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Utilization of Surgical Safety Checklist in Low – and Middle Income Countries

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ABSTRACT

Despite successful introduction of rules of asepsis, antisepsis, antibiotic treatment, medicine still fights with human errors in medicine. One of the crucial and sensitive to miscommunication are surgical situations, where plenty of multidisciplinary team members are involved in successful provision of the treatment. That is why starting from 2008 a useful tool supporting provision of safe surgery - Surgical Safety Checklist (SSC) - was introduced by World Health Organization. In single worldwide studies in beginning of implementation, SSC was proven to be effective in many both high- and low income settings. The aim of our study was to review the effectiveness of the SSC based on the review of research in low- and middle income countries in years 2008-2017. Within 302 articles of PubMed Medline database, 12 articles were chosen for further analysis, with majority research held in Sub-Saharan Africa (42%), and Upper Middle Income Countries group (42%). The review proved the effectiveness of implementation of SSC in all income groups, especially in terms of reduction of surgical site infection, postoperative sepsis and improvement of communication in healthcare. Promising results of the few studies should encourage more research in this field, which may be difficult to conduct due to the lack of necessary resources in the LMIC.

***Keywords*:** surgical safety checklist, patient safety, low and middle income countries

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1. INTRODUCTION

Human civilizations fought countless battles against unknown enemies in the medical battlefield, starting from epidemics, war wounds, plenty of the undiscovered diseases concealed in human organs. Patient safety started not only with the understanding of microbiology and pathomechanism of epidemics, introduction of modern equipment in order to reduce the severity of surgeries, mortality associated with the blood loss and infections, but more importantly - more than a century ago with antiseptic and aseptic techniques introduced by Semmelweis, Lister and Pasteur [1,2]. However nowadays, provision of safe surgery still depends on the human factor - errors in team communication as well as individual chacteristics of health care providers. [3]

Year 2018 marks as the 10th anniversary of WHO Surgical Safety Checklist (SSC) introduction to modern surgical world. This tool was created in order to fulfill the International Patient Safety Goal- Ensure safe surgery for all, since the occurrence of adverse events is still frequent in modern surgery (25-50%). [4] The Checklist is a set of items grouped in three phases: Sign In - Before Anesthesia induction, Time Out - Before Skin Incision, Sign Out - Before Patient leaves the OR [5].

Table 1. Phases of the Surgical Safety Checklist. Prepared by authors.

Phase	Time of the procedure	Items checked	Person responsible
Sign in	Before induction of anaesthesia	Identity of patient and site of surgery Anaesthesia safety check Pulse oximeter Allergies/airway difficulties/blood loss risk	Leader + anaesthesia team
Time out	Before skin incision	Patient/Site/Procedure Team introduction and confirming roles Critical events possibility Antibiotics and imaging	Leader + All Teams (Surgical, Anaesthesia, Nursing Teams)
Sign out	Before patient leaves the theater	Procedure performed, Counting instruments, Labeling the specimen, Key concerns	Leader + Nursing Team

One of the first international successful research on SSC implementation proved its effectiveness in both lower-income and higher-income countries. Haynes et al. in 2009 conducted comparisons of rate of complications and death rates within 3773 pre- and 3955 post- checklist implementation surgeries in 8 cities of all continents. Study proved decreasing

the mortality rates in both groups (lower-income countries decrease from 2,1% to 1,0% with P = 0.006; in higher-income countries decrease from 0,9% to 0,8% with P = 0.18) as well as the complication rates (in lower-income countries from 11,7% to 6,8% with P < 0.001, higher-income countries from 10,3% pre to 7,1% post implementation with P < 0.001). [6]

It has been reported that after the decade of checklist introduction several high income countries applied the SSC and incorporated it to existing patient safety mechanisms, however in lower and middle income countries the implementation rates are low, due to lack of infrastructure and necessary resources [7,8]. Investing in surgical safety in low income countries was already proved to result in significant improvements in maternal and neonatal care. [9] Not only in human, medical aspect of improvements, but also within socio-economic benefits, investment in healthcare results in 10:1 benefit to cost ratio. [10]

2. AIM OF THE STUDY

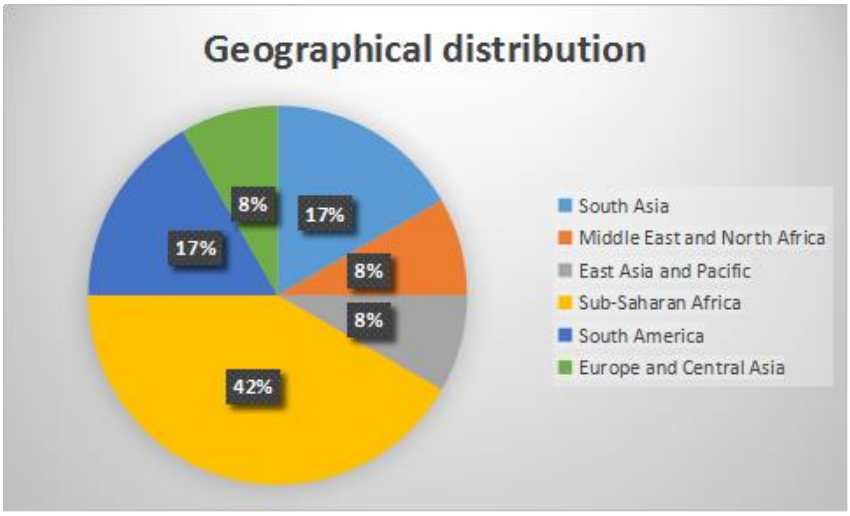
The aim of the study is to present the utilization and effectiveness of implementation of Surgical Safety Checklist in Low Income Countries and Middle Income Countries in years 2008-2017.

3. METHODS

Substantial articles on checklist implementation in LIC and LMIC from period 2008-2017 have been analyzed. Among 302 articles in PubMed Medline database, 12 articles were selected for analysis, excluding articles not related to the regional focus or topics other than usage, compliance and effectiveness.

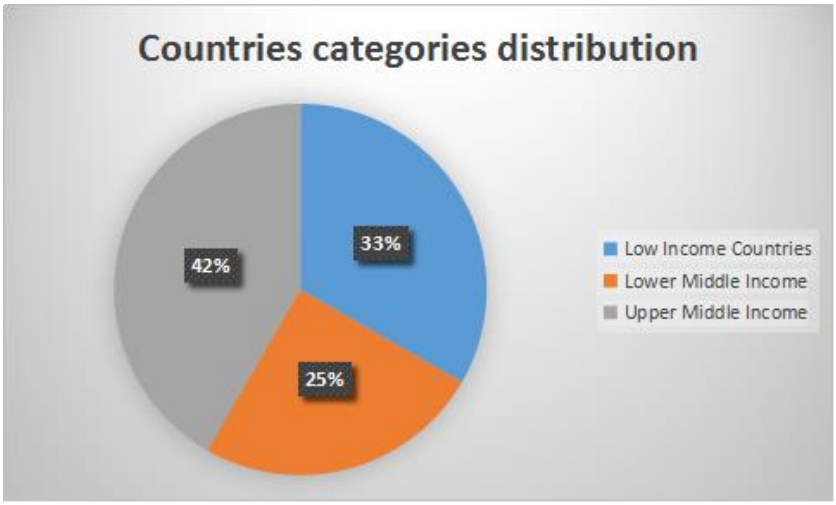
4. RESULTS

4. 1. Research distribution, environment and target group specification



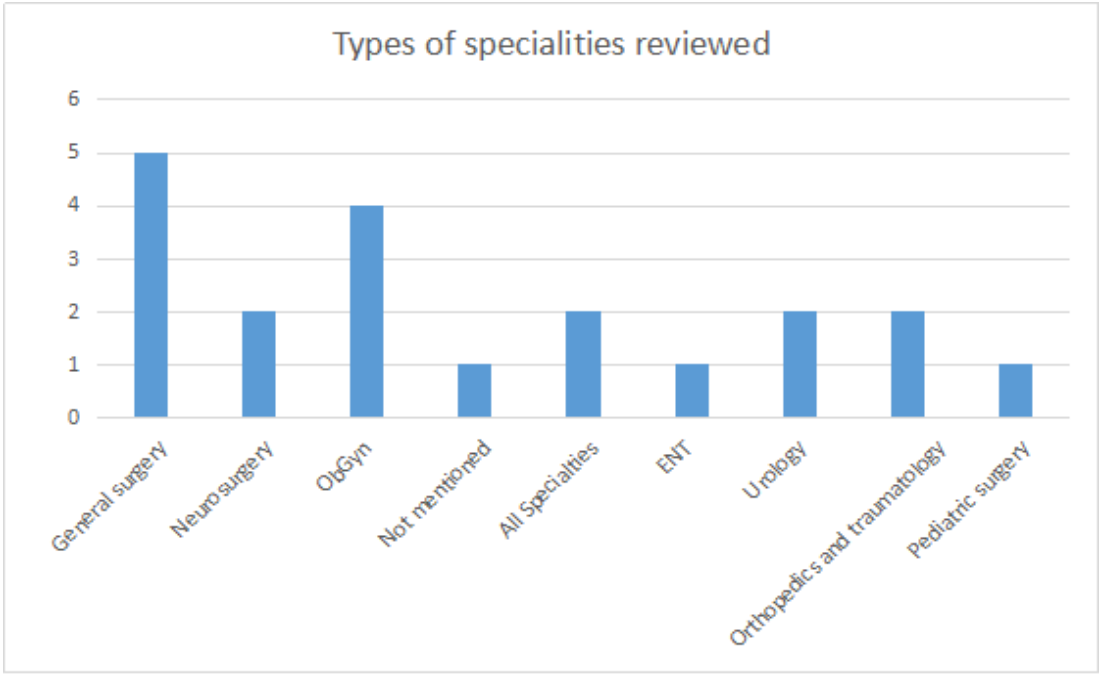
Graph 1. Geographical distribution in research. Prepared by authors.

Among 12 articles, the most of research studies were conducted in Sub-Saharan Africa (42%), South Asia (17%) and South America (17%).



Graph 2. Countries categories distribution in research. Prepared by authors.

Within countries category according to World Bank Classification, Low Income Countries accounted for 33%, Lower Middle Income for 25% and Upper Middle Income for 42% of countries of researched institutions.



Graph 3. Types of specialties reviewed. Prepared by authors.

Within reviewed articles papers focused mostly on situation in general surgery (5/12), and gynecology-obstetrics departments (4/12).

4. 2. Detailed results in particular countries

Table 2. Summary of the results of the reviewed research. Prepared by authors.

Authors	Country	Category	Target group	Amount of cases	Aim of the study	Results	Additional Comments
Melekie et al. 2015	Ethiopia	LIC	General and spinal surgery	282 surgeries	Measurement of overall and each step compliance and completeness	39.7% compliance 63.4 % completeness	Most important barriers: 45.1% lack of training 21.6% lack of team cooperation
Ellis R et al. 2017	Ethiopia	LIC	General surgery, gynecology and obstetrics	90 surgeries total, three phases of observation	Measurement of overall and each step compliance and completeness	94% compliance 60% completeness in general surgery 100% compliance 40% completeness in gynecology and obstetrics	
Close et al. 2015	Madagascar	LIC	All surgical disciplines	427 participants in 21 hospitals	Evaluation of educational training within self-reported teams feedback	- 77% claimed training improved teamwork in OR - 61% improved communication -72% improvement of hospital organization -60% improvement of infection control -56% safer anaesthesia	Subjective opinion of the staff
Lilaonitkul et al. 2015	Uganda	LIC	Obstetrics, general surgery, ENT, neurosurgery, urology, orthopedics	3341 surgeries within a year	Measurement of overall compliance, swab and instrument counts	85% overall compliance, 83% overal surgical count compliance	Challenges in implementation: Sociocultural norms, lack of resources and infrastructure, lack of official instruments list

Toor et al 2013	Pakistan	Lower MIC	General surgery	103 surgeries in 10 hospitals	Measurement of least performed items of SSC	88,5% no timeout concept 53,8% no information about allergies, 37,6% antibiotics not given	
Anwer et al. 2016	Pakistan	Lower MIC	General surgery	3638 elective surgeries of one hospital	Measurement of compliance and correlation between surgical site infection (SSI), mortality, near-misses (site error)	89,9% compliance, With reduction of SSI by 56,9%, No near-miss with site/side error as well as no difference in mortality rate	
Garland et al. 2017	Cambodia	Lower MIC	Orthopedic traumatology	695 surgeries of one hospital	Measurement of SSC compliance, performance of specific items of the checklist	100% completeness of anesthesia check, estimated blood loss, confirmation of equpiment and imaging - Antibiotics prophylaxis, instrument sterility and counting in sign out underperformed	
Khorshidifar et al. 2012	Iran	Upper MIC	Not mentioned	100 patients	Patient observation on SSC implementation	90% of cases anesthesia check, pulse oximeter check, allergic, airway, aspiration risk, patient/site/surgery check were performed	
McGinlay et al 2015	Romania	Upper MIC	Pediatric surgery	40 surgeries	Measurement of completeness, relation between healthcare resources and implementation	0% of completeness, 55% average number of completed items, completeness did not depend on number of staff, type of surgery (elective/emergency), surgeries per day	More training and better communication between team members as solutions for improvement

Freitas et al. (2014)	Brasil	Upper MIC	Urology and gynecology	375 surgeries	Measurement of performance and completeness of the SSC	61% of performance, 4% of completeness, Checklist performed more in gynecology	SSC associated with longer operating time
Santanta et al. (2016)	Brasil	Upper MIC	All specialties	Total 2193 surgeries (1141 pre-, 1052 post implement ation)	Measurement of performance of specific items of the checklist and mortality rates	Most completed items: patients identification, antibiotics, pulseoximeter. Least completed: allergy, airway obstruction, blood loss.	
Naidoo et al 2017	South Africa	Upper MIC	Obstetrics	Surgeries in 18 hospitals	Measurement of adverse incidents rate improvement	0.805 IRR in adverse events, 0.615 in postoperative Sepsis, 1.409 referral to higher levels of care, 0.719 unscheduled return to the operating theatre	

4. 2. 1. Low Income Countries

In Ethiopia, low income country with surgical mortality of 7%, uttermost efforts in ensuring patient safety resulted in implementation of Ethiopian Hospital Reform Implementation Guidelines in 2010, with WHO SSC being an essential part of the reform process. Observational study by Melekie et al. focused on implementation of checklist in 282 elective and emergency surgeries within 4 months observation - compliance and completeness (primary outcome) as well as challenges faced by the surgical teams in proper checklist utilization (secondary outcome). Research resulted in measurement of overall compliance of 39,7%, mainly procedures involving general anesthesia, held in department of surgery, surgeries of emergency status, performed during day shift. Completeness rate of the checklist monitored procedures was 63,4%. Sign in phase steps were missed in 30,5% - the least performed task was potential drug allergy assessment (38,4%).

The identity, site, procedure and consent were checked in 83% of checklist cases. Time out phase steps were not performed in 35,4% - with least performed task antibiotic prophylaxis 1h before incision (25%) and introduction of surgical teams by name and role (43,8%). Patient-site-procedure checkup was performed in this phase in 85,7% of surgeries. Sign out phase items were missed in 45,7%, with least performed concerns discussion on patients recovery (11,6%) and most often performed counting of materials (97,3%). Within secondary outcomes, one of the main concerns is the need for training, which should have preceeded the checklist implementation (45,1%).

Non-users of the checklist also underlined the lack of cooperation within surgical team while checklist is being implemented (21,6%). [11]

Next Ethiopian study by Ellis et al. measured the utilization of the SSC in general surgery and gynecology surgeries within three Phases implementation period - Phase I after introduction of the checklist and the review of its usage among surgical teams, Phase II - after a year with improving training of circulating nurses, anesthesia checks, multidisciplinary approach to checklist tasks and communication within surgical teams, Phase III - after month of second cycle of improvement and "audits" performed by senior surgeons during checklist implementations in the OR. General surgery utilized checklist in 50%, 97% and 94% in Phases I, II, III respectively. Full completion was achieved in 23%, 20% and 60% in Phases I, II, III. Between the Checklist phases, the most completed was the time out (87%) and least completed - sign in (53%), with least completed item of marking the site of surgery (60%). In Gynecology and Obstetrics, checklist was used from 50% to 100% in Phases I and II respectively. Full completion was achieved in 40% in Phase II, whereas no checklist was fully completed in Phase I. Significant differences between most and least completed phases comparing to General Surgery occured - in Gynecology, sign in was the most completed phase, and time out the least completed phase (50%). The least completed item were concerns of recovery (70%). [7]

In Uganda MRRH hospital where next research took place, the checklist was introduced in 2011 - training within 5 months period was conducted by visiting anesthetist, mainly in obstetrics department in order to improve maternal health. Among 3341 surgeries, the majority were obstetrics (71%) and emergency (82,5%) cases. Median of checklist compliance increased by 55,5% (29,5% pre- and 85% post-intervention), median of surgical counts compliance increased by 57,5% (25,5% pre- and 83% post-intervention). Positive correlation between usage of the checklist and surgical instruments and swab counts was found ($p<0.001$). Completeness of the checklist was 69,3% of all cases, with completeness of each phase 91,2% for sign in, 89,9% for time out and 87,5% for sign out procedures. Apart from that, several challenges were discovered, such as lack of staff, lack of equipment, such as eg. scissors, blade holders; lack of essential supplies (eg. water, blood, antibiotics). [12]

Madagascar study by Close et al. decided to focus on assessment of educational means in SSC implementation based on the self-reported teams feedback. 427 participants in 21 hospitals took part in a 3-day training course, followed up by the informal phone consultation 6 weeks and in-person follow-up 3-4 months after conduction of the course. Course consisted of introductory lecture and simulations of possible case scenarios, which participants had to solve in multidisciplinary groups (surgeons, anesthesiologists, operating nurses and OR assistants). Within 42,9% of the participants- respondents to the survey, 77% claimed training improved a lot teamwork in OR, 61% claimed the course improved a lot the communication between team members, 72% noticed significant improvement of hospital organization, 60% improvement of infection control and 56% of replies was related to significant improvement in safer anaesthesia [8]

4. 2. 2. Lower middle income countries

Within lower middle income countries, two research was held in Pakistan. First study by Toor et al. Focused on least performed items of the SSC. 103 surgeries in 10 hospitals were observed in Karachi with Knowledge-Attitude-Practice Survey observations. Among least performed tasks, 88,5% no timeout concept was observed, in 88,3% no team

introduction during time out was performed, 53,8% no information about allergies was obtained, in 37,6% antibiotics were not given. During sign out, recovery concerns were not discussed in 34% of cases. This study revealed ineffective implementation of the checklist in teaching hospitals of Karachi, which was awaiting for crucial changes. [13]

Next one-center study in Pakistan focused on accomplishments of implementation of SSC within 4 years period in 3638 surgeries in general surgery ward. The compliance increased by 69,5% (20,4% in first year and 89,9% in fourth year) with reduction of Surgical Site Infection by 56,9% (59% in first year, 2,12% in fourth year). Also in laparoscopic cholecystectomies, there was a reduction in SSI by 19,68% (20,8% in first, 1,12% in fourth year). There was no near-miss complication with wrong site or side, as well as no difference in mortality rate between the years. [14]

In Cambodia, over 695 surgeries of one orthopedic traumatology hospital were observed within two phases approach in 1,5 year period. First 304 cases confirmed high compliance and low compliance items. Items with highest completeness were in sign out: anesthesia check, estimated blood loss, in time out: confirmation of equpiment and imaging. However, in time out both antibiotics prophylaxis and instrument sterility, as well as counting of instruments in sign out phases, were underperformed. Among clean surgeries group, antibiotics were properly administered in 67,4%.

Within instrument and sponge counting, preoperative and postoperative completeness of counting varied significantly (83,9% to 21,5%). The argument for such differences was that counting was performed only in big incision surgeries with greater risk of mistake. In phase II, new items were asked from the observers of the surgeries, mainly on general sterility of the procedures (hand washing, gloves, drapes, gowns accessibility), as well as more detailed questions on antibiotics and gauze counting. Instrument sterility was improved from 0% to over 95% of cases, however no significant improvements in antibiotics administration and instruments counting was observed. Study focused on most fundamental issues in surgical safety care, which was overally well accepted and adjusted by the surgical teams in Cambodian settings. [15]

4. 2. 3. Upper middle income countries

Iranian study from 2012 took a different approach, asking about patients observations of the sign out procedures before anesthesia induction. According to authors, among 100 patients from 2 hospitals (median age 40+/- 15 years old), anesthesia check, pulse oximeter check, allergic, airway, aspiration risk, patient/site/surgery check were performed in 90% of cases. Moreover, total score of the SSC depended on the socioeconomic level ($p = 0.04$) and occupation of patients ($p = 0.026$), without any significant age or gender differences. The study proved that in patients evaluation, the compliance of SSC in Iranian hospitals was satisfactory in order to provide safe surgery. [16]

In Romania, pediatric surgery was observed in 40 cases in terms of completeness and correlation between healthcare resources and items completion. 62,5% of observed surgeries were elective and 37,5% emergency surgeries. None of the checklists were completed fully (0% completeness), with 55% of average items number under checkup. Most commonly checked items were pulseoximeter in sign in (100%), 97,5% availability of essential imaging in time out (97,5%), name of procedure in sign out (77,5%). In 40% of cases, patient/site/procedure was confirmed and in 87% of cases, preoperative antibiotic therapy was administered.

Completeness of the checklists did not depend on number of staff, type of surgery (elective/emergency), amount of surgeries per day. Most important challenges considered by the staff were lack of awareness and lack of time, and the remedy chosen by the staff in order to improve the awareness were formal training and presentations. Training, presentations as well as regular audits were pointed out as potential solutions for improvement of checklist compliance. [17]

South African example showed significant adverse events reduction in maternal health care in 18 hospitals. Study by Naidoo et al. confirmed successful implementation after training on maternal health modification of SSC - WHO SSC for maternity care (MSSCL) in obstetrics wards. Implementation of MSSCL resulted in 0.805 mean of incidents reduction rate (IRR) in occurrence of adverse events, 0.615 IRR in postoperative sepsis, 1.409 IRR in referral to higher levels of care, 0.719 IRR in unscheduled return to the operating theatre. Monitoring with MSSCL helped in significant reduction of mortality from cesarian delivery in perioperative period. [18]

Within Brazilian experiences of adverse events, it was noted that among three hospitals in Rio de Janeiro, the occuring adverse events in 7,6% of the cases could be prevented by 66,7%. [19] Two research regarding effectiveness of Surgical Safety Checklist was performed in Brazilian settings. First study from Freitas et al. implementation of SSC was observed in urology and gynecology settings. Among 375 surgeries, performance was rated by 61%, and completeness by 4%.

Between two specialties, gynecology ward performed SSC more often, however urological checklist were found to be more complete. SSC was associated with longer operating time. [20] In next study by Santana et al. in 2016 measured the completeness of performing each item of the checklist in among total 2193 surgeries (1141 pre-, 1052 post checklist implementation), as well as the mortality rates. Most completed items were: in sign in phase- pulse oximeter check up and patient identification, in time out - antibiotics prophylaxis and nursing team review of possible adverse events; in sign out - specimen labelling.

On the other hand, the least completed items in the following phases were: airway obstruction verification, essential imaging display, equipement problems, accordingly. The most omitted steps throughout the whole process where in sign in phase allergy, airway obstruction and estimated blood loss verification. No significant change in post-operative complications and mortality rates were observed. [21]

5. CONCLUSIONS

WHO Surgical Safety Checklist aims to ensure surgical safety for all by providing guidelines of all necessary check up items as well as improving communication within OR team. Surgical world, with over 300 million surgeries performed worldwide, awaits for high-quality implementation of safety measures on a worldwide scale. Frontline surgery providers want to ensure the safety of administered treatment at all costs, however absence of vital assets and human errors are still main reasons for adverse events in surgery. Despite a decade of SSC introduction, its implementation in low and middle income countries is insufficient and awaits proper training, monitoring and investment in required resources.

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