**Scaling uptake of ChEETAh trial evidence into practice: Mixed-methods development of an implementation research logic model**

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## **Table S1.** Summary of the different domains and constructs within the Consolidated Framework for Implementation Research1

|  |  |
| --- | --- |
| **Name of construct** | **Definition of each construct** |
| **I - Innovation Domain** *(Innovation is defined as the “thing” being implemented, which is the intervention)* |
| A. Innovation Source | The group that developed and/or visibly sponsored use of the innovation is reputable, credible, and/or trustable. |
| B. Innovation Evidence-Base | The innovation has robust evidence supporting its effectiveness. |
| C. Innovation Relative Advantage | The innovation is better than other available innovations or current practice. |
| D. Innovation Adaptability | The innovation can be modified, tailored, or refined to fit local context or needs. |
| E. Innovation Trialability | The innovation can be tested or piloted on a small scale and undone. |
| F. Innovation Complexity | The innovation is complicated, which may be reflected by its scope and/or the nature and number of connections and steps. |
| G. Innovation Design | The innovation is well designed and packaged, including how it is assembled, bundled, and presented. |
| H. Innovation Cost | The innovation purchase and operating costs are affordable. |
| **II - Outer setting domain** *(The setting in which the inner setting exists (i.e., hospital system, school district, state))* |
| A. Critical Incidents | Large-scale and/or unanticipated events disrupt implementation and/or delivery of the innovation. |
| B. Local Attitudes | Sociocultural values (e.g., shared responsibility in helping recipients) and beliefs (e.g., convictions about the worthiness of recipients) encourage the Outer Setting to support implementation and/or delivery of the innovation. |
| C. Local Conditions | Economic, environmental, political, and/or technological conditions enable the Outer Setting to support implementation and/or delivery of the innovation. |
| D. Partnerships & Connections | The Inner Setting is networked with external entities, including referral networks, academic affiliations, and professional organization networks. |
| E. Policies & Laws | Legislation, regulations, professional group guidelines and recommendations, or accreditation standards support implementation and/or delivery of the innovation. |
| F. Financing | Funding from external entities (e.g., grants, reimbursement) is available to implement and/or deliver the innovation. |
| G. External Pressure | External pressures drive implementation and/or delivery of the innovation. Note: Use this construct to capture themes related to External Pressures that are not included in the subconstructs below. |
| 1. Societal Pressure | Mass media campaigns, advocacy groups, or social movements or protests drive implementation and/or delivery of the innovation. |
| 2. Market Pressure | Competing with and/or imitating peer entities drives implementation and/or delivery of the innovation. |
| 3. Performance-Measurement Pressure | Quality or benchmarking metrics or established service goals drive implementation and/or delivery of the innovation. |
| **III. Inner Setting domain** *(The setting in which the innovation is implemented, e.g., hospital, school, city)* |
| *Note:* | *Constructs A - D exist in the Inner Setting regardless of implementation and/or delivery of the innovation, i.e., they are persistent general characteristics of the Inner Setting.* |
| A. Structural Characteristics | Infrastructure components support functional performance of the Inner Setting. Note: Use this construct to capture themes related to Structural Characteristics that are not included in the subconstructs below. |
| 1. Physical Infrastructure | Layout and configuration of space and other tangible material features support functional performance of the Inner Setting. |
| 2. Information Technology Infrastructure | Technological systems for tele-communication, electronic documentation, and data storage, management, reporting, and analysis support functional performance of the Inner Setting. |
| 3. Work Infrastructure | Organization of tasks and responsibilities within and between individuals and teams, and general staffing levels, support functional performance of the Inner Setting. |
| B. Relational Connections | There are high quality formal and informal relationships, networks, and teams within and across Inner Setting boundaries (e.g., structural, professional). |
| C. Communications | There are high quality formal and informal information sharing practices within and across Inner Setting boundaries (e.g., structural, professional). |
| D. Culture | There are shared values, beliefs, and norms across the Inner Setting. Note: Use this construct to capture themes related to Culture that are not included in the subconstructs below. |
| 1. Human Equality-Centeredness | There are shared values, beliefs, and norms about the inherent equal worth and value of all human beings. |
| 2. Recipient-Centeredness | There are shared values, beliefs, and norms around caring, supporting, and addressing the needs and welfare of recipients. |
| 3. Deliverer-Centeredness | There are shared values, beliefs, and norms around caring, supporting, and addressing the needs and welfare of deliverers. |
| 4. Learning-Centeredness | There are shared values, beliefs, and norms around psychological safety, continual improvement, and using data to inform practice. |
| *Note:* | *Constructs E - K are specific to the implementation and/or delivery of the innovation.* |
| E. Tension for Change | The current situation is intolerable and needs to change. |
| F. Compatibility | The innovation fits with workflows, systems, and processes. |
| G. Relative Priority | Implementing and delivering the innovation is important compared to other initiatives. |
| H. Incentive Systems | Tangible and/or intangible incentives and rewards and/or disincentives and punishments support implementation and delivery of the innovation. |
| I. Mission Alignment | Implementing and delivering the innovation is in line with the overarching commitment, purpose, or goals in the Inner Setting. |
| J. Available Resources | Resources are available to implement and deliver the innovation. Note: Use this construct to capture themes related to Available Resources that are not included in the subconstructs below. |
| 1. Funding | Funding is available to implement and deliver the innovation. |
| 2. Space | Physical space is available to implement and deliver the innovation. |
| 3. Materials & Equipment | Supplies are available to implement and deliver the innovation. |
| K. Access to Knowledge & Information | Guidance and/or training is accessible to implement and deliver the innovation. |
| **IV. Individuals domain** *(The roles and characteristics of individuals)* |
| *Roles Subdomain* |
| A. High-level Leaders | Individuals with a high level of authority, including key decision-makers, executive leaders, or directors. |
| B. Mid-level Leaders | Individuals with a moderate level of authority, including leaders supervised by a high-level leader and who supervise others. |
| C. Opinion Leaders | Individuals with informal influence on the attitudes and behaviors of others. |
| D. Implementation Facilitators | Individuals with subject matter expertise who assist, coach, or support implementation. |
| E. Implementation Leads | Individuals who lead efforts to implement the innovation. |
| F. Implementation Team Members | Individuals who collaborate with and support the Implementation Leads to implement the innovation, ideally including Innovation Deliverers and Recipients. |
| G. Other Implementation Support | Individuals who support the Implementation Leads and/or Implementation Team Members to implement the innovation. |
| H. Innovation Deliverers | Individuals who are directly or indirectly delivering the innovation. |
| I. Innovation Recipients | Individuals who are directly or indirectly receiving the innovation. |
| *Characteristics Subdomain* |
| A. Need | The individual(s) has deficits related to survival, well-being, or personal fulfillment, which will be addressed by implementation and/or delivery of the innovation. |
| B. Capability | The individual(s) has interpersonal competence, knowledge, and skills to fulfill Role. |
| C. Opportunity | The individual(s) has availability, scope, and power to fulfill Role. |
| D. Motivation | The individual(s) is committed to fulfilling Role. |
| **V. Implementation process domain** *(The activities and strategies used to implement the innovation)* |
| A. Teaming | Join together, intentionally coordinating and collaborating on interdependent tasks, to implement the innovation. |
| B. Assessing Needs | Collect information about priorities, preferences, and needs of people. Note: Use this construct to capture themes related to Assessing Needs that are not included in the subconstructs below. |
| 1. Innovation Deliverers | Collect information about the priorities, preferences, and needs of deliverers to guide implementation and delivery of the innovation. |
| 2. Innovation Recipients | Collect information about the priorities, preferences, and needs of recipients to guide implementation and delivery of the innovation. |
| C. Assessing Context | Collect information to identify and appraise barriers and facilitators to implementation and delivery of the innovation. |
| D. Planning | Identify roles and responsibilities, outline specific steps and milestones, and define goals and measures for implementation success in advance. |
| E. Tailoring Strategies | Choose and operationalize implementation strategies to address barriers, leverage facilitators, and fit context. |
| F. Engaging | Attract and encourage participation in implementation and/or the innovation. Note: Use this construct to capture themes related to Engaging that are not included in the subconstructs below. |
| 1. Innovation Deliverers | Attract and encourage deliverers to serve on the implementation team and/or to deliver the innovation. |
| 2. Innovation Recipients | Attract and encourage recipients to serve on the implementation team and/or participate in the innovation. |
| G. Doing | Implement in small steps, tests, or cycles of change to trial and cumulatively optimize delivery of the innovation. |
| H. Reflecting & Evaluating | Collect and discuss quantitative and qualitative information about the success of implementation. Note: Use this construct to capture themes related to Reflecting & Evaluating that are not included in the subconstructs below. |
| 1. Implementation | Collect and discuss quantitative and qualitive information about the success of implementation. |
| 2. Innovation | Collect and discuss quantitative and qualitative information about the success of the innovation. |
| I. Adapting | Modify the innovation and/or the Inner Setting for optimal fit and integration into work processes. |

## **Table S2.** Data collection form for the prospective cohort study

|  |  |
| --- | --- |
| Record ID |  |
| **BASIC DATA** |  |
| Print full name | Free text |
| Job title | Free text |
| Centre name | (drop-down option or free text) |
| Participation in ChEETAh trial? | Yes - Control / Yes – Intervention / No |
| Country | Drop-down option |
| **OPERATIVE DETAILS** |  |
| Date of operation | (DD/MM/YYYY) |
| Indication | Benign disease / Malignant disease / Trauma / Obstetrics |
| American Society of Anaesthesiologists Grade | Grade I / Grade II / Grade III / Grade IV / Grade V |
| Was the WHO surgical checklist used? | No / Yes |
| Up to 60 minutes prior to incision, were prophylactic antibiotics given? | Yes / No |
| Hair removal at the site of wound?  | No hair at site of wound / Not done / In theatre, electric / Before arrival to theatre |
| Skin preparation used | Povidone-iodine / Alcoholic chlorhexidine / Other |
| What was the operative approach? | Minimally invasive / Open – midline / Open - non-midline |
| Main abdominal operation performed | (drop-down option or free text) |
| Intra-operative level of contamination | Clean / Clean-contaminated / Contaminated / Dirty |
| Was intraoperative pulse oximetry used? | Yes / No / Not available |
| Was intraoperative temperature monitoring used? | Yes / No / Not available |
| Was intraoperative blood sugar level monitoring used? | Yes / No / Not available |
| **INTERVENTION** |  |
| Were instruments changed prior to fascial closure? | Yes / No |
| Were gloves changed by the operating surgeon prior to fascial closure? | Yes / No |
| If Yes, did the following staff also change gloves prior to fascial closure? Scrub Nurse | Yes / No |
| If Yes, did the following staff also change gloves prior to fascial closure? Scrub Nurse | Yes / No |

## **Table S3.** Summary of the topic guide used to guide discussion of the consultation workshops in phase 2 and 4.

|  |  |
| --- | --- |
| **Topic heading** | **Issues discussed** |
| Introduction  | - Introduction to the findings of the ChEETAh randomised controlled trial- Presentation of results from cohort study and survey |
| Barriers | - What do you think of the present barriers presented? - Do you think any of these barriers may require further emphasis? |
| Facilitators | *-* What do you think of the present facilitators presented?  |
| Mechanisms of actions | *-* How will the present strategies improve the implementation of ChEETAh? |
| Outcomes | *-* What are the key outcomes of interest in measuring the implementation of ChEETAh? |

## **Table S4.** Baseline characteristics of included patients in the prospective cohort study

|  |  | **Total** |
| --- | --- | --- |
| Total N (%) |  | 492 |
| Country | A | 49 (10.0) |
|  | B | 112 (22.8) |
|  | C | 65 (13.2) |
|  | D | 82 (16.7) |
|  | E | 117 (23.8) |
|  | F | 66 (13.4) |
|  | G | 1 (0.2) |
| Hospital status in ChEETAh trial | No | 104 (21.1) |
|  | Yes (Control) | 203 (41.3) |
|  | Yes (Intervention) | 185 (37.6) |
| ASA physical status | Grade I | 161 (32.7) |
|  | Grade II | 225 (45.7) |
|  | Grade III | 93 (18.9) |
|  | Grade IV | 13 (2.6) |
| Indication for surgery | Benign disease | 321 (65.2) |
|  | Malignant disease | 74 (15.0) |
|  | Obstetric | 61 (12.4) |
|  | Trauma | 36 (7.3) |
| Urgency | Elective | 244 (49.6) |
|  | Emergency | 248 (50.4) |
| WHO checklist | No | 66 (13.4) |
|  | Yes | 426 (86.6) |
| Antibiotics used | No | 28 (5.7) |
|  | Yes | 464 (94.3) |
| Pulse oximetry | No | 6 (1.2) |
|  | Yes | 486 (98.8) |
| Temperature monitoring | Missing | 1 (0.2) |
|  | No | 222 (45.1) |
|  | Yes | 269 (54.7) |
| Operative approach | Minimally invasive | 45 (9.1) |
|  | Minimally invasive converted to open | 5 (1.0) |
|  | Open - midline | 276 (56.1) |
|  | Open - non-midline | 166 (33.7) |
| Wound contamination | Clean-contaminated | 359 (73.0) |
|  | Contaminated | 73 (14.8) |
|  | Dirty | 60 (12.2) |

*\*Abbreviations: ASA: American Society of Anaesthesiologists; WHO: World Health Organisation*

## **Table S5**. Baseline patient- and operative-level characteristics on the scale of ChEETAh implementation

|  | **Scale of implementation** |
| --- | --- |
|  |  | **No** | **Yes** | **p-value** |
| Total N (%) |  | 359 (73.0) | 133 (27.0) |  |
| Country | A | 41 (83.7) | 8 (16.3) | 0.006 |
|  | B | 71 (63.4) | 41 (36.6) |  |
|  | C | 41 (63.1) | 24 (36.9) |  |
|  | D | 62 (75.6) | 20 (24.4) |  |
|  | E | 97 (82.9) | 20 (17.1) |  |
|  | F | 46 (69.7) | 20 (30.3) |  |
|  | G | 1 (100.0) |  |  |
| ASA physical status | Grade I | 118 (73.3) | 43 (26.7) | 0.056 |
|  | Grade II | 174 (77.3) | 51 (22.7) |  |
|  | Grade III | 58 (62.4) | 35 (37.6) |  |
|  | Grade IV | 9 (69.2) | 4 (30.8) |  |
|  | Grade V | 0 (0) | 0 (0) |  |
| Indication for surgery | Benign disease | 223 (69.5) | 98 (30.5) | 0.001 |
|  | Malignant disease | 58 (78.4) | 16 (21.6) |  |
|  | Obstetric | 56 (91.8) | 5 (8.2) |  |
|  | Trauma | 22 (61.1) | 14 (38.9) |  |
| WHO Checklist | No | 56 (84.8) | 10 (15.2) | 0.029 |
|  | Yes | 303 (71.1) | 123 (28.9) |  |
| Use of intraoperative antibiotics | No | 25 (89.3) | 3 (10.7) | 0.075 |
|  | Yes | 334 (72.0) | 130 (28.0) |  |
| Use of pulse oximetry | No | 6 (100.0) |  | 0.299 |
|  | Yes | 353 (72.6) | 133 (27.4) |  |
| Temperature monitoring | Missing | 1 (100.0) |  | 0.146 |
|  | No | 171 (77.0) | 51 (23.0) |  |
|  | Yes | 187 (69.5) | 82 (30.5) |  |
| Operative approach | Minimally invasive | 41 (91.1) | 4 (8.9) | <0.001 |
|  | Minimally invasive/converted to open | 4 (80.0) | 1 (20.0) |  |
|  | Open - midline | 180 (65.2) | 96 (34.8) |  |
|  | Open - non-midline | 134 (80.7) | 32 (19.3) |  |
| Wound contamination | Clean | 104 (85.2) | 18 (14.8) | <0.001 |
|  | Clean-contaminated | 181 (76.4) | 56 (23.6) |  |
|  | Contaminated | 42 (57.5) | 31 (42.5) |  |
|  | Dirty | 32 (53.3) | 28 (46.7) |  |

## **Table S6**. Summary of key barriers from phase 3 survey of key stakeholders mapped to constructs of the Consolidated Framework for Implementation Research

|  |  |
| --- | --- |
| **Name of construct** | **Number reported for each domain, n** |
| **I - Innovation Domain** *(Innovation is defined as the “thing” being implemented, which is the intervention)* |
| A. Innovation Source | 0 |
| B. Innovation Evidence-Base | 1 |
| C. Innovation Relative Advantage | 0 |
| D. Innovation Adaptability | 2 |
| E. Innovation Trialability | 0 |
| F. Innovation Complexity | 1 |
| G. Innovation Design | 2 |
| H. Innovation Cost | 1 |
| **II - Outer setting domain** *(The setting in which the inner setting exists (i.e., hospital system, school district, state))* |
| A. Critical Incidents | 0 |
| B. Local Attitudes | 0 |
| C. Local Conditions | 0 |
| D. Partnerships & Connections | 2 |
| E. Policies & Laws | 2 |
| F. Financing | 1 |
| G. External Pressure | 0 |
| 1. Societal Pressure | 0 |
| 2. Market Pressure | 1 |
| 3. Performance-Measurement Pressure | 0 |
| **III. Inner Setting domain** *(The setting in which the innovation is implemented, e.g., hospital, school, city)* |
| A. Structural Characteristics | 3 |
| 1. Physical Infrastructure | 0 |
| 2. Information Technology Infrastructure | 0 |
| 3. Work Infrastructure | 0 |
| B. Relational Connections | 0 |
| C. Communications | 3 |
| D. Culture | 5 |
| 1. Human Equality-Centeredness | 0 |
| 2. Recipient-Centeredness | 1 |
| 3. Deliverer-Centeredness | 0 |
| 4. Learning-Centeredness | 1 |
| *Note:* | *Constructs E - K are specific to the implementation and/or delivery of the innovation.* |
| E. Tension for Change | 3 |
| F. Compatibility | 0 |
| G. Relative Priority | 3 |
| H. Incentive Systems | 0 |
| I. Mission Alignment | 0 |
| J. Available Resources | 14 |
| 1. Funding | 0 |
| 2. Space | 0 |
| 3. Materials & Equipment | 9 |
| K. Access to Knowledge & Information | 1 |
| **IV. Individuals domain** *(The roles and characteristics of individuals)* |
| *Roles Subdomain* |
| A. High-level Leaders | 1 |
| B. Mid-level Leaders | 1 |
| C. Opinion Leaders | 0 |
| D. Implementation Facilitators | 0 |
| E. Implementation Leads | 0 |
| F. Implementation Team Members | 1 |
| G. Other Implementation Support | 0 |
| H. Innovation Deliverers | 0 |
| I. Innovation Recipients | 1 |
| *Characteristics Subdomain* |
| A. Need | 0 |
| B. Capability | 5 |
| C. Opportunity | 0 |
| D. Motivation | 6 |
| **V. Implementation process domain** *(The activities and strategies used to implement the innovation)* |
| A. Teaming | 0 |
| B. Assessing Needs | 0 |
| 1. Innovation Deliverers | 1 |
| 2. Innovation Recipients | 1 |
| C. Assessing Context | 0 |
| D. Planning | 2 |
| E. Tailoring Strategies | 0 |
| F. Engaging | 5 |
| 1. Innovation Deliverers | 1 |
| 2. Innovation Recipients | 0 |
| G. Doing | 8 |
| H. Reflecting & Evaluating | 3 |
| 1. Implementation | 0 |
| 2. Innovation | 0 |
| I. Adapting | 0 |

## **Table S7.** Preliminary implementation strategies identified through the CFIR-ERIC matching tool

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ERIC Strategies** | Cumulative Percent | Structural Characteristic | Networks & Communications | Culture | Tension for Change | Relative Priority | Available Resources | Knowledge & Beliefs about Intervention | Executing | Reflecting & Evaluating |
| 1. Assess for readiness and identify barriers and facilitators
 | **237%** | 36% | 13% | 41% | 35% | 36% | 13% | 20% | 31% | 12% |
| 1. Identify and prepare champions
 | **228%** | 27% | 17% | **52%** | 48% | 18% | 4% | 40% | 14% | 8% |
| 1. Capture and share local knowledge
 | **182%** | 23% | 26% | 22% | 13% | 14% | 22% | 24% | 14% | 24% |
| 1. Conduct local consensus discussions
 | **174%** | 14% | 22% | 22% | 43% | 46% | 0% | 12% | 7% | 8% |
| 1. Conduct local needs assessment
 | **156%** | 18% | 9% | 22% | 43% | 32% | 0% | 24% | 3% | 4% |
| 1. Build a coalition
 | **153%** | 27% | 39% | 19% | 9% | 18% | 17% | 16% | 0% | 8% |
| 1. Inform local opinion leaders
 | **150%** | 14% | 22% | 22% | 39% | 14% | 0% | 28% | 3% | 8% |
| 1. Create a learning collaborative
 | **148%** | 18% | 35% | 30% | 9% | 4% | 9% | 16% | 21% | 8% |
| 1. Facilitation
 | **148%** | 9% | 26% | 30% | 0% | 14% | 4% | 20% | 24% | 20% |
| 1. Organize clinician implementation team meetings
 | **147%** | 14% | **52%** | 4% | 9% | 4% | 9% | 4% | 24% | 28% |
| 1. Alter incentive/allowance structures
 | **145%** | 18% | 0% | 15% | 22% | 39% | 17% | 16% | 17% | 0% |
| 1. Audit and provide feedback
 | **135%** | 5% | 17% | 4% | 17% | 14% | 0% | 4% | 17% | **56%** |
| 1. Conduct educational meetings
 | **128%** | 5% | 13% | 22% | 17% | 7% | 0% | **56%** | 3% | 4% |
| 1. Tailor strategies
 | **123%** | 18% | 4% | 30% | 13% | 14% | 9% | 12% | 10% | 12% |
| 1. Promote network weaving
 | **119%** | 23% | **57%** | 11% | 4% | 4% | 9% | 12% | 0% | 0% |
| 1. Develop a formal implementation blueprint
 | **118%** | 18% | 13% | 7% | 13% | 14% | 4% | 4% | 28% | 16% |
| 1. Develop and implement tools for quality monitoring
 | **115%** | 5% | 0% | 4% | 9% | 7% | 0% | 0% | 31% | **60%** |
| 1. Promote adaptability
 | **111%** | 23% | 0% | 22% | 17% | 18% | 4% | 16% | 10% | 0% |
| 1. Access new funding
 | **109%** | 5% | 4% | 0% | 0% | 11% | **78%** | 8% | 3% | 0% |
| 1. Recruit, designate and train for leadership
 | **107%** | 18% | 17% | 33% | 4% | 11% | 4% | 4% | 7% | 8% |

## **Table S8.** Summary of stakeholders involved in the workshop in phase 3

|  | **Workshop 1,** **n = 26** | **Workshop 2,** **n = 13** |
| --- | --- | --- |
| **Specialty** |  |  |
| Surgeon | 9 | 2 |
| Public health | 1 | 0 |
| Principal investigators | 13 | 6 |
| Research staff | 3 | 5 |
| **Country** |  |  |
| Benin | 4 | 0 |
| Ghana | 0 | 2 |
| India | 12 | 0 |
| Mexico | 0 | 7 |
| Nigeria | 2 | 0 |
| Rwanda | 3 | 0 |
| South Africa | 1 | 0 |
| United Kingdom | 4 | 4 |
|  |  |  |

**Figure S1.** Example of a modified World Health Organisation checklist incorporating the change in gloves ad instrument, as highlighted below

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