Original Article

Implementation of the WHO Surgical Safety Checklist and surgical swab and instrument counts at a regional referral hospital in Uganda – a quality improvement project

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Summary

The World Health Organization (WHO) Surgical Safety Checklist is a cost-effective tool that has been shown to improve patient safety. We explored the applicability and effectiveness of quality improvement methodology to implement the WHO checklist and surgical counts at Mbarara Regional Referral Hospital in Uganda between October 2012 and September 2013. Compliance rates were evaluated prospectively and monthly structured feedback sessions were held. Checklist and surgical count compliance rates increased from a baseline median (IQR [range]) of 29.5% (0–63.5 [0–67.0]) to 85.0% (82.8–87.5 [79.0–93.0]) and from 25.5% (0–52.5 [0–60.0]) to 83.0% (80.8–85.5 [69.0–89.0]), respectively. The mean all-or-none completion rate of the checklist was 69.3% (SD 7.7, 95% CI [64.8–73.9]). Use of the checklist was associated with performance of surgical counts (p value < 0.001; $r^2 = 0.91$). Pareto analysis showed that understaffing, malfunctioning and lack of equipment were the main challenges. A carefully designed quality improvement project, including stepwise incremental change and standardisation of practice, can be an effective way of improving clinical practice in low-income settings.

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Introduction

The World Health Organization Surgical Safety Checklist aims to improve patient safety by standardising delivery of care within the operating theatre through a series of essential safety checks. There were significant reductions in surgical morbidity and mortality after introduction of the checklist in eight economically diverse hospitals [1]. Subsequent studies have shown improvement in patient outcomes, although most of these reports are from high rather than middle or low-income settings [2–6].

There are unique challenges to implementation of the WHO checklist in resource-limited settings. These include local healthcare infrastructure, access to basic resources, safety culture and sociocultural norms among healthcare workers [6–8].

Uganda is low on the Human Development Index, and there is currently no national policy regarding the use of the WHO checklist [9]. Mbarara Regional Referral Hospital (MRRH) is a government hospital located in a large urban area, affiliated to Mbarara University of Science and Technology and provides secondary care for a population of approximately 300 000 in the south-western region of Uganda. MRRH has 330 beds, and performs approximately 4000 operations a year. The obstetric department is the busiest surgical department, with 15 000 deliveries per year and accounts for approximately 70% of all operations. There are five operating rooms, each equipped with a working pulse oximeter, and an 8-bedded intensive care unit with limited capacity to care for ventilated patients.

The WHO checklist was first introduced within the obstetric department at MRRH in 2011 as part of a programme to improve maternal care. Checklist-training sessions were conducted over a five-month period by a visiting anaesthetist, but use of the checklist was not sustained after the volunteer left the hospital [10]. A stepwise approach to checklist implementation was then adopted, led by local clinicians in theatre. First, the international standards for intra-operative monitoring for all patients were introduced [11]. This was done in association with a large-scale training programme and donation of pulse oximeters for non-physician anaesthetists in Uganda [12]. The next step was the introduction of appropriate antibiotic administration before skin incision. Patient monitoring and surgical antibiotics prophylaxis became routine within all theatres by August 2012.

In 2012, there were two patient safety incidents at MRRH, one involving a retained surgical instrument, the other a retained surgical swab. These sentinel events highlighted that the WHO checklist was not being used effectively and, moreover, that peri-operative instrument or swab counts were performed inconsistently. We conducted a formal year-long quality improvement project with multiple ‘plan-do-study-act’ (PDSA) cycles, prospective data collection and feedback to users to explore whether we could re-introduce the WHO checklist, formalise swab and instrument counts in the operating theatres at MRRH, and whether this would lead to a sustained change in practice.

Methods

According to the policy regarding activities that constitute research at Mbarara Hospital/Mbarara University of Science and Technology, this work met criteria for operational improvement activities exempt from ethics review.

The project was initiated by the head of the anaesthetic department (ST) and the implementation process was spearheaded by an anaesthetic resident (AK) and a UK-trained anaesthetic registrar (ML) who was a long-term volunteer (The Sustainable Volunteering Project, Ugandan Maternal and Newborn HUB) at MRRH at the time. The anaesthetic department consisted of three consultants, four residents and seven non-physician anaesthetic clinical officers.

In May 2012, a US medical student undertook a survey among 69 theatre staff to identify barriers to the checklist implementation at MRRH (B. Strong, unpublished data). Through structured interviews, it was shown that > 80% of the staff were aware of the checklist, its usefulness in reducing patient morbidity and were willing to comply with its use. The main barriers identified were: the lack of clarity about responsibilities; lack of leadership and support from higher level staff; no trained nurse to assist; and not enough time to complete the checklist.

An implementation team was formed to address the barriers (ST, AK, ML), and a six-week pre-implementation phase started in August 2012. Senior representatives from each department (surgery, obstetrics and gynaecology, anaesthesia, theatre nursing) were identified by ST and approached to become the main contacts during the implementation process. They included the consultant surgeons and the sister-in-charge of the operating theatre. After getting acceptance and support from the departmental leads, we sought their opinions regarding the items on the WHO surgical safety checklist and the need to adapt it to suit the local context.

Formal educational meetings were held in each department to emphasise why we were implementing the checklist and how the implementation process was going to be carried out. Video clips from both high and low-income sources were used to demonstrate how the checklist should and should not be used [13–15].

We found that by using a documentary video produced in an Ethiopian Regional Referral Hospital, the staff were able to better appreciate the relevance and feasibility of the checklist in a low-resource setting [13, 14].

The checklist was tested in the two obstetric theatres over a period of two weeks in October 2012. During this time, there was intense coaching and 'live' feedback on how to use the checklist appropriately. Items on the checklist were reviewed for their practicality and relevance and a final locally adapted version was produced (see also Supporting Information, Appendix S1). The checklist implementation was formally launched in all five theatres in November 2012. Posters of the checklist were put up on theatre walls and each theatre was provided with a folder containing multiple paper copies of the checklist. The theatre teams decided that the checklist was to be filed as part of the patient's medical notes after completion and the person completing the checklist was asked to sign the form. A 'free text' section was included as part of the checklist to record any barriers to checklist completion.

The nurses and surgical trainees were well versed with the concept of instrument checks and how to perform them, but a number of challenges were identified during the planning phase that prevented this from being routine practice. There was no standardised instrument pack for most of the surgical procedures, no formal instrument list and no formal means of recording the swab count. Previous attempts had been made to put up white boards in theatre but this faced the challenge of missing markers and failure to replace them. To overcome these issues, each surgical department was asked to provide a list of instruments that were most commonly used during their procedures. This was later compiled into two separate lists, one for obstetric and gynaecology procedures and a generic surgical instrument list. Each list was tabulated and printed on the reverse side of the WHO checklist form (see also Supporting Information, Appendix S2).

Feedback to the theatre teams was provided on a monthly basis and summary findings were formally presented to each department (anaesthesia, general surgery, obstetrics) by one of the authors (AK). Nurses were invited to join the meetings. Feedback information included rate of checklist compliance, patient consent, antibiotic and blood administration and instrument count. Run charts were shared to keep all stakeholders updated with the progress of implementation and their individual performances. Barriers to implementation and ways to overcome them were discussed at the end of the monthly meetings.

One author (AK) completed prospective data collection from November 2012 to September 2013. This included the patient name, surgical procedure, urgency of operation and theatre team, as recorded in the operating theatre logbook. The patients' medical notes were reviewed on the ward the day after the operation to evaluate process measures: completion of the checklist; the instrument count sheet; the anaesthetic chart to check for antibiotic and blood administration; and patient's consent form. Data were uploaded to a predesigned form and then entered into Microsoft Excel© (Microsoft Corporation, Washington, DC, USA) for analysis. No patient personal identifiable information was recorded onto the database. Data were reviewed and run charts plotted using the Institute of Healthcare Improvement run chart tool© (Institute of Healthcare Improvement, Cambridge Massachusetts). Results were interpreted using run chart rules [16, 17]. A linear regression analysis was performed to show the association between use of the WHO checklist and performance of the formal instrument count. A Pareto chart was plotted to demonstrate the barriers to checklist completion.

Results

A total of 3341 operations were performed between November 2012 and September 2013. The number of operations ranged from 262 to 374 per month; 82.5% were classified as urgent or emergency and only 17.5% of the workload was elective. A total of 2380 were obstetric operations, mainly caesarean sections, which accounted for 71% of all the operations performed during this time. Gynaecological procedures accounted for 7% and the remaining 22% comprised of general surgery, ENT, neurosurgery, urology and orthopaedics.

At the start of the project, the checklist was not being used and there were no formal swab and instrument counts being recorded. The progress of implementation is presented as run charts, with both processes showing significant change. WHO checklist compliance increased from a baseline median (IQR [range]) of 29.5% (0–63.5 [0–67.0]) to 85.0% (82.8–87.5 [79.0–93.0]) and surgical count compliance increased from 25.5% (0–52.5 [0–60.0]) to 83.0% (80.8–85.5 [69.0–89.0]) by the end of our study. The change in median demonstrates a significant change in practice that was sustained (Figs. 1 and 2). Interventions at various points are annotated in Fig. 3. Of note, there is a downward trend from 93% to 82% in the WHO checklist compliance from April–September 2013 (Fig. 1).

The use of the WHO checklist was strongly associated with the performance of surgical counts. We plotted a graph of instrument count rate against WHO checklist compliance. A simple linear regression analysis showed a significant positive correlation (p value < 0.001, and the use of the checklist accounted for about 90% of variances of the use of instrument count [coefficient of determination (r^2) = 0.91] (Fig. 4).

The mean (SD) completion rate of each section of the checklist, namely sign-in, time-out and sign-out was 91.2 (5.2)%, 89.9 (5.4)% and 87.5 (5.6)% (95% CIs 88.1–94.3, 86.8–93.1 and 84.3–90.9), respectively. Despite the high completion rate for individual sections, the mean (SD) rate of a fully completed all-

Figure 1 Run chart demonstrating World Health Organization (WHO) checklist compliance rate (%) from August 2012 to September 2013. Compliance rate is determined by calculating the number of checklists used as a proportion of the total number of operations performed each month. Segmentation of the data following the significant shift in compliance rate demonstrates an increase from the baseline median of 29.5% (August 2012–January 2013) to 85% (February 2013–September 2013). Following the rules for objective interpretation of run charts, a significant shift is defined as six or more consecutive data points above or below the median [16, 17]. If a significant shift is detected, subsequent data points are used to determine a new median which is then compared with the baseline median to demonstrate change. A downward trend (defined as six or more consecutive points in the same direction) is observed from April to September 2013.

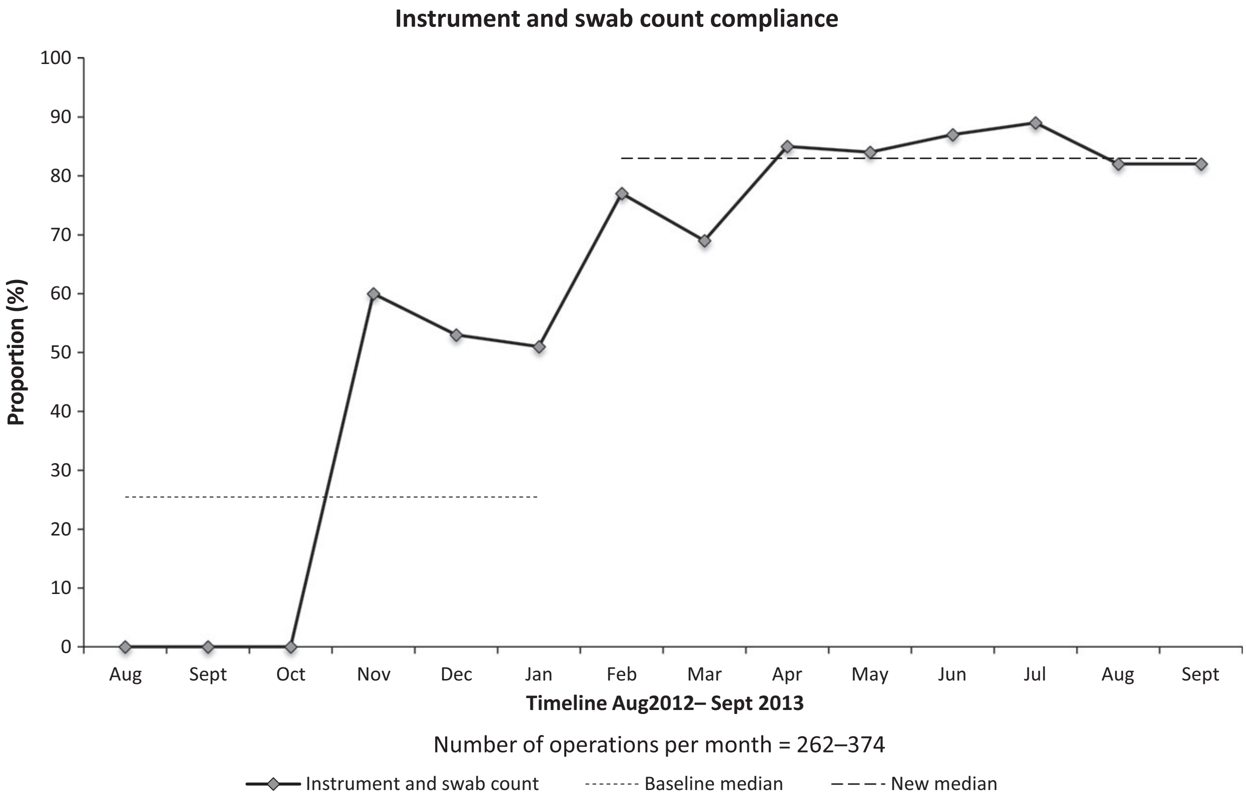

Figure 2 Run chart demonstrating surgical count compliance rate (%) from August 2012 to September 2013. Compliance rate is determined by calculating the number of completed swab and instrument count forms as a proportion of the total number of operations performed each month. A significant upward shift in the compliance rate was observed from the baseline median of 25.5% (August 2012–January 2013) to 83.0% (February 2013–September 2013). See Fig. 1 caption for advice on interpreting the chart.

or-none checklist over the 12-month period was 69.3 (7.7)% (95% CI 64.8–73.9).

The free-text section was infrequently filled in with only 95 entries in the 2645 checklists that were used. We present our findings in a Pareto chart to demonstrate the main barriers to checklist implementation (Fig. 5). A total of 30 mentioned lack of staff (e.g. “no nurse”, “1 nurse for 4 theatres”), 26 entries were about malfunctioning equipment (e.g. “pulse oximeter stopped working”, “suction machine not working”, “blunt scissors”); 20 accounts of lack of essential equipment (e.g. “no blade holders”, “no mops’, “no spinal pack”, “no scissors”); and ten were about lack of basic facilities or supplies (e.g. “no water”, “no oxygen”, “no blood in blood bank”, “no antibiotics”). There were seven accounts mentioning lack of cooperation by team members in completing the checklist. Although we feel the problems were under-represented, the comments served to highlight the difficult working circumstances in a low-resource setting.

To encourage accountability, the staff were asked to sign their names when completing the checklist and to state their job title. A total of 2645 checklists were used during the study period; 88% of the checklists were accounted and signed for. No name or signature accompanied the remaining 12% of the checklists. Out of these checklists, 37% were completed by nurses, 25% by anaesthetic clinical officers, 18% by anaesthetists, 13% by medical students and 7% were completed by surgeons.

Discussion

We have described the implementation of the WHO Surgical Safety Checklist and introduction of formal instrument and swab counts in a government regional referral hospital in Uganda. The interventions were

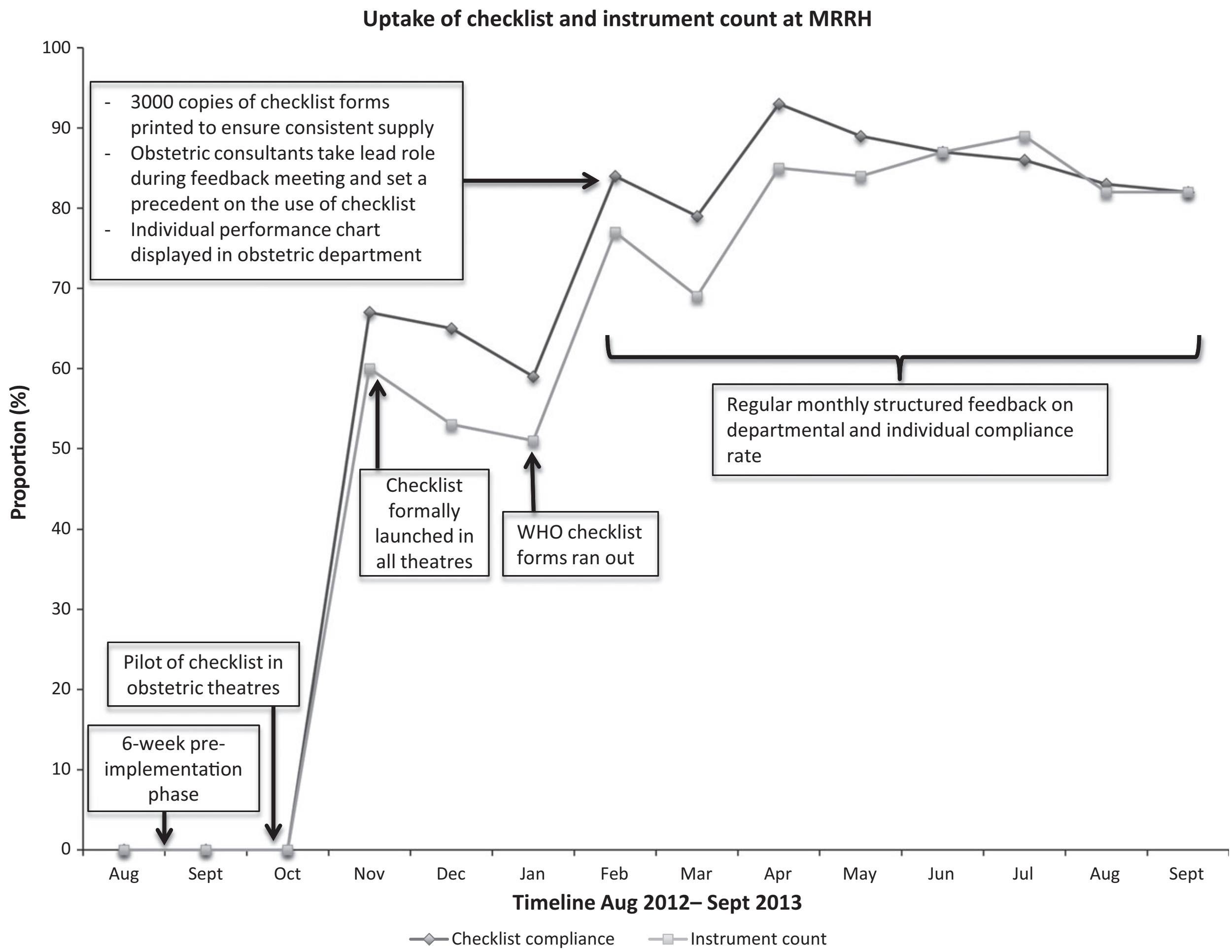

Figure 3 Run chart annotations to indicate timing and effect of the interventions at various points of the study. Significant events that may have affected the implementation process are also indicated.

conducted in this low-income setting using quality improvement methodology, prospective data collection, PDSA cycles and regular structured feedback to users to improve their performance. We achieved a checklist and surgical count compliance rate of 85% and 83% over a 12-month period. Introduction of basic paperwork was a key intervention to support the implementation process. Standardisation of the instrument list and printing this on the reverse of the checklist made it easy for the staff to adopt surgical count practice. The main strengths of this study include strong local leadership and commitment to the project, the use of available resources with minimal external input and effective monthly structured feedback meetings, which helped to further improve local engagement with the project. Understanding barriers to implementation and a process of coaching and mentorship by local champions helped the intervention to be sustained over time. Our study highlighted some of the many challenges to improving safe surgery in a low-resource setting, including lack of basic infrastructure such as oxygen, surgical instruments or blood for transfusion.

Using a checklist is an effective tool to improve surgical outcomes, but assumes that standard safety practices are already in place, which may not be the case in resource-poor settings [5, 18, 19]. At MRRH, we adopted a stepwise approach to checklist implementation, focusing initially on the routine use of pulse oximeters for intra-operative monitoring, then timely administration of antibiotics for surgical prophylaxis, and finally introduction of surgical counts. We feel that the stepwise approach with an emphasis

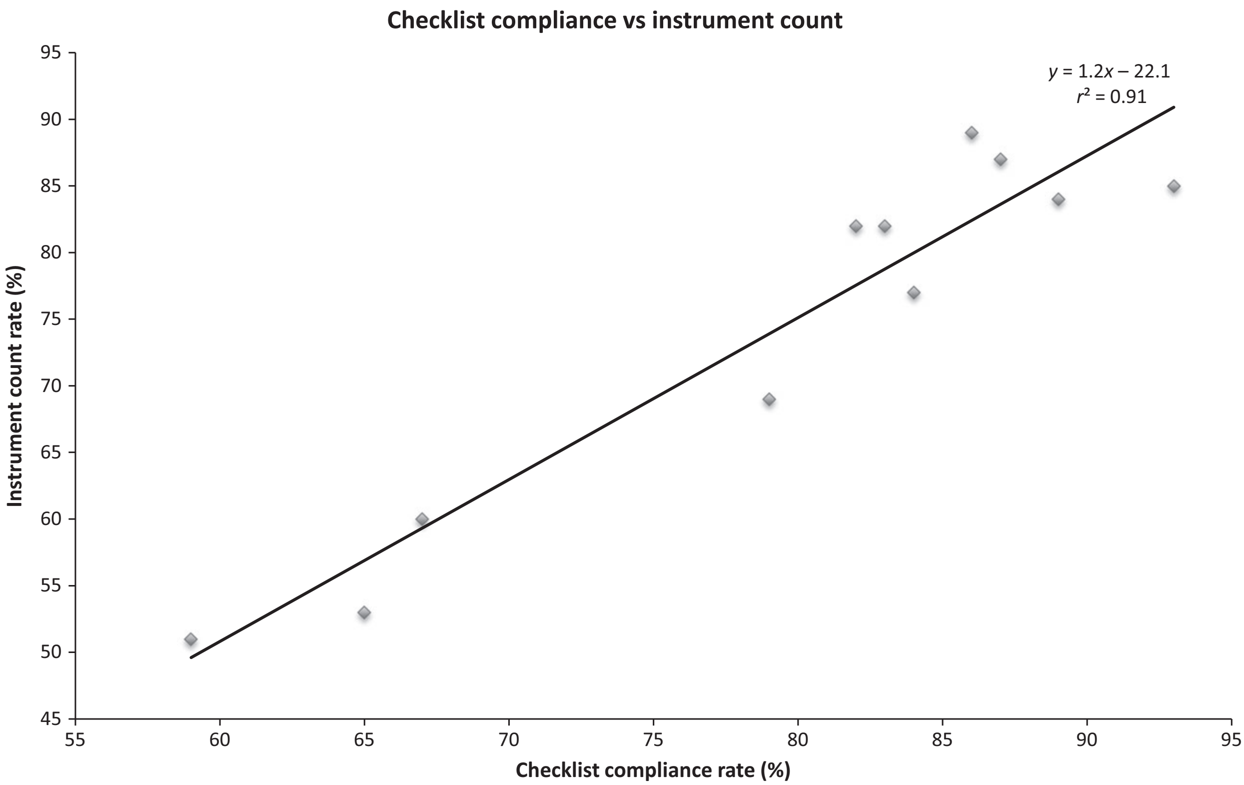

Figure 4 A scatter plot of swab and instrument count rate against WHO checklist compliance rate. A linear regression analysis demonstrates a significant positive correlation (p value < 0.001, 95% CI [0.9–1.5]) and a coefficient of determination of 0.91. This indicates that the use of the WHO checklist accounted for > 90% of variances of the performance of instrument count and that there is a strong association between the two processes.

on strengthening and standardisation of surgical systems is essential, and contributed to the use of the WHO checklist in our study.

There is good evidence to support the use of the WHO checklist to improve surgical safety but translating this evidence into clinical practice is often not as straightforward [19, 20]. The checklist is not a magic bullet but rather a tool to be used by healthcare workers as part of a multi-faceted strategy to improve patient care [21]. Modification to suit local practice and multidisciplinary leadership are major considerations [22, 23]. Other important factors include identifying and cultivating local champions, explaining 'why' and demonstrating 'how' to use the checklist through extensive education [3, 24, 25]. Compliance rates increase if team members are engaged in local adaptation and development of the checklist [3]. The intervention in our study was built on previous educational efforts, but was triggered by local safety concerns, highlighting the rationale for using the checklist. An anaesthetic resident took on the project under the leadership and support of a senior consultant at MRRH. A long-term volunteer was involved in the initial steps of the implementation, but the entire study was carried out locally and followed through with no additional resource. Ensuring local ownership of the project was key to maintaining the project momentum.

One of the important steps leading to the success of the Michigan Keystone Project was the emphasis on redefining central venous catheter infection as a social problem (i.e. harm caused to patients due to human action and behaviour) that could be solved [26]. We used real events of surgical instrument and swab retention in patients at MRRH as a demonstration of the lack of safety standards in the current practice. We then offered a solution that involved the use of the checklist and a newly developed instrument count sheet. We felt this was crucial in motivating the change in the safety culture among staff members.

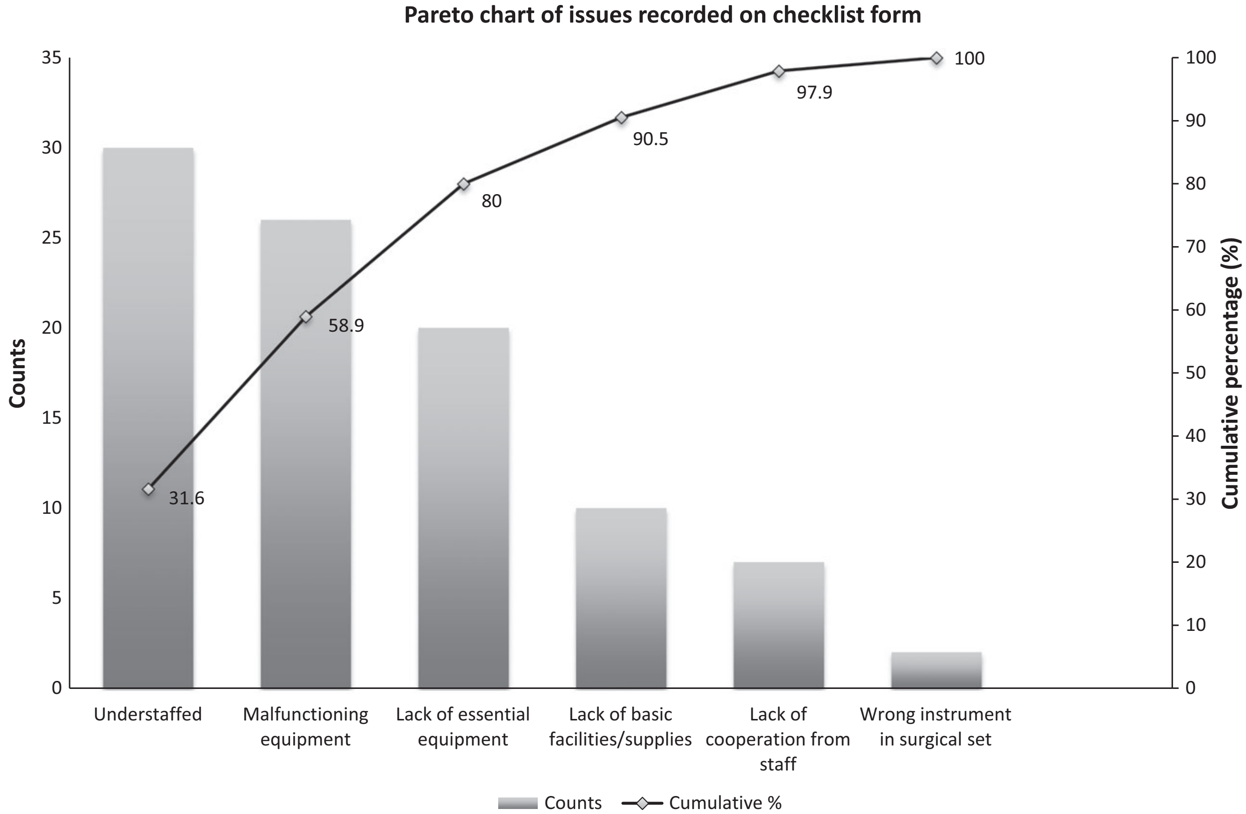

Figure 5 A Pareto chart demonstrating that 80% of the issues were due to understaffing, malfunctioning and lack of essential equipment, highlighting that these were the main barriers to checklist implementation. The Pareto chart was constructed using the 95 entries in the free-text section of the WHO checklist documenting barriers to its completion. Six main groups of issues were identified and each entry is categorised into one of the groups. The number of counts in each group was tallied and placed in the order of most frequently occurring to least frequently occurring issues. A cumulative proportion was calculated, enabling us to identify and prioritise the problems.

The positive impact on patient outcome is crucially dependent on checklist compliance. Van Klei and colleagues demonstrated that patient mortality significantly decreased after checklist implementation, and the effect was strongly related to compliance with all sections of the checklist [4]. This is difficult to achieve in high-income countries and even more so in a low-resource setting [4, 8, 19]. An experience in an Ethiopian hospital demonstrated a high initial compliance rate of 89%, which declined to 18% over an eight-month period, with a mean checklist completion rate of 20% [8]. In our study, we achieved and maintained a checklist compliance rate of 85% with a mean completion rate of 69%. The differing results may be explained by the regular feedback meetings that were conducted in our study but not in the other study. In addition, theatre staff members were asked to sign their names when completing the checklist in our study. The degree of contribution by different theatre team members was fed back to users to emphasise the importance of teamwork. This strategy was in contrast to the study by Bashford et al., where the practice of signing the form was avoided in fear of being held accountable for any mistakes [8]. This probably reflects a difference in the working culture, which can impact on compliance rate. We also note a downward trend in checklist compliance towards the end of our study from 93% to 82%. This may signify a start of a decrease in compliance, highlighting the need for continued vigilance by the local pioneers.

Quality improvement projects utilise Plan-Do-Study-Act cycles to accelerate improvement in healthcare through changes in human behaviour [16]. The efficacy and science of the methodology are well established, but less commonly used in the context of developing countries [16, 27, 28]. Feedback is central to quality improvement efforts and warrants careful planning to enhance its effectiveness [29]. We provided structured departmental feedback on a monthly basis. Leadership by senior consultants was encouraged and all staff within the departments were expected to attend. A 'league table' was presented to demonstrate compliance rate against individual and departmental performance. Those with high compliance rates were commended by consultants and asked to speak about how they were able to achieve the results. On the other hand, those who performed poorly were encouraged to discuss the barriers, and strategies to overcome them were then set out. Ranking individuals in an open forum may seem controversial and may risk promoting a 'blame culture'. However, this was not the case in our experience and we found the approach helped facilitate constructive discussions and promote a sense of accountability among staff members. By increasing transparency, we were able to increase engagement and identify who was responsible for each task.

The WHO implementation team recommended that a single person be designated the checklist coordinator responsible for checking the boxes on the list [30]. Poor staffing and resources at MRRH meant consistent role delegation was not always feasible. As part of the solution, we incorporated checklist-training sessions for the medical students during their surgical rotation and utilised them in theatre to help complete the checklist in times of staff shortage. Our experience highlights the applicability of using repeated PDSA cycles to identify and overcome local barriers in a low-resource setting.

There are several limitations to the study. Patient outcome was not measured and therefore, the impact of checklist and instrument count implementation was not quantified. Being able to demonstrate objective outcomes such as reduction in mortality or surgical site infection rate would make the value of the checklist more visible and further strengthen the implementation process. Investing effort into such a comprehensive study is worthwhile but would require greater manpower and additional resource. Moreover, measuring the impact of surgical count practice may be difficult given the low incidence of retained surgical swabs and instrument with varying estimates in the existing published data [31, 32].

Despite achieving high compliance and completion rate, exploring whether the checklist was used correctly as intended in real-time was beyond the scope of our study. Although we were able to cross check staff's adherence to safety measures such as antibiotics administration, use of pulse oximeter and instrument count through retrospective case note review, we did not assess whether the checks were actually being performed in real-time. We propose that these important areas should form the focus of the next phase of this study.

This study was conducted in a single training institution; changes in practice are likely to have influenced future providers, but may not be more widely applicable outside of the university hospital setting. Trained staff and leaders to innovate and effect change in MRRH are greater than are found in more rural settings. MRRH has strong international links and is exposed to many foreign volunteers and new ideas. These are important sociocultural factors to consider when embarking on a health partnership project in a developing country.

One of the key benefits of effective use of the checklist is improved teamwork and enhanced communication between theatre staff. Although the methodology of continuous data collection and feedback to individual departments appeared to be effective, a better approach may have been to conduct a joint multidisciplinary feedback session with surgeons, anaesthetists and nurses. Introducing standardised theatre team briefing at the beginning of the day and a debriefing at the end of day can also be a way to further enhance teamwork and interdisciplinary communication [33–35]. The importance of surgical leadership cannot be overemphasised when trying to implement a change within the operating room setting and therefore including a surgeon in the implementation team from the outset may have been a more effective strategy [36]. We also suggest early engagement with hospital administrators so that issues that require resources such as a supply of paper, antibiotics and equipment may be resolved more readily.

Implementing an adapted WHO surgical safety checklist or instituting change in clinical practice faces many challenges in low-income countries. Careful planning of interventions by local team members, with key leaders involved from the outset, can lead to sustainable change in practice. We found that prospective data collection with feedback to users in a supportive training environment was an important driver to effect change. Consideration of safety incidents in healthcare can act as a focus for successful implementation of quality improvement projects in a low-income setting.

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Competing interest

No external funding and no competing interests declared.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Adapted WHO checklist form.

Appendix S2a. Obstetric/Gynaecology surgical count sheet.

Appendix S2b. General surgical count sheet.