
H3: ICC roles	What role can interagency coordinating committees play in improving immunization financing, governance and partnership?	5th	66.7%