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Quality in Practice

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Implementation science in low-resource settings: using the interactive systems framework to improve hand hygiene in a tertiary hospital in Ghana

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Abstract

Quality issue: Low-resource clinical settings often face obstacles that challenge the implementation of recommended evidence-based practices (EBPs). Implementation science approaches are useful in identifying barriers and developing strategies to address them.
Initial assessment: Ridge Regional Hospital (RRH), a tertiary referral hospital in Accra, Ghana experienced a spike in rates of neonatal sepsis and launched a quality improvement (QI) initiative that identified poor adherence to hand hygiene in the neonatal intensive care unit as a potential source of infections.
Choice of solution: A multi-modal change package of World Health Organization-recommended solutions was created to address this issue.
Implementation: To ensure that the outputs of the QI effort were adopted within the organization, leaders at RRH and Kybele, Inc. used an implementation science framework called the 'Interactive Systems Framework for Dissemination and Implementation' (ISF) to create a package of locally acceptable implementation strategies. The ISF has never been used before to guide implementation in low-resource settings.
Evaluation: Hand hygiene compliance rose from 67% to 92% overall, including a 36% increase during the night shifts—a group of healthcare workers with typically very low levels of compliance.
Lessons learned: The drastic improvement in adherence to hand hygiene suggests the potential value of the joint use of QI and implementation science to promote the creation and application of contextually appropriate EBPs in low-resource settings. Our results also suggest that using an implementation framework such as the ISF could rapidly increase the uptake of other evidence-based interventions in low-resource settings.

Key words: implementation science, quality improvement, interactive systems framework, hand hygiene, healthcare associated infections, patient outcomes (health status, quality of life, mortality), guidelines, developing countries

Quality issue

In this paper, we describe the use of an implementation science framework, the 'Interactive Systems Framework for Dissemination and Implementation' (ISF) to develop a package of strategies to implement a locally adapted hand hygiene quality improvement (QI) intervention in the newborn intensive care unit (NICU) at Ridge Regional Hospital (RRH), a large referral hospital in Accra, Ghana [1]. At RRH, as in many other low-resource NICUs, hospital-acquired infections have become increasingly common as childbirth volumes have increased [2]. In April 2014, an outbreak of sepsis in the NICU at RRH affected 20 neonates, a 747% increase from the typical 2.4 cases per month. Starting in 2007, RRH was engaged in a system strengthening effort in partnership with Kybele, Inc. (www.kybeleworldwide.org), a non-profit humanitarian organization founded in 2001 to promote safe childbirth and compassionate care worldwide through collaboration with local institutions. Establishment of a QI program and the training of selected staff in various wards had already taken place [3–5]. This organizational capacity was leveraged to initiate a QI project which aimed to identify outbreak causes in the NICU. A senior nursing manager, trained as a QI leader, and two nurses designated and trained as 'clinical champions' formed a QI team to identify and prioritize interventions to reduce sepsis. Using a Lean Six Sigma approach [6], the QI team mapped the process of care in the NICU and developed an improvement aim and driver diagram based on local knowledge and evidence from the literature. The QI team then proposed potential focus areas to address sepsis, using an impact-effort matrix to prioritize these areas for potential QI activities. Improving hand hygiene compliance was selected as a focus area that could quickly deliver results without the significant need for resources if implemented well. This is because effective evidence-based hand hygiene practices are well-known, even for low-resource settings. The challenge lies in translating these interventions into sustainable local practice.

Implementation science has emerged as a field to rigorously investigate why this translation does not routinely occur and to develop and test methods to effectively facilitate implementation of improvement initiatives, lessening the persistent gap between the generation of local improvement evidence and its adoption in practice [1, 7, 8]. The creation of locally appropriate implementation methods or strategies can be guided through the use of selected implementation frameworks that provide a 'prescriptive series of steps summarizing how implementation should ideally be planned and carried out' [8]. As the field of implementation science has evolved, researchers have developed a number of frameworks to be used for a variety of purposes and a typology of frameworks has emerged [9]. Frameworks that provide a roadmap for implementation are termed 'process frameworks' and there are several of these, with no standard method for selecting the best framework for a particular implementation problem [9]. After reviewing multiple process frameworks, the QI team selected the ISF to assist in the adaptation and implementation of the hand hygiene QI intervention, based on this framework's conceptual simplicity and the ability to easily explain its components to the NICU staff. This framework was developed by the Centers for Disease Control and Prevention to implement sexual violence prevention programs and has also been used for implementing telepsychology innovations in underserved communities in the USA [10]. To the best of our knowledge, this paper documents the first use of the ISF in a low-income country.

The ISF, shown in Fig. 1, presents successful implementation as the result of bi-directional interaction between three main components or 'systems': a 'Synthesis and Translation System, a Support System', and a 'Delivery System' [1]. The primary purpose of the Synthesis and Translation System is to 'distill information generated through research and to prepare it for dissemination and implementation in the field' [1]. Local adaptation of evidence-based practices to make them user-friendly for local implementation is the primary role of this system. The implementation takes place through the Delivery System that consists of the individuals (NICU staff) who use these practices in their everyday work. The Support System, consisting of organizational coaches and subject-matter experts, helps the Delivery System implement with quality by building motivation for the implementation and developing any technical and organizational capacity that may be required. In this paper, we describe how these systems were used to systematically implement a hand hygiene solution developed by a QI team at RRH.

Initial assessment and choice of solution

To collect hand hygiene adherence data, the World Health Organization (WHO) recommends an anonymous observer covertly record the actions of their coworkers [11]. Baseline data in the NICU was collected by a trained nurse who rotated through all three work shifts. Six NICU activities—diaper changing, examining, feeding, baby suctioning, intravenous line installation, and bag and mask resuscitation—that had the potential to transmit infection were selected as observational points. A judgment sample [12] of 60 observations of hand hygiene adherence per shift per activity was decided upon, with an agreement to halt data collection earlier if initial observations showed high levels of adherence. Overall 771 observations were conducted, distributed across all process activities. This was enough to detect an improvement of 10% in the activity with the lowest compliance at 80% power with 95% confidence. The results, described in detail later in this paper, indicated a compliance problem primarily concentrated during night shifts and when involving non-invasive activities.

The QI team then generated a list of potential solutions to improve hand hygiene. These were a mix of solutions reported in the literature, documented as best practices by the WHO Guidelines on Hand Hygiene [13], and generated onsite based on local experience. Using an impact-effort matrix once again, the QI team selected interventions that were judged by the QI team as being low-effort while having high potential for impact. Three interventions based on the WHO guidelines and a fourth locally-generated innovation were combined into a change package. The interventions were: (1) creating a hand hygiene training course; (2) reinforcing hand hygiene practices at staff meetings; (3) visual reminders and (4) securing an adequate supply of clean towels for hand drying. In preliminary presentations to staff and leadership, there was an agreement that the change package was reasonable and had the potential to improve hand hygiene compliance.

This process of combining tested initiatives into a change package using a mix of local knowledge and known evidence is typical in QI initiatives. Interventions that are shown to work individually (either locally or in the literature), are acceptable to local staff and are relatively easy to implement together become part of a package of interventions. It is not common practice to attempt to identify the specific contributions of each component of the package as long as the overall package achieves results. The QI team felt that the effort to identify the individual mechanisms of action for each intervention component was not worthwhile since the risk of negative consequences from any ineffective component was small. The package as a whole was what mattered.

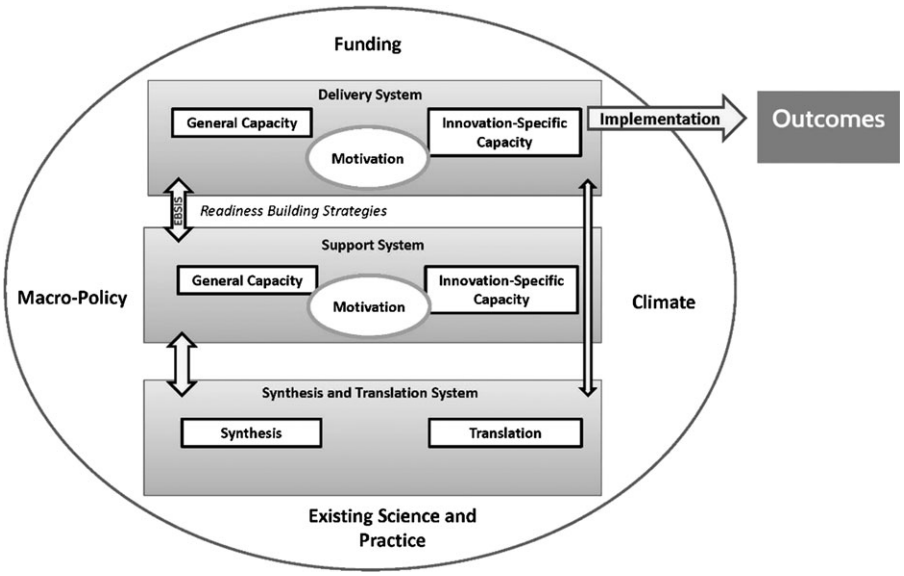

Figure 1 Interactive systems framework for dissemination and implementation.

Implementing the hand hygiene solution using the ISF at RRH

Just because the intervention change package was acceptable in theory did not mean that it would be implemented and sustained. The ISF was used to proactively guide implementation. As described earlier, the ISF consists of three interlinked systems that need to work together to support implementation. We now describe how these systems were used to create a set of activities or 'strategies' for ensuring that the QI intervention was implemented well. The change package of QI interventions and the associated package of context-appropriate implementation strategies are both needed for the achievement of outcomes. Without the change package, we do not have a viable solution, but without the implementation strategies, we do not have the confidence that the solution will be taken up and used by the hospital staff. Improvement and implementation therefore need to work together to ensure successful and sustainable results.

Synthesis and translation system activities

Activities under this system involve the adaptation of the intervention to meet local needs. Several components of the hand hygiene change package were adapted to fit the local context of the NICUs as described below.

Adapting training

The training was based on WHO materials and delivered using a narrated 20-min PowerPoint presentation [14]. The images and references to clinical scenarios in the WHO content were replaced with local photographs familiar to staff. The context was made specific to the care of neonates, by illustrating the role of hand hygiene in NICU-specific activities such as diaper changes and bottle feedings. The deputy head of nursing services at RRH narrated the presentation, both to convey the message that the intervention was promoted by the local leadership, and to adopt the rhythm and cadence of spoken English in Ghana.

Using familiar faces for visual reminders

Visual reminders included both local messages and standard WHO posters (e.g. 'Five Moments for Hand Hygiene', 'How to Wash Hands' and 'How to Sanitize Your Hands'). These were customized using local photographs of patients and staff and placed in prominent places throughout the NICU [15].

Support system activities

The role of the support system is to build motivation and capacity for implementation. The support system consisted of the clinical champions, the QI leader and an external QI coach from Kybele. Their role was to coach and support the NICU staff in adopting the practices reinforced through the training, visual aids and staff meetings. The following describes the key support system activities.

Visually demonstrating bacterial contamination

Two nurses were trained to perform hand swab tests on NICU staff at the point of care. Ten randomly chosen staff members from each shift (for a total of 30 data points) had their hands swabbed immediately prior to patient contact. The swabs were cultured on agar plates purchased from Micrology Laboratories and used specifically for detecting the presence of bacteria. Bacterial colony growth counts were observed at 24 and 48 h. Bacterial colonies manifest themselves as pink spots on the plates, as shown in Fig. 2. These plates were displayed to the NICU staff as a visual reminder of bacterial contamination present in the hands and as a trigger for action.

Sharing implementation progress transparently

The initial implementation goal for the hand hygiene training was for all staff to complete the training within 1 month. A roster was posted in a visible location for each person to document when he or she has completed the training. This visible demonstration of progress provided a gentle peer pressure on those who had not completed training to do so as quickly as possible. Similarly, those responsible for leading the monthly reinforcement sessions were

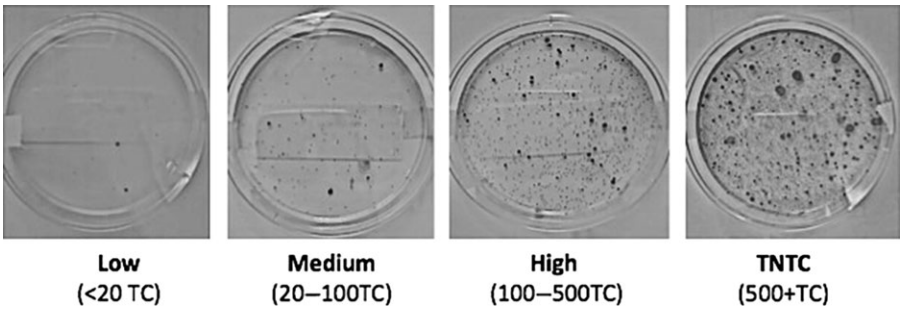

Figure 2 Plates representative of four different levels of bacterial colony growth total counts, Low, Medium, High and Too Numerous To Count (TNTC). Image courtesy of Brianne Kallam.

Table 1 Implementation strategies by ISF system and the targeted QI intervention

System	Implementation strategy	Intervention component targeted
Synthesis and translation	Adapting training to accommodate local norms	Hand hygiene training
Synthesis and translation	Using familiar faces on visual reminders	Visual reminders
Support	Visually demonstrating bacterial contamination	Hand hygiene training
Support	Sharing implementation progress transparently	Hand hygiene training reinforcements
Support	Engaging leaders for communication and support	All
Delivery	Designing flexible training delivery	Hand hygiene training
Delivery	Integrating reinforcement into regular staff meetings	Reinforcement
Delivery	Minimizing unnecessary time consuming activities	Visual reminders
Delivery	Ensuring local capacity for implementation	Ensuring supply of clean towels

required to register their initials in a visible location as a nudge to encourage others to volunteer to lead these sessions.

Engaging leaders for communication and support

As mentioned earlier, the hand hygiene project was one of several QI initiatives in the facility. The institutional leadership of obstetrics was a champion for the overall QI effort, and the department leaders were asked to diligently follow the progress of implementation and to communicate about the project to other staff as often as possible. This provided additional motivation for the NICU staff to engage in the implementation efforts.

Testing for hand hygiene knowledge

To ensure that staff understood the proper hand hygiene practices, a post-test was administered to all NICU staff immediately after viewing the presentation. Commonly missed questions were relayed to the QI leader to be added as priority topics for the reinforcement discussions during monthly meetings.

Delivery system activities

Making an intervention user-friendly and providing a strong support system to build capacity are necessary but not sufficient conditions to motivate use of an innovation. To maximize the probability of acceptance, interventions need to be implemented in a way that minimizes disruption to everyday work. Each hand hygiene intervention at RRH was implemented in a manner that worked within the existing structure and workflow. The following approaches were used to facilitate the effective use of the interventions in the NICU.

Designing flexible training delivery

For the initial training, the PowerPoint presentation was delivered in a classroom setting. However, due to shift scheduling it was impossible to gather all NICU staff together for a single training, so the presentation was also recorded to allow staff to take the training when scheduling was convenient.

Reinforcement integrated into regular staff meetings

A local reinforcement plan was developed, focusing on priority areas with the lowest adherence results. Based on this plan, topics were created and discussion sessions were scheduled during mandatory staff meetings. Each member of the NICU staff was assigned to lead a discussion on a specific topic.

Minimizing unnecessary time consuming activities

Posters were laminated to ensure their durability in the chaotic and cramped NICU environment and to ensure they could be cleaned.

Ensuring local capability for implementation

A process for providing an adequate supply of clean towels based on the local pattern of laundry cycles was instituted in a way that would not burden the laundry staff. A plan was made in the event that additional towels might be necessary in the future [16].

The activities performed in each system to facilitate implementation and the intervention components targeted are shown in Table 1. Just as it was not possible to determine the effect of each individual component of the QI intervention on hand hygiene adherence, neither was it possible to determine the contribution of each of individual implementation strategy. The package as a whole was deemed feasible by the hospital staff and all activities were conducted.

Evaluation

Hand hygiene knowledge

All nineteen staff members trained in the hand hygiene protocols scored more than the 70% required to pass the post-training test, with eleven scoring 100%, five scoring 90% and three scoring 80%.

Hand hygiene compliance

Results of the baseline and post-intervention hand hygiene adherence data collected by the anonymous observer are shown in Table 2. These note the number of observations collected and percent adherence stratified by activity, shift and location. Baseline data was collected from November 2014 to January 2015, and post-intervention was conducted from April to May 2015.

Overall at baseline, 771 observations were collected and 518 were compliant with the hospital's hand hygiene protocols (67.2% adherence). Compliance was higher for clinical procedures compared with routine care activities. For example, there were 34 observations of bag and mask resuscitation with 100% adherence. In comparison, there were 358 observations of diaper changes with 53% adherence. Diaper changing, feeding and examination practices accounted for the largest portion of hand hygiene protocol non-compliance. Observations during the night shift found less than two-thirds of employees adhered to hand hygiene protocol, which was the lowest of the daily shifts.

Post-intervention observational hand hygiene adherence data were collected 3 months after the implementation of the four interventions to assess whether a change was observed. Results (Table 2) showed a statistically significant improvement in hand hygiene compliance post-intervention in all but one activity. Notably, adherence for diaper change activities increased by 36 percentage points and for feeding activities by 24 percentage points, the latter achieving nearly 100% compliance. The night shift also achieved nearly 100% compliance, boosting compliance by 36 percentage points. The total adherence observed increased by 25 percentage points overall, with 92% compliance following implementation, as compared with 67% before.

Most hand hygiene interventions do not use microbiological testing to assess improvements in hand hygiene outcomes [17]. In this study, we did not use microbiological testing as the primary mechanism for measuring change in adherence because of the complexity and cost of implementation in a field setting. However, using hand swabs as a motivational tool also facilitated their use as an informal data collection tool to verify whether the observed changes in behavior resulted in a measurable reduction in bacterial contamination. The small sample of 30 before-and-after swabs showed an increase in the percentage of hands with 'low' or 'medium' contamination from 60% to 83% after the intervention as shown in Fig. 3. It is plausible to believe that a careful approach using the ISF facilitated the process of measurable positive change.

Limitations

Practical considerations arising from the resource-intensive observational data collection process and the need for anonymity restricted us to a pre- and post-evaluation instead of using the time-series data and control charts recommended for the evaluation of QI projects [18]. The cost and effort involved in swabbing and culturing plates limited us from collecting more than a few hand swab samples, which were thus primarily used for illustrative purposes. Finally, the post-intervention results were collected 3 months after the change package was in place, and longer-term sustainability is unknown.

Lessons learned

In comparison with other published multi-modal hand hygiene interventions using WHO Guidelines on Hand Hygiene in LMIC hospital settings, the results of this intervention range from above-average to quite significant. Overall, the intervention achieved a 25-percentage point increase, in comparison to an average of 17.9% [19–24]. Additionally, this intervention achieved the highest total percentage of compliance at 92% adherence; the next-highest total reported compliance result was 84%, and was achieved by a multi-phase Continuous QI intervention [21]. Of perhaps the greatest significance, this intervention achieved the highest improvement among healthcare workers on night shifts, which have been shown to have the lowest levels of hand hygiene compliance in LMIC hospital settings [25]. However, the higher adherence to hand hygiene protocols shown in our study may also be attributed to the risk perceived by healthcare workers to patients in the NICU relative to other areas of the hospital. The efforts of the ISF 'support system' in particular helped to reinforce these messages [26, 27].

Table 2 Hand hygiene compliance at baseline and at follow-up, Ridge Regional Hospital, Accra, Ghana

Variable	Baseline			Follow-up			% Change	P^a
	Adhered to protocol	Total no. of observations	Compliance, %	Adhered to protocol	Total no. of observations	Compliance, %		
Overall	518	771	67	1113	1211	92	25	<0.001*
Activity								
Diaper Change	189	358	53	452	510	89	36	<0.001*
Feeding	198	266	74	434	443	98	24	<0.001*
Examination	131	147	89	227	258	88	−1	0.34
Location								
Cot	183	323	57	412	470	88	31	<0.001*
Warmer	166	205	81	364	374	97	16	<0.001*
Incubator	169	243	70	337	367	92	22	<0.001*
Shift								
Morning	221	297	74	450	507	89	14	<0.001*
Afternoon	148	226	65	306	334	92	26	<0.001*
Night	149	248	60	357	370	96	36	<0.001*

[a]Determined by *Z*-tests for each activity, location and shift.

*Significant at $P < 0.05$.

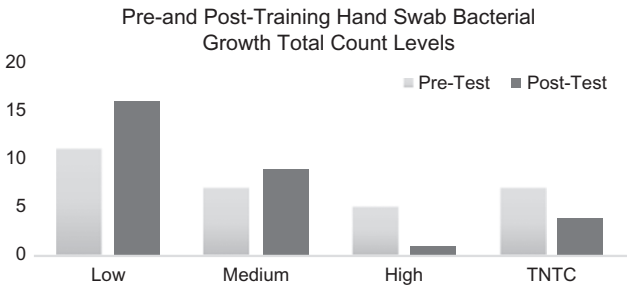

Figure 3 Bacterial growths from hand swabs taken at point of patient care before-and-after handwashing training.

At least two other published studies achieved a greater difference between baseline and outcome. Both of these incorporated alcohol-based hand rubs (ABHR) as part of their intervention, which may have significantly impacted their results [20, 21]. Given that we were unable to use ABHR for our intervention and yet achieved a significant outcome, it is plausible that the use of a carefully designed implementation methodology contributed to our results despite our more basic intervention.

While the actual mechanisms that contributed to our successful results are difficult to identify in a QI project, there are some contextual factors that could have had a positive influence. This project was part of Kybele's ongoing relationship with the hospital, described elsewhere [28]. It is possible that the atmosphere of mutual trust created over time facilitated the acceptance of the results and the adoption of these kinds of interventions. Additionally, other QI projects had been undertaken in the hospital and therefore the staff was familiar with and open to the QI approach. The spike in sepsis rates might have increased the sense of urgency associated with the need for an intervention and its uptake. As Kotter [29] states, the first step to organizational transformation is establishing a sense of urgency, and the deaths from sepsis certainly inspired a focus on the problem. However, while these factors may have contributed to a need to find answers, results are not achieved without first creating the answers, and then implementing them well. This requires a systematic stepwise approach. First, there is the need to create and test an intervention package that incorporates the knowledge of local practitioners. This is one component of Deming's System of Profound Knowledge [30]. The contribution of individual components of this package is less important if the package as a whole is feasible to implement. Second, a systematic implementation approach is needed, and there is evidence that systematic implementation affects the achievement of outcomes [31]. Frameworks such as the ISF provide a roadmap for implementation, and while it is difficult to define the precise mechanisms by which the support system activities (training, visual aids and integration into the existing system through staff meetings) contributed to the success of the intervention, there is enough evidence to suggest that the participatory QI approach and the use of the ISF are contributors to the success of this project.

Dixon-Woods [32] identified 10 challenges to the successful implementation of QI projects, including convincing workers there is a problem, overcoming the burden of data collection, improving the organizational leadership and lack of staff engagement. Studies have also shown that two limitations to complying with hand hygiene protocol include lack of resources to properly dry hands with clean towels [33] and a failure to associate poor hand hygiene with unseen bacteria instead of a feeling of 'dirtiness' [34]. Use of implementation frameworks such as the ISF allow for the identification of local determinants affecting implementation and for the creation of locally acceptable implementation strategies. While there is a growing body of literature on the use of implementation frameworks in high resource settings, their application in countries such as Ghana where resources for support and implementation are limited is sparse. This paper demonstrates that the ISF is applicable, without modification, to address implementation challenges in these settings. This insight will be valuable to other organizations in other low-resource settings seeking to implement change packages and evidence-based interventions.

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