



## Brief Communication

# Bridging the know-do gap in low-income surgical environments: Creating contextually appropriate training videos to promote safer surgery in Ethiopia



Jessica Hawkins, MD<sup>a</sup>, Uriel Jhovanny Sanchez Rangel, BS<sup>b</sup>, Assefa Tesfaye, MD<sup>c</sup>, Natnael Gebeyehu, MD<sup>d</sup>, Thomas G. Weiser, MD, MPH<sup>b,e,f</sup>, Senait Bitew, BSc, MPH<sup>f</sup>, Tihitena Negussie Mammo, MD<sup>d,f</sup>, Nichole Starr, MD, MPH<sup>f,g,\*</sup>

<sup>a</sup> Massachusetts General Hospital, Department of Anesthesia, United States of America

<sup>b</sup> Stanford University School of Medicine, United States of America

<sup>c</sup> St. Peter's Specialized Hospital, Department of Surgery, Ethiopia

<sup>d</sup> Addis Ababa University, Department of Surgery, Ethiopia

<sup>e</sup> Stanford University, Department of Surgery, United States of America

<sup>f</sup> Lifebox Foundation, Ethiopia

<sup>g</sup> University of California, San Francisco, Department of Surgery, United States of America

## ARTICLE INFO

## Article history:

Received 8 September 2022

Accepted 21 October 2022

Available online 7 November 2022

## Keywords:

Surgical education

Infection prevention

Ethiopia

Low-income country

Surgical site infection

## ABSTRACT

Although international guidelines exist for the prevention of surgical site infections, their implementation in diverse clinical contexts, especially in low and middle-income countries, is challenging due to the lack of available resources and organizational structure of facilities. The goal of this project was to develop a series of video training aids to highlight best practices in surgical infection prevention in hospitals with limited resources and to provide practical solutions to common challenges faced in these settings.

Using the validated Clean Cut education framework for infection prevention developed by Lifebox, a charity devoted to improving surgical and anesthetic safety, we partnered with clinicians in one Ethiopian hospital to create six educational videos giving practical guidelines for infection prevention under resource variable conditions. These include: 1) proper use of the WHO Surgical Safety Checklist, 2) hand and skin antisepsis, 3) confirming instrument sterility, 4) maintaining the sterile field, 5) antibiotic prophylaxis, and 6) gauze counting.

Gaps in available online educational materials were identified in each of the six areas. Videos were created providing setting-specific education and addressing gaps in existing materials for each of the infection prevention topics. These videos are now integrated into infection prevention curricula through Lifebox in Ethiopia and ongoing data collection to evaluate acceptability and efficacy is ongoing.

Surgical education videos on infection prevention topics addressing location-specific resources and workarounds can be useful to hospitals operating in resource-limited settings for training staff and supporting quality and safety efforts in surgery.

© 2022 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Introduction

Surgical site infections are a major cause of morbidity and mortality, which in low- and middle-income countries can be several-fold higher than in high-income countries, with documented rates ranging from 10 to 23% [1–7]. Commonly cited causes of preventable

infections include incomplete decontamination of reusable surgical materials, compromised sterility, missed or improperly timed administration of prophylactic antibiotics, and improper surgical instrument reprocessing [6,7,17–19]. Detailed international guidelines exist for the prevention of surgical site infections; however, they are not always easily adaptable to diverse clinical contexts, frequently fail to account for the availability of resources, and lack specific implementation strategies [6,8,20,21].

Consequently, attention has been given to creating or adapting guidelines specific to a LMIC context [8,10–13]. ‘Clean Cut’, a six-

\* Corresponding author at: Department of Surgery, University of California, San Francisco, 505 Parnassus Ave., S-321, San Francisco, CA 94143, United States of America.  
E-mail address: [nichole.starr@ucsf.edu](mailto:nichole.starr@ucsf.edu) (N. Starr).

month quality improvement program developed and facilitated by Lifebox, is one such program that endeavors to improve adherence to infection prevention guidelines in LMICs through targeted, site-specific interventions (Fig. 1). Initially piloted in urban and rural hospitals in Ethiopia, the Clean Cut program has now expanded internationally as data from pilot sites demonstrated improved infection prevention processes and patient outcomes at institutions following its implementation [14].

A core part of the Clean Cut program is delivering evidence-based training to operating room staff to close any identified knowledge gaps. Although adding videos to the package of education and training materials would potentially increase the program's scalability by removing the need for many in-person training sessions, we did not find pre-existing videos to be helpful for these contexts. Current publicly available training videos display patient care and hospital processes taking place in high-income country hospitals using unavailable and unaffordable resources, technology, and organizational processes. These depictions demonstrate unrealistic and impractical options for many healthcare workers in LMICs.

Videos filmed in and directed to high-resource hospitals may inadvertently send the message that such processes cannot be safely completed outside of a high-resource context. Operations conforming to best practices in patient safety and infection prevention can be performed in resource-variable environments but require thoughtful adaptation of guidelines and an approach that is both culturally and contextually informed. Success requires hospital management to engage and empower local clinicians to practice safely and sustainably within their unique context [15].

We aimed to develop a series of video training aids to 1) highlight best practices in surgical infection prevention that reflect realistic conditions in Ethiopian hospitals and 2) provide practical solutions to common challenges to compliance with best practices in resource-variable settings. We hoped that by creating these videos we could reinforce the message of safe surgery, strengthen compliance in a diversity of clinical contexts and settings, and improve engagement with the Clean Cut program by making educational materials more accessible to participants.

## Methods


**Identifying common challenges.** After implementing the Clean Cut program at 8 hospitals, clinicians and program team members met to identify common gaps in infection prevention processes that were seen at most or all hospitals. This team reviewed field notes, meeting minutes and observational program data and reached consensus on the gaps in practice identified at the initial eight hospitals, as well as workaround strategies where available. We designed our videos to depict realistic conditions for many Ethiopian hospitals while remaining broad enough that they might apply to other LMIC hospitals.

We created one video for each of the six Clean Cut pillars of infection prevention: 1) proper use of the WHO Surgical Safety Checklist, 2) appropriate hand and skin antisepsis, 3) confirmation of instrument sterility, 4) maintenance of the sterile field, 5) appropriate antibiotic prophylaxis, and 6) routine gauze counting [6,16]. Members of the content creation team, which included local physicians and surgeons, drew on their experience working in numerous local hospitals to identify common challenges, misconceptions, and lapses in each of the six infection prevention areas and then brainstormed how to address these gaps in each video (Table 1).


Where applicable, we included both correct and incorrect versions of the same scene to allow the video to be paused for discussion. The “incorrect” scenes depicted some of the common pitfalls are identified in Table 1; the “correct” scenes provided some examples and approaches to addressing them.

For best practices often missed due to lack of resources, we identified low-cost and practical alternatives which could be implemented in an austere setting. For example, the Clean Cut sterile processing curriculum emphasizes the importance of both internal and external indicators for all autoclaved items. However, most hospitals in Ethiopia do not have access to internal chemical indicators. In the sterile processing video, we therefore demonstrated how to fold external sterility indicator tape to create an internal indicator (Fig. 2). We also depicted using toothpicks as under-nail cleaners in lieu of the plastic nail cleaners that are typically supplied with packaged soap-impregnated disposable


# CLEAN CUT



**1. Appropriate Skin Preparation**

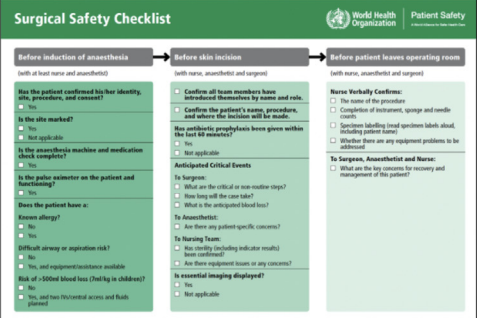



**2. Antibiotic Prophylaxis**




**3. Sterile Field: Reusable Surgical Linens**

**Aim: Improve compliance with known standards of perioperative infection prevention, based in the WHO Surgical Safety Checklist.**






**4. Instrument Sterility**



**5. Gauze Counting**



**6. Use of Surgical Safety Checklist**




Fig. 1. Components of the Clean program.

**Table 1**  
Topics for each video with observed gaps in practice and proposed solutions.

| Video topic                        | LMIC common IPC gaps not addressed in existing educational materials                                                                                                                                                                                                                                                                                                               | Solutions proposed in videos                                                                                                                                                                                                                                                                                                                                |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Handwashing                        | <ul style="list-style-type: none"> <li>Protocol for when running water is not available</li> <li>Manufactured soap--impregnated scrub brushes not available</li> <li>Nail cleaners not available</li> </ul>                                                                                                                                                                        | <ul style="list-style-type: none"> <li>Included WHO formula for preparing Alcohol-Based Hand Rub in the facility</li> <li>Guidance on hand scrubbing without brushes</li> <li>Using toothpicks as nail cleaners</li> </ul>                                                                                                                                  |
| Antibiotics                        | <ul style="list-style-type: none"> <li>Prophylactic antibiotics traditionally administered in surgical ward &gt;60 minutes before incision</li> <li>Paper-based chart documentation makes the timing of medication administration difficult to track</li> </ul>                                                                                                                    | <ul style="list-style-type: none"> <li>Highlight passage of time during routine preoperative preparation and importance of giving antibiotics in OR</li> <li>Highlight use of the whiteboard for documenting antibiotics administration</li> </ul>                                                                                                          |
| Instruments                        | <ul style="list-style-type: none"> <li>Bleach soaking is common practice but damaging to instruments</li> <li>Industrial instrument washing and reprocessing machines not generally available</li> <li>Large, improper brushes used for instrument cleaning</li> </ul>                                                                                                             | <ul style="list-style-type: none"> <li>Provide guidance on what cleaning agents to use for instrument decontamination instead of bleach</li> <li>Teach technique for three--bucket manual instrument cleaning system</li> <li>Use of firm bristle tooth-brushes and granulated laundry powder for improved instrument cleaning</li> </ul>                   |
| Gauze counting                     | <ul style="list-style-type: none"> <li>Surgical gauze packs are cut by hand and do not have radiopaque or scanner tracking mechanisms</li> <li>Soiled gauze is often thrown into mixed trash rather than separated individually</li> <li>Gauze reconciliation is often done by one person</li> <li>Mismatching numbers during gauze counts are sometimes not reconciled</li> </ul> | <ul style="list-style-type: none"> <li>Use of a handmade grid to separate gauze and organize counting</li> <li>Emphasize counting out loud with more than one person</li> <li>Highlight the importance of using a whiteboard for reconciling beginning and end counts</li> </ul>                                                                            |
| Surgical safety checklist          | <ul style="list-style-type: none"> <li>Checklist generally paper--based and not completed out loud with the team</li> <li>Sign-in performed without the patient, or after receiving anesthesia</li> <li>Sign out often not performed</li> </ul>                                                                                                                                    | <ul style="list-style-type: none"> <li>Demonstrate crises that might be mitigated by checklist use aloud with the entire perioperative team</li> <li>Demonstrate how to include patient in the sign-in portion of the checklist</li> <li>Highlight critical components of a safe sign out</li> </ul>                                                        |
| Instrument, gown & drape sterility | <ul style="list-style-type: none"> <li>Resource shortages lead to the use of surgical linens with holes or tears</li> <li>Dryers are often not available; reusable linens may be damp upon opening</li> <li>Internal chemical sterility indicators not available</li> </ul>                                                                                                        | <ul style="list-style-type: none"> <li>Guide proper patching and repair of torn surgical linens for extended use</li> <li>Emphasize the importance of checking for dryness of linen gowns &amp; drapes before use</li> <li>Teach using folded external indicator tape as internal sterility indicator in instrument trays, gown, and drape packs</li> </ul> |

surgical scrub brushes. These workarounds can improve sterile practices and help raise awareness of the importance of sterility among staff.

**Filming & editing.** Local operating room staff and the Clean Cut team were recruited as actors. We filmed the videos in hospital rooms and an out-of-use operating theater at a public hospital in Ethiopia (Fig. 3). The videos were edited with summary bullets and discussion questions, translated and subtitled in Amharic, Spanish, and French. The final videos were incorporated into the Clean Cut curriculum, posted publicly to YouTube for international distribution and incorporated into an

online Lifebox self-learning course on perioperative infection prevention (available at <https://www.lifeboxlearningnetwork.com>).

## Hurdles

Major hurdles in the execution of this project included buy-in from local administration, video editing, and translation. One of the early hurdles this project faced was establishing buy-in from all parties. Approval for filming at the hospital required buy-in from hospital administrators and strategic planning to ensure that space in the hospital would be available to film without compromising patient care.

An unexpected hurdle was affording an editor within our budget with an appropriate background in healthcare capable of executing our vision. After one round of failed editing, we identified an editor with appropriate skill sets who provided pro-bono work; this facilitated the process, as editing is time and labor-intensive. Translating each script for subtitling and narrating each video was likewise resource- and time-intensive; we recruited a team of clinicians and medical student volunteers to help with this and ensure clinical accuracy in translation.

## Measuring success

Following training in infection prevention practices, including the IPC videos as part of the Clean Cut program, hospital staff take a 20-question multiple-choice questionnaire which they must achieve 80% or higher on to receive a certificate of completion (Appendix). We plan to compare test scores before and after the implementation of our video curriculum to determine if supplementing the curriculum with context-specific suggestions improves knowledge transfer and increases knowledge retention.

## Conclusion

Creating supplementary surgical infection prevention educational materials adapting guidelines to an LMIC context is an important step in maximizing adherence to guidelines and reducing surgical infection in LMICs. In this report, we have reviewed our process for planning and filming a series of videos that highlight best practices for safe surgery in an austere environment and emphasize solutions to common challenges within Ethiopian hospitals and those in other resource variable contexts.

The Clean Cut videos are now translated and available in English, Amharic, Spanish and French. They are released publicly via YouTube (<https://www.youtube.com/playlist?list=PLUL1vGqCkmiNcrtG07j4pizyLMW8eZBlp>) and the Lifebox Learning Network online courses. The videos are being incorporated into Lifebox Clean Cut training internationally. It is our hope they will be of use to other hospital teams operating in resource-limited settings as well.

Our next steps are to evaluate the videos on effectiveness and their acceptability to viewers (Appendix) to inform future iterations.

## YouTube channel link

<https://www.youtube.com/watch?v=76eI3OXfGNk&list=PLUL1vGqCkmiNcrtG07j4pizyLMW8eZBlp>.

## CRediT authorship contribution statement

JH, UJSR, AT, NG, SB, and NS contributed to project design, screenplay writing, editing, filming and production. JH, TGW, TNM, NS wrote and edited the manuscript. JH, AT, NG, TGW, TNM, NS critically appraised





**Fig. 2.** Screenshot from “Sterility” Video demonstrating how to create an internal sterility indicator using folded indicator tape.

and revised the manuscript. All authors reviewed and approved of the final manuscript.

#### Declaration of competing interest

Jessica Hawkins received grant support from Stanford University Design School during the course of this work; Uriel Jhovanny Sanchez Rangel received payment from Lifebox Foundation for video editing services; Assefa Tesfaye has nothing to disclose; Natnael Gebeyehu has nothing to disclose; Thomas G Weiser is Chief Medical Officer of Lifebox Foundation; Senait Bitew is East Africa Director of Programmes for Lifebox Foundation; Tihitena Negussie Mammo is Global Clinical Director of Lifebox Foundation; Nichole Starr was a Lifebox Fellow and received grant support through NIH Fogarty International Center (Global Health Equity Scholars NIH FIC D43TW010540) and NIH T32 training grant DK007573 during the course of the work.

#### Acknowledgments

Acknowledgments to the translators and to the clinician-actors in the educational videos: Dr. Nahom Tadelle, Milena Abreha, Dr. Yodit Semere, Dr. Ewnetu Mulugeta, Mr. Fissiha Fentie, Dr. Esayas Gorems Melesse, Mr. Tsega Tilahun, Mr. Yonas Tesfaye, Dr. Samuel Negash, Sr. Hiwot Tadele.

#### Funding sources

This project was funded through the Stanford Design for Extreme Affordability Program, a charity organization from the Graduate School of Business at Stanford University. N.S. was supported by NIH T32 training grant DK007573 and the NIH Fogarty International Center (Global Health Equity Scholars NIH FIC D43TW010540) during the course of this work.



**Fig. 3.** Filming in a working operating theater.

## Ethical approval

Approval for the project and filming was given by the administration of St. Peter's Specialized Hospital in Addis Ababa.

## References

- [1] Nepogodiev D, Martin J, Biccadd B, et al. Global burden of postoperative death. *The Lancet*. 2019;393(10170):401. [https://doi.org/10.1016/S0140-6736\(18\)33139-8](https://doi.org/10.1016/S0140-6736(18)33139-8).
- [2] Monahan M, Jowett S, Pinkney T, et al. Surgical site infection and costs in low- and middle-income countries: a systematic review of the economic burden. *PLoS One*. 2020;15(6):e0232960. <https://doi.org/10.1371/journal.pone.0232960>.
- [3] Rickard J, Beilman G, Forrester J, et al. Surgical infections in low- and middle-income countries: a global assessment of the burden and management needs. *Surg Infect (Larchmt)*. 2019;21(6):478–94. <https://doi.org/10.1089/sur.2019.142>.
- [4] Rojas-Gutierrez E, Vilar-Compte D. An overview of surgical site infection in low- and middle-income countries: the role of recent guidelines, limitations, and possible solutions. *Curr Treat Options Infect Dis*. 2019;11(3):300–16. <https://doi.org/10.1007/s40506-019-00198-1>.
- [5] Allegranzi B, Nejad SB, Combescure C, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *The Lancet*. 2011;377(9761):228–41. [https://doi.org/10.1016/S0140-6736\(10\)61458-4](https://doi.org/10.1016/S0140-6736(10)61458-4).
- [6] World Health Organization. Global guidelines for the prevention of surgical site infection; 2016..
- [7] Bhangu A, Ademuyiwa AO, Aguilera ML, et al. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: a prospective, international, multicentre cohort study. *Lancet Infect Dis*. 2018;18(5):516–25. [https://doi.org/10.1016/S1473-3099\(18\)30101-4](https://doi.org/10.1016/S1473-3099(18)30101-4).
- [8] National Institute for Health Research Global Research Health Unit on Global Surgery. Delphi prioritization and development of global surgery guidelines for the prevention of surgical-site infection. *Br J Surg*. 2020;107(8):970–7. <https://doi.org/10.1002/bjs.11530>.
- [10] Patel A, Vieira MMC, Abraham J, et al. Quality of the development of traumatic brain injury clinical practice guidelines: a systematic review. *PLoS One*. 2016;17.
- [11] Fervers B, Burgers JS, Haugh MC, et al. Adaptation of clinical guidelines: literature review and proposition for a framework and procedure. *Int J Qual Health Care J Int Soc Qual Health Care*. 2006;18(3):167–76. <https://doi.org/10.1093/intqhc/mzi108>.
- [12] Fast O, Uzoka F-M, Cuncannon A, et al. The impact of a sterile processing program in Northwest Tanzania: a mixed-methods study. *Antimicrob Resist Infect Control*. 2019;8(1):183. <https://doi.org/10.1186/s13756-019-0633-0>.
- [13] White MC, Randall K, Ravelojaona VA, et al. Sustainability of using the WHO surgical safety checklist: a mixed-methods longitudinal evaluation following a nationwide blended educational implementation strategy in Madagascar. *BMJ Glob Health*. 2018;3(6):e001104. <https://doi.org/10.1136/bmjgh-2018-001104>.
- [14] Forrester JA, Starr N, Negussie T, et al. Clean Cut (adaptive, multimodal surgical infection prevention programme) for low-resource settings: a prospective quality improvement study, 10; 2020..
- [15] Sadler SJ, Fuller AT. Reframing infection control approaches in low-resource health care settings: a nod to the emic perspective. *J Glob Health*. 10(2). . <https://doi.org/10.71789/jogh.10.020340>.
- [16] Clean Cut. Lifebox<https://www.lifebox.org/clean-cut/>. [Accessed 10 April 2021].
- [17] Shahida SM, Islam A, Dey B, Islam F, Venkatesh K, Goodman A. Hospital acquired infections in low and middle income countries: root cause analysis and the development of infection control practices in Bangladesh. *Open J Obstet Gynecol*. January 2016. <https://doi.org/10.4236/ojog.2016.61004>.
- [18] Garibaldi RA. Prevention of intraoperative wound contamination with chlorhexidine shower and scrub. *J Hosp Infect*. 1988;11:5–9. [https://doi.org/10.1016/0195-6701\(88\)90149-1](https://doi.org/10.1016/0195-6701(88)90149-1).
- [19] Anderson DJ, Podgorny K, Berríos-Torres SI, et al. Strategies to prevent surgical site infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol*. 2014;35(S2):S66–88. <https://doi.org/10.1017/S0899823X00193869>.
- [20] Berríos-Torres SI, Umscheid CA, Bratzler DW, et al. Centers for disease control and prevention guideline for the prevention of surgical site infection, 2017. *JAMA Surg*. 2017;152(8):784–91. <https://doi.org/10.1001/jamasurg.2017.0904>.
- [21] Tietjen Linda, Bossemeyer Debora, McIntosh Noel. Infection prevention: guidelines for healthcare facilities with limited resources. Jhpigo Corporation; 2003..