Identifying interventions that improve medication safety & rational use of medicines in India

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Background & objectives: Medication-related harm is known to be the cause for about 1/10th of hospitalizations. Some estimates from India show that about 90 per cent of medicines consumed are inessential or irrational and contribute towards high out-of-pocket expenditure on health. In this context, the Indian Council of Medical Research in 2022 constituted a National Task Force (NTF) to explore possible solutions that could improve safe and rational use of medicines (SRUMs). The objective of this study was to identify research ideas in the field of SRUM through a survey of relevant stakeholders, and further to prioritize the research ideas using a pre-identified set of criteria.

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Technical Advisory Group (TAG): Bengaluru: St. Johns Medical College, Denis Xavier; Lucknow: CSIR-Central Drug Research Institute, V.P. Kamboj; New Delhi: All Indian Institute of Medical Sciences, S.K. Maulik; Ex-Director, ICMR-National Institute of Medical Statistics, Vishnu V. Rao; Ex-National Chair of Clinical Pharmacology, & Co-chair of ICMR-SRUM National Task Force: Nilima Kshirsagar; Noida: GIMS, C.D. Tripathi, Vellore: Christian Medical College, Sujith J Chandy

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Methods: **The responses from the identified stakeholders were assessed using the Child Health and Nutrition Research Initiative method, which is an established research priority-setting methodology. First, the NTF asked for two to six research ideas from relevant Indian and global stakeholders on solutions to improve SRUM. The ideas were checked for duplicates, re-phrased where necessary and classified into various sub-themes. Subsequently, the research ideas were scored by Indian experts with relevant technical expertise using a pre-defined set of five criteria: innovativeness, effectiveness, translational value, answerability and applicability. Each research idea received from a stakeholder was assigned a score under each of the five criteria. The overall research priority score was calculated as a mean of all five criteria-specific scores and converted into a percentage.**

Results: **The final output of the prioritization process was a list of research ideas or questions, ranked by their scores. Total 209 unique ideas were received from 190 respondents, which were scored by 27 experts. The top three research topics on medication safety focused on cost-effective strategies for improving antimicrobial stewardship, safe use of poly-pharmacy in geriatric patients and drug take-back policy interventions. Regarding the rational use of medicine, the top three topics included testing mobile application-based antimicrobial stewardship interventions, development of diagnostics for antimicrobial resistance, and behavioural interventions.**

Interpretation & conclusions: **Several priority ideas found in this study also align with those of global priority, *e.g.,* safe disposal practices and enhanced pharmacovigilance, rational use of medicines. Patient engagement, which underlines many of the top scoring ideas found in this study, is also inclined with the top research priorities reported by the WHO priority exercise on research into the safe use of medicines. However, to the best of our knowledge, this is the first such work from a low- and middle- income country on medication safety and rational use of medicines. The findings of this research priority-setting exercise can help to guide research for the development of policy-relevant and novel interventions to improve SRUM in India.**

Medication safety has been receiving increasing attention since the World Health Organization's (WHO) Global Patient Safety Challenge: Medication Without Harm initiative was introduced in 2017 (*who.int/initiatives/medication-without-harm*). Unsafe use of medicines accounts for nearly one per cent of global healthcare expenditure[1,2]. However, the concept of rational use of drugs is much older, with the WHO endorsing its significance in a resolution in 1986 and estimating that more than half the medicines are used inappropriately in 2002[3,4]. As per the Organization for Economic Cooperation and Development (OECD) 2022 report[5], the cost associated with preventable medication errors was 54 billion USD in OECD countries. More significantly, medication-related harm may be the cause of about 1/10th of hospitalizations and about 1/5th of patients admitted to hospitals experience medication-related harm[5].

Some medicines are known to have a higher risk, requiring additional caution[6,7]. Moreover, this risk is variably distributed with certain patients more likely to experience medication-related harm[8]. Such groups include the elderly, paediatric, immune-compromised, renal and hepatic impaired patients, and patients at transition of care[9-12]. A systematic review by Hodkinson *et al*[13] 2020 found that three per cent of patients were exposed to preventable medication harm, with more than 25 per cent of this harm considered severe and avoidable medication-related harm occurring most commonly at the stage of prescription and monitoring of the medication use[13].

Earlier studies have adequately described the burden of unsafe and irrational use of medicines globally[13]. There have been several publications from various parts of India estimating the burden of medication errors or irrational use of medicines arising from various policies and practices ranging between 20-60 per cent of family spending[14-18]. National Health Systems Resource Centre (NHSRC), India estimated that about 90 per cent of medicines consumed are inessential or irrational, and contribute to the huge out-of-pocket expenditure on health[19]. The Indian

Council of Medical Research (ICMR), the apex medical research agency in the country, constituted a National Task Force (NTF) in 2022 to conduct research for developing possible solutions to improve safe and rational use of medicines (SRUM). A Technical Advisory Group (TAG) was constituted to advise the operations of the NTF. To ensure appropriate relevance of the planned research and facilitate effective use of resources, the TAG advised a prioritization exercise to identify solution-oriented research ideas that are relevant to India.

In this context, this study undertook a stakeholders' consult to pool expert suggestions related to the topics relevant for undertaking research.

We considered various prioritization methods, including Delphi, Multi-Criteria Decision Analysis (MCDA), Child Health and Nutrition Research Initiative (CHNRI) and consultative approaches, among others. We found that the CHNRI method had a relatively greater transparent, replicable, systematic and structured approach that was suited to our objectives when compared to the other methods. Thus, for this study, the research prioritization exercise was adapted from the CHNRI methodology[20]. There have been a few such 'setting-research-priorities' exercises on improving medication safety, but the present work is the first from a low- and middle- income country (LMIC)[21-23]. This paper describes the process and results of this prioritization exercise meant to steer the course of the NTF. The objective was to identify research ideas in the field of SRUM through a survey of relevant stakeholders, and further to prioritise the research ideas using a pre-identified set of criteria.

Material & Methods

This study was conducted jointly at the Division of Discovery and Development Research, Indian Council of Medical Research, from November 2022 to March 2023.

Operational definitions: There are various definitions for 'safe use of medicines' (SUM) and 'rational use of medicines' (RUM), however, for the purpose of this study, the definitions adapted were to simplify the message for a broad range of stakeholders. SUM was defined for the purpose of this study as freedom from injury due to medical errors or preventable adverse events during the medication-use process[24]. RUM was defined as the process of appropriate use of medicines based on the patients' need[4].

Study methodology: Child Health and Nutrition Research Initiative (CHNRI) was the methodology adopted in this study. CHNRI is an established methodology for setting research priorities, helpful to funding agencies and policymakers to inform research gaps and guide resource allocation, and has been described in detail previously[25,26]. Further to prioritizing research ideas, the ideas received were classified into four major domains based on the question that an idea proposes and the general research design needed to answer the question: *(i)* 'Description'-ideas that estimate the burden of a health condition/problem and its determinants and usually involve observational epidemiological methods; *(ii)* 'Development'-ideas that involve testing a new/improve an existing intervention, usually through the design and conduct of clinical trials; *(iii)* 'Delivery'-ideas that involve research aimed at delivering effective interventions to the people who need them, through implementation or operations research methods; and *(iv)* 'Discovery'-ideas that generate novel interventions/new knowledge that can further be developed into potential interventions, usually involving laboratory-based studies. The classification of ideas into the four major domains was done as described by Rudan I to aid the elimination of low-value descriptive research ideas[25].

Study Participants: In this study, the research priority-setting exercise was developed after setting up the advisory and management teams. The management team developed the protocol for the study and coordinated its execution, while the advisory team reviewed and recommended the protocol (details in Supplementary Figure). The advisory team and management teams did not participate in the identification of ideas. In the first survey, involving the identification of research ideas, the NTF invited solution-oriented ideas using a questionnaire from various stakeholders such as policymakers, clinicians, epidemiologists, pharmacists, public health experts, programme leaders, scientists, experts from scientific organizations, medical colleges and private health organizations. Professional networks having interest and expertise in SRUM were also invited to share ideas. These included the Indian Society for Rational Pharmacotherapeutics (ISRPT), ICMR and its 31 institutes, the Nursing Research Society of India (NRSI) and the International Society of Pharmacovigilance Medication Error special interest group. In addition, 160 global and Indian researchers who have published on SRUM were identified from MEDLINE®/PubMed®.

Table I. Various criteria utilized for evaluation of research ideas during survey 2	
Criterion	Description
1. Innovativeness	In your opinion, will the research idea generate truly novel & non-existing knowledge?
2. Effectiveness	In your opinion, is the research idea well-defined with clear objectives & more likely to yield solutions/answers (in <3 yr) to existing problems?
3. Translational value	In your opinion, will the research idea lead to interventions that are sustainable & easily scalable across multiple settings?
4. Answerability	In your opinion, will the research idea yield decisive & definitive solutions/answers (in <3 yr) to existing problems than the other ideas?
5. Applicability	In your opinion, does this research idea have relevance to Indian context?

To enable the involvement of beneficiaries, ideas were invited from Indian civil society or patient groups such as All India Drug Action Network (AIDAN), WHO Patients for Patient Safety Network – India chapter and Patient Academy for Innovation and Research, India. Finally, national stakeholders who received special invitations to the survey included the Indian Pharmacopoeia Commission (IPC), the Central Drugs Standards Control Organisation (CDSCO), the National Institute of Pharmaceutical Education and Research (NIPER), the National Medical Council, the Pharmacy Council of India, the Indian Nursing Council and NHSRC.

The survey form included a section on consent before the participants shared their inputs, to allow the management team to ensure participants' consent for reporting their ideas for academic dissemination.

Through this method, we reached out to more than 5000 potential participants directly or through networks, associations, institutions or agencies. In addition to basic demographic information, each responder was invited to share anywhere between two and six ideas each, on potential solutions to improve the SUM and RUM. The ideas received were checked for duplicates, re-phrased where necessary, and classified into various sub-themes (Supplementary Table). Some ideas that did not include enough information for classification were grouped as 'unclassifiable'. The ideas were then stratified into two domains – SUM and RUM. Some ideas that were suggested under the RUM category had to be re-appropriated to SUM, and *vice-versa* based on the definition adopted for the purpose of this study.

Scoring methodology: In the second survey that involved scoring of research ideas based on pre-defined criteria, 33 Indian stakeholders with relevant subject expertise were identified by the NTF. In addition to providing necessary instructions on the scoring method, an online training session was also conducted to sensitize the scorers. The scoring was carried out using a transparent set of five criteria (Table I) for which four response options were available: 0 (research idea unlikely to meet the criterion/NO); 1 (research idea likely to meet the criterion/Yes); 0.5 (not sure if research idea can meet the criterion); and blank (if the expert felt insufficiently informed to judge)[26]. Each research idea received a score against each of the five criteria by each of the 27 experts. An intermediate score for each criterion was calculated by adding up all the non-blank answers ('1', '0', or '0.5') given by all 27 scorers. This score was then divided by the number of answers received (and converted into percentages). The calculation did not consider blanks in the numerator and denominator. This approach is suitable for handling missing responses because it acknowledges that not all experts will have enough knowledge about every research option to evaluate them against all criteria. The overall research priority score percentage (RPS%) assigned to each research question was an unweighted mean of all five criteria-specific scores calculated using MS Excel. The final output of the prioritization process was a list of research ideas or questions, ranked by their scores.

Results

In this study, out of ~6000 potential participants contacted in the first survey, 190 (3.8%) participants responded with research ideas. Total of 441 ideas related to SUM and 411 ideas related to RUM were received in this study. Characteristics of responders to survey 1 are provided in Table II. A vast majority (70%) were clinicians, while around 12 per cent of respondents resided outside India. After excluding ideas which were duplicate or unclassifiable, there were finally 122 and 87 unique ideas, in the SUM and RUM domains, respectively (Fig. 1). Of the 209 ideas,

	Identification of ideas (Survey 1)	Scoring of ideas (Survey 2)
Table II. Characteristics of participants in Survey 1 and Survey 2		
Responders/Potential participants	190/~5000 (3.8%)	27/33 (81.8%)
Mean age (yr)	47 ± 0.55	46 ± 1.22
Gender (%)	Male: 52 Female:48	Male: 88 Female: 22
Type of stakeholder (%)	Clinicians (70.5) Pharmacist (14.7) Others (8.4) Patient group/ civil society (2.1) Policymaker (2.6) Nurses (1.6)	Clinicians (59.3) Pharmacist (11.1) Policymaker (11.1) Nurses (11.1) Others (7.4) Patient group/ civil society (0)
Country distribution	India: 88.4% Others:11.6% (4 responders from United Kingdom, 3 from United States, Portugal and Colombia, & 1 from Saudi Arabia, Netherlands, Canada, New Zealand, Switzerland, Argentina, Northern Ireland, Mexico & United Arab Emirates	India: 100%
Experience working in LMIC settings (%)	88.9	100
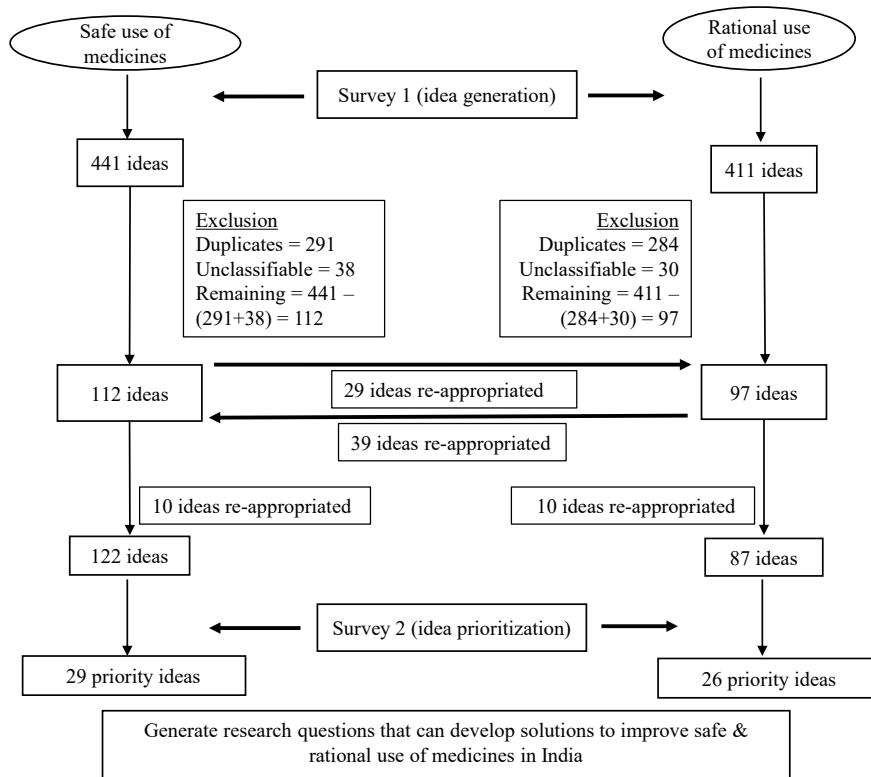
Fig. 1. Flowchart of ideas under the SUM and RUM domains.

67 were from descriptive research, which was of low priority, while 126 and 16 were from the development and delivery domains, respectively. There were no ideas that were classified as 'discovery'.

Of the 33 stakeholders approached in survey 2, scores for 209 ideas from 27 stakeholders were received. The 15 ideas for SUM (Table III) and RUM (Table IV) that scored the highest RPS per cent are

Table III. Top 15 research ideas in the SUM domain based on the scores from 27 experts

Criterion score calculated as: (sum of scores given by 27 scorers/count of scores given by 27 scorers)* 100

Maximum possible count for each criterion=135 (if all 5 criteria scored by all 27 scorers)

RPS calculated as unweighted mean of 5 criterion scores

Rank	Research question	Innovativeness score	Effectiveness score	Translational value score	Answerability score	Applicability score	Overall score (RPS%)
1	Cost-effective interventions for antibiotic stewardship to promote safe prescriptions and usage	77.9	90	78.8	92	98	87
2	Estimating the extent and pattern of polypharmacy in geriatric population In India and interventions to promote safe use of drugs	67.3	87.9	88	88	90.4	84
3	Drug take-back programme in India: Policymaking, regulations, and implementation.	81.3	85.6	85.4	81.3	84	84
4	Methods for finding adverse events due to irrational use of drugs and QALY lost	82	88.5	76	81.3	90	84
5	Burden of medication errors at patients' homes and interventions to improve them	72.1	84.3	87.5	73.9	95.8	83
6	Fixed drug combinations as an intervention in improving medication adherence and clinical outcome in cardiac multi-morbidity	74	84	80	84	93.8	83
7	Effectiveness of personal health cards/Pill cards with list of medications (in generic name) in improving medication safety in geriatric population at primary health centres and digitalization of the same with periodic updates	68.1	86.5	81.1	90.4	86.5	83
8	Impact of hospital-based drug safety alerts on the prescribing of drugs	71.1	85.6	86.5	83.2	88.2	83
9	Methods to promote rational use of antibiotic utilization in ICU in a tertiary care teaching hospital	54	90	84.6	91.7	93.8	83
10	Preventability of ADRs and drug–drug interactions in ICU patients on multiple antimicrobial agents	69.2	87	80.8	82.6	94.2	83
11	Importance of risk communication on the prevention of medication errors during transitions of care in tertiary hospitals	72.2	81.5	78.8	82.3	93.5	82
12	Effectiveness of a "How to take your Medicines desk" in improving patients' knowledge regarding drug administration, fixed drug combinations, over-the-counter, and antibiotic resistance for improving drug safety	66	92	84	76	90	82
13	Developing guidelines for OTC medications and self-administration to ensure safe use of medicines and educating patients and pharmacists on OTC	60.3	86.5	85.2	80.8	90.4	81
14	Drug-induced liver injury and/or failure specifically focusing on DILI or liver failure due to alternative system of medicine.	72.7	82.6	87	71.7	89.1	81
15	Developing or strengthening pharmacovigilance services and patient reporting of ADR	61.5	87	80.8	76.9	94.2	80

RPS, research priority score; QALY, quality adjusted life years; ICU, intensive care unit; ADRs, adverse drug reaction; FDC, fixed drug combination; OTC, over-the-counter; DILI, drug induced liver injury

Table IV. Top 15 research ideas in the RUM domain based on the scores from 27 experts

Rank	Research question	Innovativeness score	Effectiveness score	Translational value score	Answerability score	Applicability score	Overall score (RPS%)
1	Mobile app-based antimicrobial stewardship intervention to align prescriptions with local antibiotic policy/STG and to assess its effectiveness to improve rational use of antimicrobials as well as user feedback using structured questionnaire.	78.8	98.1	84.6	88.1	94.2	89
2	To develop diagnostic marker of antibiotic resistance	86.5	88	88	70.1	94	85
3	Intervention study to measure the impact of behavioural intervention in prescribing antibiotics in children in primary care setting	76.1	84.1	82.6	80.4	84.8	82
4	Educational intervention to improve rational use of medicines by training all prescribers and final year medical students	59.6	90.4	87.1	86.5	88.5	82
5	Antimicrobial switch as a stewardship intervention in tertiary medical facilities	73.4	83.5	88.1	68.4	85	80
6	Study on economic impact due to irrational use of antibiotics	75	75	82.7	75.9	92.3	80
7	A multi-method tool will be developed to assess patient medication adherence for common diseases occurring in our region and measures to be taken to improve it which will help in promoting rational use of medicines	72.3	80.8	80	78	84	79
8	Steps to avoid antibiotic use in viral infections	46	84	90	82	90.1	78
9	Interventions to prescribe narrow spectrum first-line antibiotic when it is sufficient instead of starting with broad spectrum antibiotics	54.3	79.2	80.4	93.5	84.8	78
10	Interventions to avoid drug substitution in community pharmacies	62.8	77.5	79.2	78.6	90.5	78
11	Studying the extent of use of left over medicine at home by general public to determine its irrational use	74.1	82	73.9	74.2	84	78
12	Steps to improve compliance of prescriptions to the Hospital Antibiotic Policy for Specific Infections.	40	88	80.8	86	92	77
13	Feasibility and fidelity testing of prescription audit using Artificial Intelligence & Machine Learning	92	77.1	68.4	67.7	79.2	77
14	Impact of patient education about medications at transitions of care to improve reconciliation	65.2	78.3	80.4	80.4	79.5	77
15	Rational use of medicines in pregnant women in ambulatory setting	61.5	78.8	74.2	80.8	88.5	77

Criterion score calculated as: (sum of scores given by 27 scorers/count of scores given by 27 scorers)* 100

Maximum possible count for each criterion=135 (if all 5 criteria scored by all 27 scorers)

RPS calculated as unweighted mean of 5 criterion scores

presented along with their criteria-wise scores. All 209 ideas that were scored in survey 2 are available in the supplementary material (Supplementary Materials 1 and 2).

In the SUM domain, the top three research topics focused on testing cost-effective strategies for the improvement of antimicrobial stewardship, safe use of polypharmacy in geriatric patients, and drug take-back policy interventions. In the RUM domain, the top three topics were on testing mobile application-based antimicrobial stewardship interventions, development of diagnostics for antimicrobial resistance, and behavioural interventions to improve rational prescription of antimicrobials in children. Across both domains, 9 out of 30 (30%) topics were related to antimicrobial resistance interventions and stewardship; 5 out of 30 (16%) ideas were related to educational/communication/behavioural interventions, while 3 out of 30 (10%) topics were related to policy/technological interventions. Ideas which had elements of both safe and rational use, were classified into safe or rational domains based on the proposed outcomes. On considering the level of interventions, 7 (23%) topics focused on household/community/primary-care level interventions.In the domain of safe use, the RPS of the top 15 ideas were relatively more clustered, with a range of 87-80, compared to the domain of rational use, where the RPS ranged from 89 to 77. Across both domains, when we analysed individual criterion scores, on an average, 'innovativeness' received lower scores while 'effectiveness' and 'applicability' received higher scores.

Discussion

This research priority-setting exercise was undertaken to help steer the focus of research for the SRUM NTF by identifying and prioritizing a set of research ideas to address issues of unsafe and irrational use of medicines in India. Through this study the aim was to make the data available openly for relevant stakeholders in India to identify and develop interventions to improve safe and rational use of medicines. To our knowledge, this is the first such work from an LMIC and the first such work globally on RUM. This is also the first such work that focuses exclusively on solutions that can improve SRUM. Moreover, this research priority-setting exercise is based on the CHNRI methodology, which is a well-documented systematic process. The main advantage of this methodology is that it is transparent, objective,

and replicable. The CHNRI methodology allows policymakers and funding agencies to understand the strengths as well as the weaknesses of every research priority while evaluating against predefined criteria.

The research ideas prioritized in both domains of SRUM reflect real-world challenges faced by a wide range of stakeholders such as clinicians, pharmacologists, policymakers, and researchers. Most of the top 15 ideas scored higher for their applicability and effectiveness, thus reflecting a preference for ideas with higher chances of implementation. Some of these ideas included general solutions to improve SRUM, while a few had a narrow focus on specific solutions addressing a particular issue. While antimicrobial stewardship is identified by policymakers as one of the high-priority health programmes in India, antimicrobial resistance is considered a public health problem[27]. One of the topics which scored high priority – development of diagnostics for antimicrobial resistance – was recommended to be dropped by the advisory team to avoid duplication of research efforts. Safe use of polypharmacy among the elderly population emerged as a priority in our analysis. It is a key consideration for India, as the country is progressively facing a rapid demographic and epidemiological transition with a significant proportion of elderly suffering from chronic morbidities and on various medications[28]. Communication/behavioural interventions were also scored high, underlining the crucial role of knowledge and practices of health workers and beneficiaries. Patient medication safety training and training courses for healthcare professionals were also among the top research priorities identified by the WHO exercise[18], thus highlighting that these topics are of universal concern.

In our study, testing the efficacy of technological interventions was also one of the top priorities. The top research ideas for both safe and rational use of medicines address issues that need the involvement of multiple types of stakeholders. Some of the proposed interventions were targeted towards medical doctors, some were targeted at pharmacists, while few were targeted at patients, indicating the importance of multiple stakeholders in ensuring SRUM. Further, many of the top ideas involved interventions that require some degree of systems-level changes, such as health cards/pill cards, fixed-drug combinations for cardiovascular diseases and promoting rational use of antibiotics in intensive care units, among others,

thus re-iterating that interventions to improve SRUM effectively will have a greater likelihood of success with the involvement of all levels of the healthcare systems in India. We would like to state here that preparing a list of the top 15 ideas in each domain was based on an arbitrary cut-off and the ideas ranked immediately below the top 15 did not differ greatly in their RPS from the earlier ideas. Further, many of the lower-ranked ideas may have contextual relevance and can be taken up in consultation with stakeholders. The finding that the scores of the top 15 ideas were relatively closely spaced (87-80) in the domain of safe use of medicines are similar to those by the original authors of the CHNRI method[29], wherein they state that the collective opinion of experts regarding research ideas, expressed through categorical responses, maximises relatively quickly in terms of identifying the ideas that have the most support. This can occur simply due to the relative nature of scoring in the CHNRI process; alternatively, it can mean that a certain set of ideas were assigned higher values due to a shared belief regarding the perceived benefits of researching these ideas.

These results were then discussed in detail with the advisory team before obtaining inputs during separate meetings from the competent authority of ICMR and other relevant Indian stakeholders (including ISRPT, NRSI, AIDAN, IPC, CDSCO, NIPER, Pharmacy Council of India, Indian Nursing Council and NHSRC). All stakeholders were in general agreement with the prioritized list of research ideas and no changes were required in the list of top 15 research ideas in both SUM and RUM domains.

It is acknowledged that there could be other ways of classifying the ideas received than to group them into different themes. One such method is to group different ideas based on where they fall in the pharmaceutical value chain, highlighting every important link between the manufacturer and the patient[30]. In this classification, interventions such as improved product labelling will fall under manufacture or regulations, while antimicrobial stewardship will fall under prescribers/pharmacists. Some of the themes that we did not consider relevant for the purpose of this study included intellectual property, substandard medicines, development of new diagnostics/drugs, *etc*.

Identification of research ideas was carried out by inviting national and international experts identified through publications or relevant networks. Of these, there were only 22 non-Indian responders and 88.9 per cent of all responders had experience working in the LMIC setting. The response rate to survey one, which included the identification of research ideas, was only 3.8 per cent despite two reminders, and this may reflect the need for creating interest and awareness in the domain. Other reasons why the response may have been low were that we reached out to experts through professional networks rather than as individuals, and the response period was only two wks. However, from the responders, we received 209 unique research ideas across the two domains, which is a substantial number. However, we admit that some relevant research ideas may not have been accounted for in this list. Scoring of research ideas, *i.e.*, survey 2, was done only by Indian scorers who could determine whether the idea was contextually relevant for India. Having said this, we understand that India is a country with a heterogeneous health system and substantial inequity in healthcare utilization. With such wide-ranging scenarios, the conclusions of the study may still not be generalizable to all Indian healthcare settings. By engaging with various relevant networks to gather ideas, a serious attempt was made to ensure regional representation and lower selection bias. One of the major limitations of the CHNRI process is that it is driven by expert opinion, which can lead to a bias in the scoring, based on the scorer`s value judgement. Other limitations in this study include those that are inherently associated with the CHNRI methodology, such as the risk of not having achieved saturation of ideas, the possibility of scoring ideas by persons with inadequate expertise in the subject, and poor quality of responses received. In this study, we attempted to mitigate the risk of missing out on important research ideas or inappropriate ranking of ideas as per the prioritization exercise, by discussing the ranked ideas with the TAG members and other relevant national stakeholders. These discussions with subject experts provided some level of independent validity to the prioritization results.

The findings of the research priority-setting exercise will help the ongoing SRUM efforts by highlighting opportunities for research. This may further help translate the priority ideas into research topics and further research questions to answer pressing problems. Suitable partners will be identified to evaluate some of these research questions to eventually help formulate policy recommendations. An interesting finding is that many of the priority ideas found in this study aligned with those of global priority, *e.g.*, safe disposal practices[31] and enhanced pharmacovigilance have been

highlighted as areas of action by WHO[1]. Furthermore, the ideas related to the rational use found in this study such as interdisciplinary collaborations, and pharmacy workflow improvements are core components included by WHO to promote rational use of medicines[3]. Patient engagement, which underlines many of the top research ideas found in this study, also underlines many of the top research priorities reported by the WHO priority exercise on research into safe use of medicines[18]. Our findings can initiate various discussions at the national/regional level, which will ultimately help policymakers and practitioners guide their decision-making. Eventually, the NTF is expected to identify policy, technological, or educational interventions that can improve SRUM. Thus, there is a scope in the future for implementing shared solutions based on mutual learning across countries.

Overall, this study has identified and prioritized possible solutions to improve SRUM in India. Further work will entail working closely with development partners in India to translate the identified research ideas into research questions and develop and test solutions that are policy-ready and can be adopted by health systems in India.
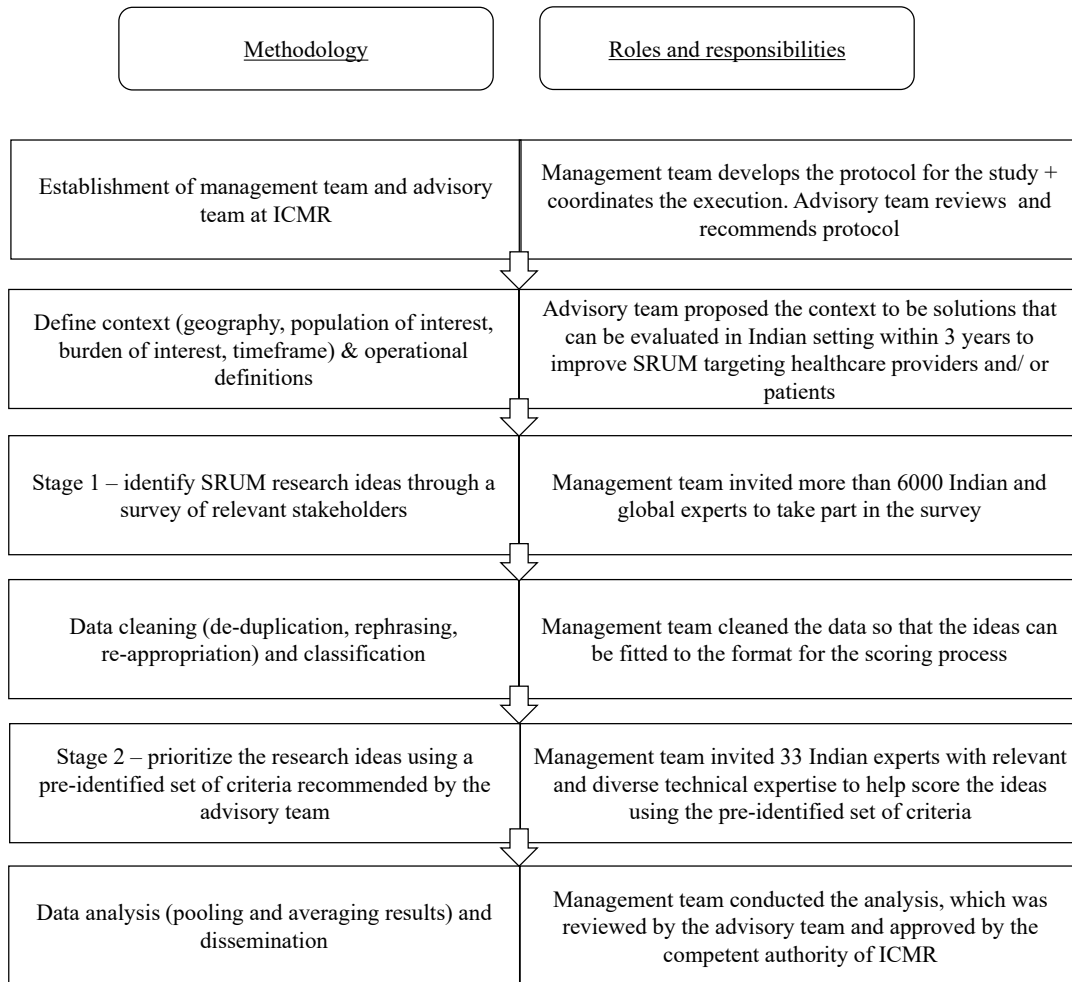
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Methodology	Roles and responsibilities
Establishment of management team and advisory team at ICMR	Management team develops the protocol for the study + coordinates the execution. Advisory team reviews and recommends protocol
Define context (geography, population of interest, burden of interest, timeframe) & operational definitions	Advisory team proposed the context to be solutions that can be evaluated in Indian setting within 3 years to improve SRUM targeting healthcare providers and/ or patients
Stage 1 – identify SRUM research ideas through a survey of relevant stakeholders	Management team invited more than 6000 Indian and global experts to take part in the survey
Data cleaning (de-duplication, rephrasing, re-appropriation) and classification	Management team cleaned the data so that the ideas can be fitted to the format for the scoring process
Stage 2 – prioritize the research ideas using a pre-identified set of criteria recommended by the advisory team	Management team invited 33 Indian experts with relevant and diverse technical expertise to help score the ideas using the pre-identified set of criteria
Data analysis (pooling and averaging results) and dissemination	Management team conducted the analysis, which was reviewed by the advisory team and approved by the competent authority of ICMR

Supplementary Figure. Summary of the methodology for stage 1 and stage 2

Supplementary Table. Sub-themes and domains under SUM and RUM used for classification

Theme	Sub-theme	Domain				Total
		Discovery	Development	Delivery	Description	
Safe	Antibiotic/anti infective	0	2	0	1	3
	Community Pharmacy	0	2	0	1	3
	Education, Information, Communication	0	2	3	2	7
	High risk population	0	14	5	1	20
	Pharma industry related	0	1	0	2	3
	Pharmacovigilance	0	5	1	5	11
	Policy/process/technology	0	33	0	6	39
	Prescription review/TDM/Transition of care	0	6	3	7	16
	Self medication/OTC	0	1	0	3	4
	Specific disease/drug	0	11	1	4	16
	Total	0	77	13	32	122
Rational	Antibiotic/anti infective	0	8	0	6	14
	Education, Information, Communication	0	5	1	0	6
	High risk population	0	5	0	3	8
	Pharma industry related	0	1	0	2	3
	Policy/process/technology	0	21	1	6	28
	Prescription review/TDM/Transition of care	0	5	1	9	15
	Self medication/OTC	0	0	0	3	3
	Specific disease/drug	0	3	0	6	9
	Community Pharmacy	0	1	0	0	1
	Total	0	49	3	35	87

No.	Research question
	Supplementary Material 1: 122 ideas to improve SUM that were scored during stage 2

Domain 1- Antibiotic/anti infective

Discovery

NIL

Development

| 1 | Developing Interventional methods for managing risks from TB antimicrobials |
| 2 | Developing SOP or protocol for stop using high end antibiotics initially for a treatment. |

Delivery

NIL

Description

| 3 | To establish the expression of drug resistance molecular mechanisms |

Domain 2- Community Pharmacy

Discovery

NIL

Development

| 4 | New methods for proper Storage of medicines |

Delivery

NIL

Description

| 5 | To find out availability of banned drugs in pharmacies and chemist shops |

Domain 3- Education, Information, Communication

Discovery

NIL

Development

| 6 | Effectiveness of a "How to take your Medicines desk" in improving patients' knowledge regarding drug administration, FDC, OTC, and antibiotic resistance for improving drug safety |
| 7 | To evaluate the impact of clinical pharmacology led drug information unit to provide critically appraised information to health-care professionals for better clinical care |

Delivery

8	Estimating public knowledge on OTC drugs and impact of pharmacist-based education in dispensing OTC drugs for diarrhoea
9	Estimating the effectiveness of a structured brief training program in improving medication prescribing practices by unqualified practitioners
10	Impact of hands-on training to various disease for health care workers

Description

| 11 | Whether previous experience of the physician influences treatment of disease? |
| 12 | Awareness through mass media. |

Domain 4- High risk population

Discovery

NIL

Development

No.	Research question
13	Preventability of ADRs and drug drug interactions in ICU patients on multiple antimicrobial agents
14	Estimating the effectiveness of albumin transfusion in preeclamptic patients, Knowledge about teratogenic drugs in pregnancy
15	Safety of levetiracetam in pregnancy or pediatric population; effectiveness of the drug in neuropathic pain, dosing errors in emergency paediatric set up
16	Estimating the extent and pattern of polypharmacy in geriatric population In India methods to promote safe use of drugs
17	Burden of medication errors at patients' homes and interventions to improve them
18	Determining the effectiveness of interventions for safe dispensing of OTC medicines during pregnancy
19	Estimating the effectiveness of Aspirin 150 mg versus 75 mg in patients with past history of pre-ecclampsia or ecclampsia
20	Estimating effectiveness of Safe FDCs for elderly
21	Developing methods for converting adult formations like tablets in a suitable form for paediatric use.
22	Methods to promote rational use of antibiotic utilization in ICU in a tertiary care teaching hospital
23	Effectiveness of pharmacist intervention to improve the outcomes within older patients with polypharmacy
	Delivery
24	Fixed drug combinations as an intervention in improving medication adherence and clinical outcome in cardiac multi-morbidity
25	Developing interventions to reduce redundant medications
26	Practices to improve predictability of allergic reactions using various methods of test dose
27	Emergency management practices in case of accidental consumption of wrong dose or route for patients
28	Providing education about safe use of drugs and vaccines in pregnancy to reduce the risk of unsafe of drugs in pregnancy
	Description
29	A multicenter retrospective survey on the prescribing pattern of medicines in pregnant and lactating mothers
	Domain 5- Pharma industry related
	Discovery
	NIL
	Development
30	An interventional study to check the role of pharma industry in shaping the prescription practises of doctors
	Delivery
	NIL
	Description
31	Marketing strategies of branded (originator) products over generics and biosimilars
32	Study of drug promotion by top ten drug companies
	Domain 6- Pharmacovigilance
	Discovery
	NIL
	Development
33	Developing or strengthening the Pharmacovigilance services and patient reporting of ADR
34	Methods to check safety of repurposed medicine used in COVID
35	Methods for finding Adverse events by the irrational use of drugs and QALY lost
	Delivery
36	Improving Adverse drug reaction monitoring in patients taking Anti-leprosy regimen and Anti tuberculosis drugs
	Description
37	Estimating the extent of Pharmacovigilance in pediatric patients and elderly

No.	Research question
	Domain 7- Policy/process/technology
	Discovery
	NIL
	Development
38	Interventions to prevent medication administration errors at the level of nurses and patient attendants and improving electronic -patient medical record system in hospitals
39	Evaluating the effectiveness of Clinical Pharmacist led interventions to prevent wrong dosing among in-patients and their role in providing information related to discharge medicines
40	Estimating methods to calculate burden of medicine wastage and accidental administration resulting from improper storage and developing safe packing methods for drugs
41	Estimating the effectiveness of an app based education to restrict self medication in order to improve safe use of medicines and effectiveness of drug-drug interaction checking software
42	Interventional study to check effectiveness of Applications *vs.* manual pill organizers to effectively manage medication adherance and ensure safety in geriatric patients on multiple medications
43	Regulatory requirement for assessment of long term safety of new medicines by an independent body
44	Steps to promote use of generic names of drugs, atleast within bracket by prescribers
45	Warning signs on medical products in local languages and pictures as effective ways of improving drug safety
46	Role of barcodes and qrcodes with patient details to support health literacy and safe use of medicines
47	Steps to ensure clear, distictive labelling of medications by pharmacist
48	Drug-drug interaction software and its effectiveness in improving safe use of medicines
49	Safety interventions to prevent drug induced phlebitis
50	Steps to ensure LASA and high risk medicine policy compliance at hospital pharmacy
51	Implementation of a Medication Error and Patient Safety Incident Reporting System in a Tertiary Healthcare Institute and developing legal provisions for penalising prescribers violating drug safety
52	Narcotic policy and standards of implementation at hospitals
53	What the different steps required for ensuring safe use of medicines
54	Steps to implement laws to prevent OTC sale of antibiotics
55	Medical teaching curriculum revisions (Gen med and Pharmac exams at same year) as an intervention to improve rational use of medicine
56	Have all generic medicines available in the market gone through BA-BE testing
57	Evaluate provider incentives for using wise-use, essential medicine lists, for generic prescribing, and for avoiding fixed dose combinations.
58	Policies and national guidelines based on rather ambiguous evidence (*e.g.* fixed-dose combinations of antihypertensives) + review of literature on the real quality of evidence
	Delivery
	NIL
	Description
59	Ecological impact of medicine waste from unused or expired medicine
60	Examine off label use of medicines and survey on irrational FDC
61	Identify the use of AYUSH and modern medicine together
62	Impact of banned medicines on drug companies and consumers in the context of FDCs banned by drug controller
63	Cost effectiveness of antibiotic stewardship interventions
	Domain 8- Prescription review/TDM/Transition of care
	Discovery
	NIL

Contd...

No.	Research question
	Development
64	Elucidation of causes of medication errors or preventable adverse events during the medication-use process.
65	Safe use of cough medicines in children
66	Safe medication practices in pediatric ICU and ward
67	Effect of therapeutic drug monitoring based vancomycin dosing on clinical outcome in critically ill patients
68	Voriconazole and interpatient variability: Role of Therapeutic drug Monitoring
	Delivery
69	Importance of risk communication on the prevention of medication errors during transitions of care in tertiary hospitals
70	Training, education and CME in assessing difference in WHO/INRUD prescribing indicators
71	Safe use of medicines in cardiac, renal and hepatic disease patients- a chart review.
	Description
72	Prescription analysis of drugs prescribed for extremes of ages at primary secondary and tertiary level
73	Role of frequent interruption in causing medication error.
74	Knowledge about patient problems and drug prescription: How can indication-based prescribing improve patient safety?
	Domain 9- Self medication/OTC
	Discovery
	NIL
	Development
75	Developing guidelines for OTC medications and self administration to ensure safe use of medicines and educating patients and pharmacists on OTC
	Delivery
	NIL
	Description
76	Comparison of usage of physician-prescribed *vs*. over-the-counter available sedatives and mood stabilizers among persons with chronic depression and mood disorders
77	Over the counter usage of steroids and antibiotics
	Domain 10- Specific disease/drug
	Discovery
	NIL
	Development
78	Developing guidelines for safe use of Anticoagulants
79	Accuracy and precision of IV medication preparation
80	Methods to study Unsafe use of NSAIDs in different patient populations
81	Study to access long term use of Tamoxifen for breast cancer andits safety for the endometrium
82	Evaluating IV smart pump data for impact on reducing medication errors
83	Better services for epilepsy
84	Safety of use of statins by type 2 diabetic patients
85	Use of contraceptive methods, you can evaluate the cost for the governments and correlate with the public health policies
86	Comparison of two similar but different molecules, like Vildagliptin and sitagliptin or telmisartan and olmesartan
87	Methods for Rational treatments in psychiatry and mental illness
	Delivery
88	Audit of safe use of antimalarials during pregnancy and pregnancy outcome
	Description
89	Cohort study for safety of OC pills in PCOS including thromboembolic episodes in Indian population
90	A study on Diabetic patients and use of insulin

No.	Research question
	Domain 1- Antibiotic/anti infective
	Discovery
	NIL
	Development
	NIL
	Delivery
	NIL
	Description
	NIL
	Domain 2- Community Pharmacy
	Discovery
	NIL
	Development
91	Containers with safety cap for medicines: Dispensing of medicines in containers having safety caps to prevent the accidental use of medicines by children. Patients with children below 14 years of age in family will be divided in two groups. One group will receive medicines in child lock containers and other in regular packaging. At the end of study both groups will be compared in terms of accidental consumption of medicines by children
	Delivery
	NIL
	Description
	NIL
	Domain 3- Education, Information, Communication
	Discovery
	NIL
	Development
	NIL
	Delivery
	NIL
	Description
	NIL
	Domain 4- High risk population
	Discovery
	NIL
	Development
92	Effectiveness of Personal health cards/Pill cards with list of medications (in generic name) in improving medication safety when given to geriatric population in the PHCs (NCD clinics and OP) and digitalization of the same with periodic updates
93	Application of Integrated medicines management (IMM) model to optimise prescribing in elderly patients in hospital settings in India: a randomised controlled trial
94	Development and implementation of evidence based programs to reduce risk of falls as a result of irrational prescription of FRIDS (Fall Risk Increasing Drugs) in Geriatric population.The use of FRIDS can be identified using the list prepared by the Swedish National Board of Health and Welfare as well as Beers criteria. Attempts will be made to deprescribe the patient using algorithms suggested by the EuGMS Task and Finish group on Fall Risk Increasing Drugs (FRIDs).
	Delivery
	NIL
	Description
	NIL

No.	Research question

Domain 5- Pharma industry related

Discovery

NIL

Development

NIL

Delivery

NIL

Description

Domain 6- Pharmacovigilance

Discovery

NIL

Development

95	WhatsApp based alerts to mothers to prevent adverse drug reaction in children: Children may get adverse effects of drugs due to incorrect dosing or incorrect frequency of the drugs. In this study, mother's mobile number will be added into á WhatsApp group and general instructions about safer use of medicine will be sent in the group. The frequency of adverse events in children whose mother received alerts in WhatsApp group will be compared with children of mothers who were not the part of WhatsApp app group.
96	The ADR Alert Card is a novel way and gaining traction to prevent ADR recurrence . It reduces avoidable morbidity, helping to bring down costs and improve hospital workflow. Unnecessary admissions and resource wastage are prevented. Being a frugal innovation, it is very easy to implement in LMICs. We developed this card that has details of suspected ADR, suspected medication, date of onset of reaction, contact details, emergency contact number, blood group, major illnesses of the patient and Helpline number.

Delivery

NIL

Description

97	Estimating the magnitude of adverse events in married infertile women on ovulation inducing drugs in a tertiary care hospital
98	A review on adverse events associated with cardiac medical devices to formulate guidelines on safe use of cardiac devices.
99	"Impact Analysis of Vigilance Programs on Indian Healthcare system"
100	Adverse events due to covid 19 vaccination at the population level among those acceptors

Domain 7- Policy/process/technology

Discovery

NIL

Development

101	Considering Swiss cheese model for prevention of medication error it is a responsibility of each personnel involved in the cascade to be alert in pointing out the errors. The cascade ranges from the prescribing doctor, dispensing pharmacist, administering nurse, patient and their attendees. Monday, Thursday the doctor is the leader, Tuesday and Friday pharmacist and Wednesday and Saturday Nurse. Outcome will be to evaluate its impact on errors made.
102	Impact of hospital based drug safety alerts on the prescribing of drugs: Drug safety alerts are regularly given by the regulatory authorities like FDA or CDSCO. In this study, the baseline prescription audit will be done and the audit assessment will be done periodically. The impact of drug safety alerts which are disseminated regularly amongst the clinicians will be assessed based on change in prescription writing. Reasons for following or not following the alerts will also be analyzed.
103	Co-production of best practice fit for purpose models for e-pharmacy regulation
104	Drug Takeback program in India: Policy making, regulations and implementation. Improper disposal of drugs result in polluting the environment and ultimately results in many problems, especially antimicrobial resistance.

No.	Research question
105	Development of a tailored healthcare dashboard based on a unique patient identifier for outpatients in a tertiary care hospital. Formatting and customizing a dashboard panel by creating 1. Unique patient identifier (Aadhar-Linked) 2. Details of prescription and investigations 3. Flagging of the patient (to avoid duplication of prescription by visiting multiple OPD) 4. Using the centralized prescription (by Pharmacist) for dispensing the prescribed drugs. 5. To identify and flag adverse drug reactions, drug interactions, and nutraceuticals/herbal product usage for the patient
106	Evaluating the utility of Pharmacogenetic testing for safe use of medicines
107	Research Question: Are the blood and blood-products being used safely and rationally in different clinical settings? Aim of the study is to evaluate safety and rationality of use of blood and blood-products with respect to prevailing standard of care and guidelines in hospital In-patient Departments and day-care centers
108	An interactive digital (audio/video) interface between healthcare providers to vulnerable patients and their care-givers about the medical history of drug allergy and efficacy of the patient to enable appropriate decision making in emergency situations.
109	System like DOTS for patients taking resistance prone antimicrobials
110	Development of Evidence based Guidelines for management of Vertigo to prevent irrational prescription of vestibular depressants that are known to cause drug induced Parkinsons disease.
111	Effectiveness of giving drug information card while dispensing comprising ADR, DOs and donts during drug usage for each drug in patients language
112	Develop guidelines to manage drug shortages and assess their impact on patient outcome prospectively.
	Delivery
	NIL
	Description
113	DOES THE ADDITION OF A POST OF PHARMACIST ASSISTANT TO CLINICIANS ASSIST IN PRACTICE (EG IN THE NHS)
	Domain 8- Prescription review/TDM/Transition of care
	Discovery
	NIL
	Development
114	'Brown bag' medication reviews (a method to review all the medicines consumed by the patient) as a means of optimizing patients' use of medication to reduce medication errors
	Delivery
	NIL
	Description
115	Drug induced liver injury and/or failure specifically focusing on DILI or liver failure due to alternative system of medicine.
116	Role of gastroprotective agents in reducing short-term gastrointestinal complications when prescribed concurrently with NSAIDS in the emergency department.
117	Active surveillance of use of neuromuscular blockers (NMBs) and sedatives in critical care unit to reduce weakness and prolonged immobility
118	To estimate the medication errors in management of Stroke and venous thromboembolism medical conditions in view of anti-coagulation therapy.
	Domain 9- Self medication/OTC
	Discovery
	NIL
	Development
	NIL
	Delivery
	NIL

No.	Research question
	Description
119	1. Area-Self medication; 2. Intervention- Cost-effective analysis of self medication of antibiotics for upper respiratory tract infection in two groups- self medicated and taking medicines as prescribed by physician 3. Study design- Prospective, non-randomized, cost effective analysis; 4. Indicators- ICER in two groups with direct, indirect and intangible cost as cost parameters while time to partial/complete recovery, duration to resume routine daily activities, loss of wage days as effectiveness parameters
	Domain 10- Specific disease/drug
	Discovery
	NIL
	Development
120	RCTs to determine how and when can we taper off the drugs during remission of chronic ailments such as metabolic and autoimmune diseases for Minimal side effects, maximal drug-free and disease-free duration for patients?
	Delivery
	NIL
	Description
121	Estimating the drug combinations given as a treatment in primary health care centres for treatment of urinary tract infections among females in reproductive age groups?
122	Assessment of diabetes risk in patients on long term proton pump inhibitors – A prospective cohort study

No	Research question
	Supplementary Material 2: 87 ideas to improve RUM that were scored during stage 2
	Domain 1- Antibiotic/anti infective
	Discovery
	NIL
	Development
1	To develop diagnostic marker of antibiotic resistance
2	Steps to avoid antibiotic use in viral infections
3	Interventions to prescribe narrow spectrum first line antibiotic when it is sufficient instead of starting with broad spectrum antibiotics
4	Trial on pregnancy outcomes with and without use of antibiotics in uncomplicated normal vaginal delivery
5	Antimicrobial switch as a stewardship intervention in tertiary medical facilities
	Delivery
	NIL
	Description
6	Study on compliance of empirical treatment and implementation of antibiotic stewardship program
7	Study on Economic impact due to irrational use of antibiotics
8	Availability of Access group of antibiotics in all primary secondary and tertiary center
9	Irrational use of oral faropenam as a reason for AMR
10	A study of Fixed Dose combination of antibiotic skin ointments/ear drops/eye drops
	Domain 2- Education, Information, Communication
	Discovery
	NIL
	Development
11	Educational intervention to improve rational use of medicines by training to all prescribers and final year medical students
12	Developing Rational drug use by patient centered approach
13	Interventions to improve patient counselling
14	Randomised control trial of physicians' prescribing behaviour based on training
	Delivery
	NIL
	Description
	NIL
	Domain 3- High risk population
	Discovery
	NIL
	Development
15	Audit of prophylactic antenatal corticosteroids in low risk pregnant mothers
16	Intervention study to measure the impact of behavioral intervention in prescribing antibiotics in children in primary care setting
17	Developing prescribing criteria for elderly patients in India
	Delivery
	NIL
	Description
18	Rational use of medicines in pregnant women in ambulatory setting
19	Prescribing pattern of FDC of antimicrobial agents in ICU

No	Research question
	Domain 4- Pharma industry related
	Discovery
	NIL
	Development
20	Methods of engaging pharmaceutical industry in improving rational use of drugs
	Delivery
	NIL
	Description
21	Study of price of top selling patented drugs in India
	Domain 5- Policy/process/technology
	Discovery
	NIL
	Development
22	Rational drug use in polycystic ovarian syndrome using standard treatment workflows
23	Methods to check whether physician is following the diagnostic criteria and treatment flow charts
24	Steps to develop Essential Drug List, Hospital formulary and Standard Treatment Guidelines in all the Health care institutes in India to promote rational drug use
25	Feasibility and fidelity testing of prescription audit using Artificial Intelligence & Machine Learning
26	Study on comparison of electronically entered and delivered prescriptions and traditional prescribing in promoting prescription safety and rationality.
27	Prescription review of patients receiving medications for asthma and interventions to align to SMART therapy and its impact on Patient outcome.
28	Estimating the effectiveness of hospital based "Drugs and Therapeutic Committee" in promoting rational drug use
29	Estimating the effect of Clinical Pharmacology based Antimicrobial Stewardship activity on the rational prescription of medicines including antibiotics
30	Steps to implement EMR based nudging of precriptions to align with WHO indications of good prescriptions
31	A policy change of prescription rights restricting only to consultants and not postgraduate students
32	Preparation of list of combination drugs which are commonly prescribed along with guidelines
33	Steps to implement ICMR and NCDC recommendations for the proper use of medications in India.
34	An interventional study to check the quality and efficacy of Brand *vs.* generic medicines in India
35	Steps to implement restricted use of reserve antimicrobials.
36	Reward based inventives to improve rational prescribing of senior medical doctors
37	Steps for interdepartmental integration amongst the Clinicians to avoid duplication of drugs in the same patient
	Delivery
38	Evaluate the feasibility and efficacy of pre-visit pharmacist-led comprehensive patient medication reviews on physician prescribing behaviors.
	Description
39	Study on Pharma- doctor nexus in India.
40	Pharmacoeconomics of using rational medicines
41	A study on rational use of FDC
42	Evaluating the current status of medication reconciliations and patient adherence
	Domain 6- Prescription review/TDM/Transition of care
	Discovery
	NIL

No	Research question
	Development
43	To perform drug utilization and drug audit studies for antimicrobials and drugs with chance for causing high adverse drug reactions and interactions
44	Steps to improve compliance of prescriptions to the Hospital Antibiotic Policy for Specific Infections.
45	Methods to Avoid over-prescribing and low-value prescribing
46	Impact of IV to oral switching on time to discharge
	Delivery
47	Impact of patient education about medications at transitions of care to improve reconciliation
	Description
48	Prescribing pattern of FDC in cardiac multi-morbidly
49	Use of parenteral preparation of drug when oral formulations will suffice-a retrospective chart review
50	Prescribing pattern of FDC in diabetic patient
51	Study on Rational prescribing in kidney disease patients
52	Factors affecting clinicians' prescription behaviour with a focus on knowledge and attitude
53	Beers criteria to deprescribe fall risk medicine in elderly
	Domain 7- Self medication/OTC
	Discovery
	NIL
	Development
	NIL
	Delivery
	NIL
	Description
54	Studying the extent of use of left over medicine at home by general public to determine its irrational use
55	Analysis of OTC, analgesics and antimicrobial use in general public
	Domain 8- Specific disease/drug
	Discovery
	NIL
	Development
56	Developing methods for Rationality of drugs like serratiopeptidase, thiocolchicoside, fatty acids , antioxidants
57	Methods to check effectiveness of multi-vitamins in non-specific pain and fatigue
58	Develop methods to identify excessive use of unsafe FDCs
	Delivery
	NIL
	Description
59	Interventions to improve rational use of PPI when co administered with other medicines such as NSAIDS and Domperidone.
60	Cough syrups containing both expectorant and suppressants. Frequency and responses of patients regarding its effects
	Domain 9- Community Pharmacy
	Discovery
	NIL
	Development
61	Interventions to avoid Drug substitution in community pharmacies

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No	Research question
	Delivery
	NIL
	Description
	NIL
	Domain 1- Antibiotic/anti infective
	Discovery
	NIL
	Development
62	Mobile app based anti microbial stewardship intervention to align prescriptions with local anti biotic policy/STG and to assess its effectiveness to improve rational use of anti microbials as well as user feedback using structured questionnaire.
63	Assessing the effectiveness of WHO AWare guidelines in reducing the irrational use of antimicrobials
64	Interventions to improve rational prescribing of antibiotics in reducing surgical site infections (choice of antibiotic/local *vs.* systemic/time of administration/duration)
	Delivery
	NIL
	Description
65	Study of antibiotic prescriptions by AYUSH practitioners
	Domain 2- Education, Information, Communication
	Discovery
	NIL
	Development
66	Creating a peer support group to educate and aid compliance with the prescribed drugs for chronic diseases in a community setting. 1. Baseline compliance will be assessed for patients with chronic diseases in a community setting- Preintervention phase 2. Formation of peer support groups, capacity building of the facilitators for the peer-led program- Intervention 3. Compliance after the intervention will be assessed
	Delivery
67	Educational interventions to strengthen Pharmacotherapeutic committees to improve their role in local medicines management policies, selecting medicines formularies, appropriate treatment protocols, essential medicines and awareness regarding adverse drug reaction reporting.
	Description
	NIL
	Domain 3- High risk population
	Discovery
	NIL
	Development
68	How artificial intelligence can guide polypharmacy in geriatric healthcare? Safety profile of polypharmacy for an individual may be difficult to predict. Using artificial intelligence, one can try to predict the possible adverse consequences of combination of medications in geriatric people in Indian context. For training dataset, we should try to gather reliable data in this perspective and then develop the model.
69	A multi centre hospital based study to optimize patient selection to improve rational use of tocolytics
	Delivery
	NIL
	Description
70	Pharmacotherapeutic interventions to optimize management of diarrhoea in immunocompromised patients.

Contd...

No	Research question
	Domain 4- Pharma industry related
	Discovery
	NIL
	Development
	NIL
	Delivery
	NIL
	Description
71	To evaluate the effect of claims in drug promotional literature by manufacturing companies on prescription pattern by medical practitioners
	Domain 5- Policy/process/technology
	Discovery
	NIL
	Development
72	Development and validation of the app for suggesting cheaper generic alternative of brand drugs: App can be developed which shows availability of multiple generics drugs for any brand name drug prescribed. The app can be made available to the clinicians. One group of clinician will use this app and another group will not. At the end of the study, patients in both the groups will be compared for efficacy, safety and cost. Qualitative study will be done to assess issues faced by clinicians while using app.
73	Common software for doctors and pharmacist: Patients will be randomized in 2 groups: in one group common software will be used for prescribing by doctors and dispensing by pharmacists and in group 2conventional prescribing and dispensing method will be used. In interventional group patient will be identified by aadhar number of patient in the software and the doctor and pharmacist both can see the disease history and medicines prescribed to patient's whole life. At the end of study, both group will be compared for of polypharmacy, repeated prescriptions and for drugs having interactions.
74	Development of Standardized Indian Guidelines for evidence based storage and organization of drugs in pharmacies specifically to reduce medication errors. Guidelines may be developed on the basis of Good Distribution Practices and Good Storage Practices. Mandatory certification on Good Storage Practices and Good Distribution Practices to be made mandatory for pharmacists, pharmacologists and quality control personnel. Implementation of techniques such as Tall Man Lettering, Basket techniques, guidelines for temperature control using thermohygrometer.
75	There is a wide spectrum of the level of rationality of practitioner. Patients are not aware of the rationality of the prescription and there is no way to know rational standard of drug use of a practitioner. If the practitioners are under monitoring for the rationality of drug prescriptions, it is likely that they will make deliberate attempt to be as rational as possible in prescription as this might affect their acceptance by patients. It is worthwhile to set up a monitoring body that will review selected prescription. Score for each practitioner should be accessible to the public.
76	Shared decision model for selection of medications for patients: Currently clinicians decide about selection of brand of medicine. In this study, once the prescription is written, the pharmacist will inform clinician and patients about the availability of different alternatives for the brand written by doctors. The decision will be taken by the clinician in consultation with the pharmacist and patient. The experience of patient, pharmacist and doctors can be assessed. Efficacy and safety will be compared between shared decision model group and control group.
	Delivery
	NIL
	Description
77	To evaluate the availability, usage and affordability of selected 50 essential medicines from NLM-2022 & WHO essential medicines list in selected five PHCs& tertiary care hospital in and around Puducherry
78	A study in collaboration with Anganbadi to assess the primary healthcare delivery system to the inherent tribal population in view of reproductive and mental health.
	Domain 6- Prescription review/TDM/Transition of care
	Discovery
	NIL

No	Research question
	Development
79	a multi-method tool will be developed to assess patient medication adherence for common diseases occurring in our region and measures to be taken to improve it which will help in promoting rational use of medicines
	Delivery
	NIL
	Description
80	Evaluation of the number of women receiving contraceptive pills without considering the eligibility criteria.
81	Pharmacoeconomic analyses for cost rationalization of new/repurposed medications
82	Adherence to the fixed drug regimens or blister pack regimens should be monitored effectively for proper cure.
	Domain 7- Self medication/OTC
	Discovery
	NIL
	Development
	NIL
	Delivery
	NIL
	Description
83	qualitative study to identify the reason for medication discontinuation at community level
	Domain 8- Specific disease/drug
	Discovery
	NIL
	Development
	NIL
	Delivery
	NIL
	Description
84	Review of use of Monoclonal antibodies alone or in combination with other biologics or non biologics.
85	evaluation of rationality of iron supplementation in gestational diabetes to prevent impairment of glycaemic control
86	Assessment of patterns of use of misoprostol in hard to reach populations
87	Research question: is the opioid use practice in orthopaedic OPD rational and safe? Aim of the study is to assess the rationality of opioid use in orthopaedics Out-patient Department of tertiary-care healthcare centre