Original article

Variation in global uptake of the Surgical Safety Checklist

M. Delisle[1,6], J. C. Pradarelli[1,2], N. Panda[1,3], L. Koritsanszky[1,4], Y. Sonnay[1], S. Lipsitz[1], R. Pearse[7], E. M. Harrison[8], B. Biccard[9], T. G. Weiser[4,5,8] and A. B. Haynes[1,3], on behalf of the Surgical Outcomes Study Groups and GlobalSurg Collaborative*

[1]Safe Surgery Program, Ariadne Labs, Harvard T. H. Chan School of Public Health and Brigham and Women's Hospital, [2]Department of Surgery, Brigham and Women's Hospital, and [3]Department of Surgery, Massachusetts General Hospital, Boston, Massachusetts, [4]Lifebox, Brooklyn, New York, [5]Department of Surgery, Stanford University Medical Center, Stanford, California, USA, [6]Department of Surgery, University of Manitoba, Winnipeg, Manitoba, Canada, [7]William Harvey Research Institute, Queen Mary University of London and Barts Health NHS Trust, London, and [8]Department of Clinical Surgery, Royal Infirmary of Edinburgh, University of Edinburgh, UK, and [9]Department of Anaesthesia and Perioperative Medicine, University of Cape Town and Groote Schuur Hospital, Cape Town, South Africa

Correspondence to: Dr A. B. Haynes, Dell Medical School, University of Texas at Austin, 1601 Trinity Street, Building B, Stop Z0800, Austin, Texas 78712, USA (e-mail: alex.haynes@austin.utexas.edu)

Background: **The Surgical Safety Checklist (SSC) is a patient safety tool shown to reduce mortality and to improve teamwork and adherence with perioperative safety practices. The results of the original pilot work were published 10 years ago. This study aimed to determine the contemporary prevalence and predictors of SSC use globally.**

Methods: **Pooled data from the GlobalSurg and Surgical Outcomes studies were analysed to describe SSC use in 2014–2016. The primary exposure was the Human Development Index (HDI) of the reporting country, and the primary outcome was reported SSC use. A generalized estimating equation, clustering by facility, was used to determine differences in SSC use by patient, facility and national characteristics.**

Results: **A total of 85 957 patients from 1464 facilities in 94 countries were included. On average, facilities used the SSC in 75·4 per cent of operations. Compared with very high HDI, SSC use was less in low HDI countries (odds ratio (OR) 0·08, 95 per cent c.i. 0·05 to 0·12). The SSC was used less in urgent compared with elective operations in low HDI countries (OR 0·68, 0·53 to 0·86), but used equally for urgent and elective operations in very high HDI countries (OR 0·96, 0·87 to 1·06). SSC use was lower for obstetrics and gynaecology *versus* abdominal surgery (OR 0·91, 0·85 to 0·98) and where the common or official language was not one of the WHO official languages (OR 0·30, 0·23 to 0·39).**

Conclusion: **Worldwide, SSC use is generally high, but significant variability exists. Implementation and dissemination strategies must be developed to address this variability.**

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*Members of the Surgical Outcomes Study Groups and GlobalSurg Collaborative are listed in *Appendices S1–S4* (supporting information).

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Introduction

Addressing preventable harm from surgery is a less recognized global public health challenge, impacting the lives of millions of patients and their families. Recent estimates describe a total global volume of 4·2 million postoperative deaths per year, many of which might be averted with improved systems of care[1,2]. Discrepancies in adherence to perioperative best practices, rooted in insufficient communication between caregivers and patients, as well as resource limitations, are an important cause of preventable postoperative adverse events. The Surgical Safety Checklist (SSC) is a patient safety tool available from the WHO in its six official languages[3]. Appropriate SSC use improves adherence to perioperative safety practices, enhances teamwork and communication, and improves safety culture[4]. In the original trial in 2009, the SSC decreased postoperative morbidity and mortality by up to 50 per cent[5]. Given the inherent risks of surgery, there is urgent need to improve uptake and use of tools, such as the SSC, to reduce avoidable morbidity and mortality[2].

Although the checklist is intended to be an easy-to-use and low-cost surgical patient safety tool, challenges in successful implementation exist across patient populations and resource contexts[6]. Studies to date have focused on the association between SSC use and postoperative outcomes[7–9]. Few have attempted to characterize systematically the global variation in SSC use. It is important that variations in SSC use are identified and addressed in order to improve implementation and dissemination strategies for the SSC, and thereby improve patient access to safe surgical care[7–9]. The purpose of this investigation was to provide contemporary and globally representative estimates of SSC use and to identify independent predictors of SSC uptake.

Methods

Pooled data from five large international, multicentre, prospective epidemiological studies were analysed to describe reported SSC use in 2014–2016. The results of this analysis are reported according to the STROBE guidelines[10].

Sources of data

Data were included from GlobalSurg 1[11], GlobalSurg 2[12], the African Surgical Outcomes Study (ASOS)[13], the South African Surgical Outcomes Study (SASOS)[14] and the International Surgical Outcomes Study (ISOS)[15]. Data from the European Surgical Outcomes Study (EuSOS) were excluded as they were collected in 2011 and, therefore, not representative of contemporary SSC use[16]. Only existing data from these sources were considered for inclusion, and no facilities were actively recruited to participate in this analysis.

All five studies were conducted using study procedures described and published previously[11–15]. In summary, facilities from countries within each study's geographical scope were recruited to participate using convenience sampling. Participating facilities completed data collection on all consecutive eligible patients over a 1- or 2-week period between 2014 and 2016. Notably, despite these data being collected at multiple different times for different prospective studies and by different groups, many of the variables collected were defined similarly with respect to demographics, procedures, outcomes and reported checklist use, making their aggregation for this work possible.

This study was considered non-human subjects research based on institutional policy regarding deidentified secondary analysis.

Participants

Patients of any age were eligible for inclusion in GlobalSurg 1 and 2. GlobalSurg 1 included only patients undergoing emergency intraperitoneal operations. GlobalSurg 2 included gastrointestinal operations classified as clean/contaminated, contaminated, or dirty. ASOS and ISOS included patients over the age of 18 years and SASOS included patients over 16 years of age. ASOS, ISOS and SASOS included any type of elective inpatient surgical operation. All patients with missing data for SSC use were excluded, as were facilities where data were collected for only one patient. Excluded patients accounted for less than 1 per cent of the total sample population.

Variables

The primary exposure was the Human Development Index (HDI). The HDI is a country-level summary measure, ranging from 0 to 1, used to assess the development of a country[17]. It is composed of three dimensions: health, education and standard of living. Zero represents less developed countries and one represents more developed countries. The HDI was divided using the cut-off points reported by the United Nations (UN) Human Development Report[18]. These are fixed cut-off points that were introduced by the UN in 2014, and are obtained by calculating the quartiles of the distributions of the component dimensions that make up HDI. Each year, the UN Development Programme publishes its Human Development Report in which these cut-off points are used to make comparisons on several development indices. To be consistent with the broader literature and for ease of interpretability, HDI was treated as a categorical variable using these same cut-off points. The very high HDI category included countries with an HDI between 0·800 and 1·000; the high HDI category included countries with an HDI between 0·700 and 0·799; the medium HDI category included countries with an HDI between 0·555 and 0·699; and the low HDI category included countries with an HDI of 0·554 or less[18].

The primary outcome was reported use of the SSC during an operation, which was recorded as a binary yes or no variable in all five studies.

Potential confounders included urgency of surgery, complexity of surgery, specialty, and whether the country's common or official language was one of the six official languages of the WHO (Arabic, Chinese, English, French, Russian and Spanish). Urgency of surgery was defined as either emergency/urgent or elective. Complexity of surgery was defined using the National Institute for Health and Care Excellence (NICE) criteria[19]. Minor surgery was defined as operations such as removal of a skin lesion or drainage of a breast abscess; intermediate surgery included operations such as repair of an inguinal hernia, knee arthroscopy, removal of varicose veins or removal of tonsils; major or complex surgery included operations such as laparotomy, thoracotomy and cardiac surgery. Specialty categories included orthopaedics, breast/plastics/cutaneous, obstetrics and gynaecology, vascular, abdominal (upper/lower gastrointestinal, hepatopancreatobiliary and general surgery), cardiothoracic, head and neck, urology and kidney, and other. Information on each country's official or common language was obtained from the US Central Intelligence Agency's World Factbook[20] and cross-verified using Ethnologue[21].

Statistical analysis

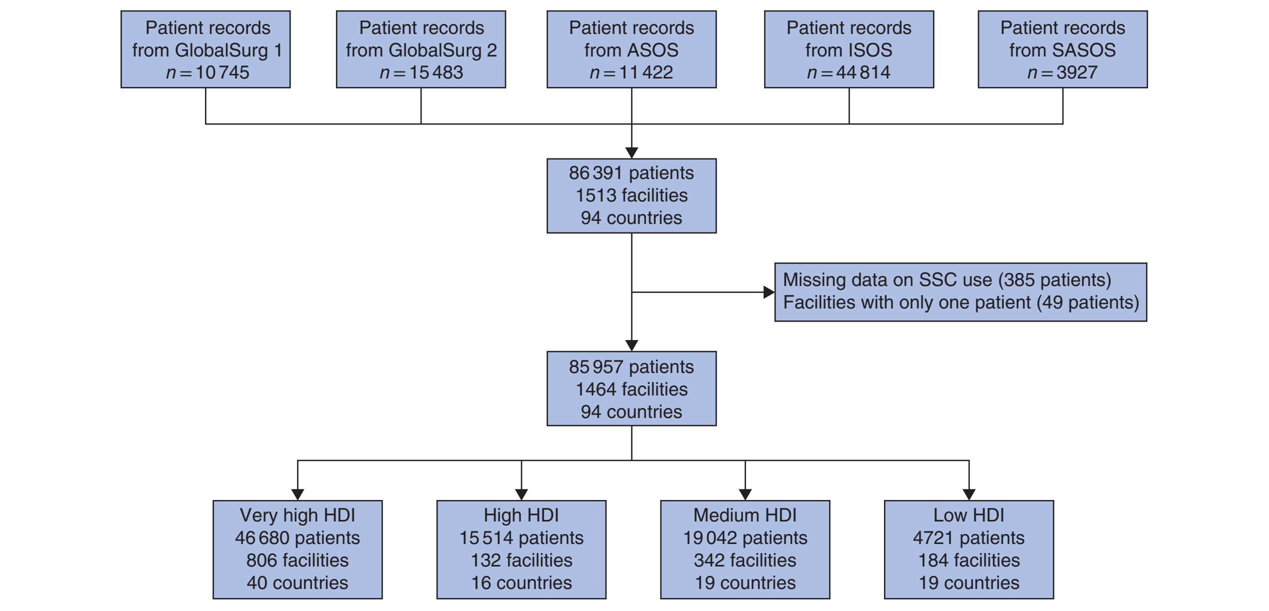
Differences between the HDI categories were tested with Pearson's χ^2 test and the Kruskal–Wallis test for categorical and continuous variables respectively. The intraclass correlation coefficient (ICC) was calculated to assess within-facility variability in SSC use and the Spearman correlation coefficient (ρ) was determined to assess variability between facilities across HDIs. A generalized estimating equation, clustering by facility, was used to determine differences in SSC use by patient, facility and national characteristics. The model did not converge when clustering by country, regardless of whether clustering by facility was accounted for or not.

Previous studies have demonstrated significant differences in SSC use in emergency/urgent *versus* elective operations, and these differences were found to vary by HDI[9]. For these reasons, effect modification by urgency of surgery was tested by including an interaction term in the general estimating equation, and there was evidence of significant effect modification. Therefore, the odds of SSC use in emergency/urgent *versus* elective operations are reported stratified by HDI category and the odds of SSC use across HDI categories are reported stratified by urgency of surgery. Coefficients are expressed as odds ratios (ORs) with 95 per cent confidence intervals and *P* values. All data analyses were conducted using Stata® statistical software release 15 (StataCorp, College Station, Texas, USA) and SAS® software version 9.4 (SAS Institute, Cary, North Carolina, USA).

Results

A total of 85 957 patients from 1464 facilities in 94 countries were included (*Fig. 1*). The majority of patients were from very high (54·3 per cent) and high (18·0 per cent) HDI countries, compared with medium (22·2 per cent) and low (5·5 per cent) HDI countries. This distribution was different from that in the total world population, and more closely resembled the estimated surgical volume performed

Fig. 1 Flow chart of numbers of patients, facilities and countries included in the study



ASOS, African Surgical Outcomes Study; ISOS, International Surgical Outcomes Study; SASOS, South African Surgical Outcomes Study; SSC, Surgical Safety Checklist; HDI, Human Development Index.

Table 1 Patient and operative characteristics by Human Development Index category

	Very high HDI	High HDI	Medium HDI	Low HDI	*P**
Total world population 2015 (million)[18]	1426·2 (19·5)	2348·3 (32·1)	2659·5 (36·4)	878·3 (12·0)	
Total estimated surgical volume 2015 (million)[22]	137·9 (48·9)	108·9 (38·6)	29·2 (10·4)	6·0 (2·1)	
Total included patients	46 680 (54·3)	15 514 (18·0)	19 042 (22·2)	4721 (5·5)	
Age (years)					< 0·001
< 45	14 526 (31·1)	6182 (39·8)	12 836 (67·4)	3610 (76·5)	
45–64	15 552 (33·3)	6326 (40·8)	4342 (22·8)	762 (16·1)	
> 64	16 602 (35·6)	3006 (19·4)	1864 (9·8)	349 (7·4)	
Sex					< 0·001
M	21 732 (46·6)	6732 (43·4)	8535 (44·8)	1641 (34·8)	
F	24 473 (52·4)	8695 (56·0)	10 252 (53·8)	3069 (65·0)	
Unknown	475 (1·0)	87 (0·6)	255 (1·3)	11 (0·2)	
ASA grade					< 0·001
1	12 411 (26·6)	5535 (35·7)	9579 (50·3)	2613 (55·3)	
2–3	32 137 (68·8)	9769 (63·0)	8445 (44·3)	1907 (40·4)	
4–5	1736 (3·7)	166 (1·1)	649 (3·4)	104 (2·2)	
Unknown	396 (0·8)	44 (0·3)	369 (1·9)	97 (2·1)	
WHO official language is primary or common language					< 0·001
No	13 277 (28·4)	3191 (20·6)	2918 (15·3)	743 (15·7)	
Yes	33 403 (71·6)	12 323 (79·4)	16 124 (84·7)	3978 (84·3)	
Complexity of surgery					< 0·001
Minor	5245 (11·2)	3225 (20·8)	3324 (17·5)	465 (9·8)	
Moderate	14 338 (30·7)	5954 (38·4)	5450 (28·6)	1560 (33·0)	
Complex	27 082 (58·0)	6335 (40·8)	10 214 (53·6)	2674 (56·6)	
Unknown	15 (< 0·1)	0 (0·0)	54 (0·3)	22 (0·5)	
Urgency of surgery					< 0·001
Elective	36 040 (77·2)	13 369 (86·2)	7721 (40·5)	2022 (42·8)	
Urgent/emergency	10 639 (22·8)	2140 (13·8)	11 311 (59·4)	2680 (56·8)	
Unknown	1 (< 0·1)	5 (< 0·1)	10 (0·1)	19 (0·4)	
Specialty					< 0·001
Orthopaedics	7316 (15·7)	2161 (13·9)	2460 (12·9)	373 (7·9)	
Breast/plastics/cutaneous	2385 (5·1)	766 (4·9)	999 (5·2)	248 (5·3)	
Obstetrics and gynaecology	4100 (8·8)	2086 (13·4)	3345 (17·6)	2068 (43·8)	
Vascular	1383 (3·0)	291 (1·9)	349 (1·8)	18 (0·4)	
Abdominal	19 680 (42·2)	4573 (29·5)	9013 (47·3)	1323 (28·0)	
Cardiothoracic	2263 (4·8)	684 (4·4)	614 (3·2)	117 (2·5)	
Head and neck	4078 (8·7)	2329 (15·0)	567 (3·0)	200 (4·2)	
Urology and kidney	3523 (7·5)	1285 (8·3)	641 (3·4)	266 (5·6)	
Other	1952 (4·2)	1339 (8·6)	1054 (5·5)	108 (2·3)	

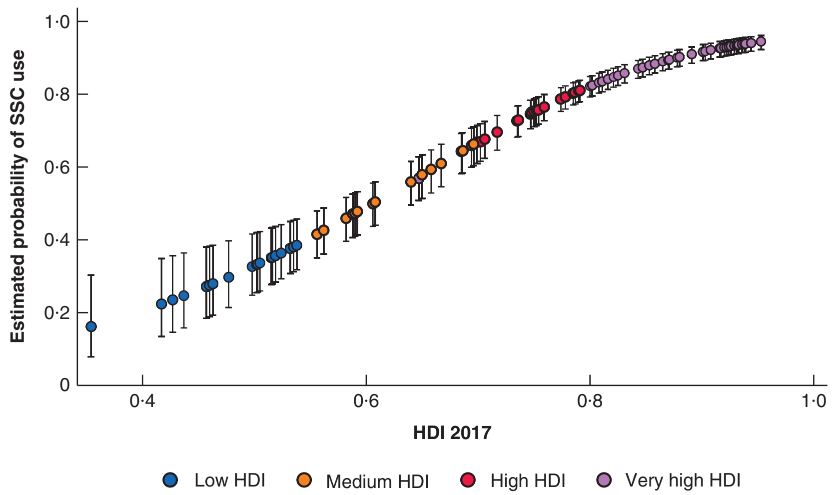
Values in parentheses are percentages. HDI, Human Development Index. *χ^2 test.

in each of these HDI categories (*Table 1*)[18,22]. Patients, facilities and countries were distributed across HDI categories (*Fig. 1*).

Patient and operative characteristics

There were significant variations in patient and operative characteristics across the HDI categories (*Table 1*). A larger proportion of patients from higher HDI countries were older, male and had a higher ASA score. Operations performed in the higher HDI countries were more likely to be of minor or moderate complexity and performed in the elective setting. The case mix varied by HDI category, with obstetrics and gynaecology accounting for almost 50 per cent of operations performed in low HDI countries, compared with only 9–13 per cent in high HDI countries. There was a larger proportion of higher HDI countries among those where the WHO SSC was not available in the country's official or common language (*Table 1*).

Fig. 2 Estimated use of the Surgical Safety Checklist in facilities in low, medium, high and very high Human Development Index countries



SSC, Surgical Safety Checklist; HDI, Human Development Index.

Table 2 Unadjusted rates and adjusted odds of Surgical Safety Checklist use by Human Development Index category stratified by urgency of surgery

	Unadjusted mean checklist use (%)	Odds ratio	*P*
Elective surgery			
Very high HDI	88·5 (88·2, 88·9)	1·00 (reference)	
High HDI	91·2 (90·7, 91·7)	0·64 (0·42, 0·98)	0·043
Medium HDI	64·6 (63·5, 65·6)	0·24 (0·17, 0·33	< 0·001
Low HDI	35·9 (33·8, 38·0)	0·08 (0·05, 0·12)	< 0·001
Emergency/urgent surgery			
Very high HDI	89·7 (89·1, 90·2)	1·00 (reference)	
High HDI	66·4 (64·3, 68·3)	0·64 (0·42, 0·99)	0·039
Medium HDI	57·4 (56·5, 58·4)	0·21 (0·15, 0·30)	< 0·001
Low HDI	25·3 (23·7, 26·9)	0·05 (0·04, 0·09)	< 0·001

Values in parentheses are 95 per cent confidence intervals. HDI, Human Development Index.

Between-facility variation in Surgical Safety Checklist use

Overall, the SSC was used in 67 967 patients (79·1 per cent). It was used more frequently in facilities from very high and high HDI countries (mean 88·8 (95 per cent c.i. 99·5 to 89·1) and 87·8 (88·5 to 90·1) per cent respectively) than in facilities in medium and low HDI countries (mean 60·4 (59·7 to 61·0) and 29·8 (28·5 to 31·1) per cent respectively) (*Fig. 2*).

Compared with higher HDI countries, SSC use decreased down HDI categories for both emergency/urgent and elective operations (*Table 2*). Facilities in countries where the common or official languages were not one of the WHO official languages had lower odds of SSC use (OR 0·30, 95 per cent c.i. 0·23 to 0·39; $P < 0·001$) (*Table 3*).

Within-facility variation in Surgical Safety Checklist use

Facilities used the SSC with moderate consistency (mean(s.d.) 75·4(21·1) per cent of operations; within-facility variability ICC = 0·62). The SSC was less likely to be used in urgent/emergency *versus* elective operations in low (OR 0·68, 95 per cent c.i. 0·53 to 0·86; $P = 0·002$) and medium (OR 0·85, 0·77 to 0·94; $P = 0·002$) HDI countries, but there was no difference in use in

Table 3 Unadjusted rates and adjusted odds of Surgical Safety Checklist use

	Unadjusted mean checklist use (%)	Odds ratio	*P*
Specialty			
Abdominal	74·8 (74·4, 75·3)	1·00 (reference)	
Orthopaedics	85·2 (84·6, 85·8)	0·97 (0·90, 1·05)	0·409
Breast/plastics/cutaneous	80·1 (78·9, 81·3)	0·98 (0·90, 1·06)	0·536
Obstetrics and gynaecology	71·8 (71·0, 72·6)	0·91 (0·85, 0·98)	0·009
Vascular	85·6 (84·0, 87·1)	0·95 (0·87, 1·05)	0·322
Cardiothoracic	85·1 (83·9, 86·2)	0·89 (0·80, 1·01)	0·062
Head and neck	88·6 (87·9, 89·3)	0·97 (0·89, 1·06)	0·489
Urology and kidney	84·1 (83·1, 85·0)	0·95 (0·88, 1·03)	0·195
Other	83·2 (82·1, 84·3)	0·93 (0·85, 1·02)	0·111
Complexity of surgery			
Major or complex	77·4 (77·0, 77·8)	1·00 (reference)	
Minor	79·3 (78·6, 80·0)	0·84 (0·78, 0·91)	< 0·001
Moderate	81·8 (81·3, 82·2)	0·90 (0·85, 0·96)	< 0·001
WHO official language is primary or common language			
Yes	81·7 (71·4, 72·6)	1·00 (reference)	
No	72·0 (71·4, 72·6)	0·30 (0·23, 0·39)	< 0·001
Database			
ASOS	56·7 (55·8, 57·6)	1·00 (reference)	
ISOS	89·9 (89·6, 90·1)	1·89 (1·19, 2·95)	0·006
SASOS	64·0 (62·5, 65·5)	1·38 (0·76, 2·50)	0·289
GlobalSurg 1	74·4 (73·6, 75·2)	1·56 (1·00, 2·44)	0·048
GlobalSurg 2	71·0 (70·3, 71·8)	1·39 (0·91, 2·13)	0·127

Values in parentheses are 95 per cent confidence intervals. ASOS, African Surgical Outcomes Study; ISOS, International Surgical Outcomes Study; SASOS, South African Surgical Outcomes Study.

high (OR 0·97, 0·88 to 1·07; $P = 0·061$) and very high (OR 0·96, 0·87 to 1·06; $P = 0·412$) HDI countries. It was used less often in patients undergoing obstetric and gynaecological *versus* abdominal surgery (OR 0·91, 0·85 to 0·98; $P = 0·009$) and minor and moderate *versus* major operations (OR 0·84, 0·78 to 0·91, $P < 0·001$; and OR 0·90, 0·85 to 0·96, $P < 0·001$, respectively) (*Table 3*).

Discussion

In this pooled analysis of 85 957 patients from 1464 facilities in 94 countries from five international studies, reported use of the SSC was generally found to be high. Significant variability exists, however, across different resource settings and patient populations, even within similarly resourced countries and settings. Most facilities are reportedly using the SSC, but with only moderate consistency. On average, the SSC was used less frequently in countries with lower HDIs and where the common or official languages were not one of the six WHO official languages. Major gaps exist in SSC use for patients undergoing less complex or more urgent surgery, and obstetric and gynaecological operations. Although the SSC has spread worldwide in a relatively short period of time, these results highlight important gaps in the uptake of the SSC globally that can be used to direct future research, implementation and advocacy efforts.

A significant aspect of the present results was the variability in reported SSC use across facilities. The SSC is reported as being used in only about one-third of patients from low HDI countries, compared with almost 90 per cent of patients in high and very high HDI countries. This suggests that the SSC is known and available in lower HDI countries, but is not being used or implemented consistently. It is possible the SSC is viewed as irrelevant when the resources required to complete all of its elements successfully are not available. The WHO SSC was developed with the goal of being a universal surgical patient safety tool. The original pilot trial demonstrated that the SSC can be implemented successfully and lead to clinical benefits across a variety of resource settings[5,23]. However, in real-world contexts, limited infrastructure, equipment and trained personnel can create unique implementation challenges[6].

Not only did variability in SSC use exist between facilities, but the SSC was also reported to be used with large variability within facilities. On average, facilities used the SSC in only about three-quarters of operations. A possible explanation for this inconsistency may be related to provider acceptance of the SSC. Previous qualitative research has found providers have polarized views about the relevance of checklists: 'These tools tend to be liked and embraced or disliked and avoided'[24]. Common complaints include concepts that checklists are 'poorly worded, time-consuming, inappropriate or redundant and another top-down initiative'[25]. These negative attitudes may arise in any member of the perioperative team due to inadequate introduction and training, duplication with other safety checks and/or poor integration with existing workflows[24].

Successful and sustained uptake of the SSC can be achieved if implementation strategies are tailored to each local context and based on principles from previously successful initiatives seeking to introduce team-based safety tools into complex clinical environments, particularly those emphasizing multidisciplinary engagement, team alignment and a culture of patient safety. For example, when a province-wide mandate was given to implement the SSC in operating rooms in Ontario, Canada, there was no significant effect on patient outcomes[26]. However, when a state-level quality improvement initiative was undertaken to foster collaborative implementation of the SSC in South Carolina, a significant 22 per cent relative reduction in the 30-day postoperative mortality rate was observed in hospitals that completed the implementation programme, compared to those that did not complete the programme[27]. Similarly, when the SSC was implemented as part of a large-scale quality improvement initiative in Scotland, there was a significant 36 per cent relative reduction in postoperative mortality[28]. Together, this growing body of evidence suggests the SSC is not a 'quick fix' and cannot be implemented in a vacuum. Rather, adoption of the SSC must represent a system-wide culture and practice change that commits to making patient safety a priority.

Some of the reported variability in SSC use between and within facilities may be due to the gaps in SSC use across patient and provider characteristics. For example, the SSC was less likely to be used in urgent compared with elective operations in low and medium HDI countries. Although the SSC has been shown to decrease postoperative morbidity and mortality across diverse patient populations[5,7], previous studies have noted hesitancy among providers over use of the SSC in urgent or emergency situations[29]. This may be due to perceived concerns over causing delays in lifesaving operations that may consequently increase the risk of negative postoperative outcomes[30,31]. However, previous work[9,30,31] has demonstrated that implementation of SSCs in patients undergoing urgent non-cardiac surgery was associated with a greater than one-third reduction in complications, suggesting that use of SSCs in this setting is feasible and beneficial.

Interestingly, there was no significant difference in the use of the SSC in urgent/emergency *versus* elective operations in high and very high HDI countries in the present study. This may be due to disparities in the rate of knowledge translation, with higher HDI countries already accepting the benefits of the SSC use in urgent/emergency cases. It is important to note that these findings contrast with those of a recent pooled analysis of GlobalSurg 1 and 2 data[9], where the authors found the SSC was more likely to be used for elective operations in low HDI countries and more likely to be used for emergency operations in high HDI countries. The GlobalSurg pooled analysis included only laparotomies, whereas a variety of operations were included in the present study. Thus, one reason for the difference in findings between the present results and those of the pooled analysis of GlobalSurg 1 and 2 data may be related to the variations in practice patterns that exist across specialties and types of operation.

The WHO SSC was designed to be adaptable to meet the needs of specific procedures, but significant differences were found in reported use across specialties, with particularly low use in obstetric and gynaecological procedures. This may be related to two factors: first, the clinical needs and concerns addressed in the WHO SSC may not be seen as germane to obstetric and gynaecological procedures; and second, obstetrics and gynaecology as a specialty has, over time, worked in parallel with other surgical specialties, with a loss of professional overlap and cross-pollination[32–34]. Modifying the SSC to meet the needs of the local context and procedure is recommended. There exists limited formal guidance, however, for local champions to modify the SSC effectively[35]. Solsky and colleagues[35] reviewed 155 different SSCs to understand how modifications were being made, and found concerning patterns. Conversational prompts meant to improve team communication were often removed, and alterations in the layout of SSCs frequently made them less intuitive[35]. Thus, although SSC modification is encouraged, without appropriate guidance this may lead to a less effective intervention and increase the risk of provider non-compliance and resistance to implementation. Since 2015, detailed principles for customizing the SSC based on lessons learned from over 4000 facilities globally have been available in an open-source manual from Ariadne Labs, a health system innovation lab affiliated to Brigham and Women's Hospital and Harvard T. H. Chan School of Public Health[36].

Partnerships that emphasize training, knowledge-sharing and local capacity-building have proven to be a sustainable way to help overcome some of the barriers to SSC uptake[6,37,38]. The fact that these types of partnership are rare rather than routine highlights the need for a global platform that facilitates new connections, ongoing discussion, practical problem-solving and resource-sharing. For example, countries where the common or official languages were not one of the WHO official languages had a significantly lower odds of the SSC being used. It is likely that the SSC has been translated into other languages, but without a centralized area for exchange of knowledge, access to these resources remains a challenge. Establishing a global community of practice will help fuel learning and connectivity to support local champions in improving surgical safety, and will allow for the continued spread of the SSC[39].

Although this study represents the largest sample of patients, facilities and countries in which SSC use has been described in real-world settings, there are limitations with regard to generalizing these findings. First, patients from very high HDI countries were overrepresented, whereas those from high, medium and low HDI countries were underrepresented compared with the world population; this may limit the representativeness of the latter samples. Nonetheless, this reflects the distribution of the global volume of surgery, and variation in the reported use of the SSC was still observed. Another potential reason why the study sample may have limited generalizability is because data were collected from a random sample of patients over a relatively short period of time. All five studies included sites that self-selected to participate in data collection. This methodology is subject to selection bias at the facility level, as collaborators may hail from better resourced institutions compared with others within the country or region. Patient-level selection bias was minimized by requiring consecutive patients be enrolled during the data collection period. However, operating room teams may have modified their behaviours because they knew they were being observed (Hawthorne effect). All studies collected data on self-reporting of SSC use as a binary yes or no without any review to verify the accuracy of reporting or confirmation of compliance with checklist items; previous studies have found significant discordance between reported checklist completion and actual completion[40], and poor compliance with all items can reduce the benefits of SSCs[41]. Despite these limitations, this study provides the most contemporary evidence on SSC use globally, which is needed to inform the future of SSCs and improve patient safety in surgery.

Since its introduction 10 years ago, the WHO SSC has spread across the globe, and its use is generally high in high HDI environments, yet significant variability exists across different resource settings and patient populations. This study does not provide causal explanations for the observed gaps in SSC use. The body of evidence accumulated since the introduction of the SSC suggests that these variations may be reduced through the establishment of a global community of practice to improve partnership formation and sharing of knowledge. The global burden of preventable postoperative morbidity and mortality is still poorly characterized, although a recent study[1,2] indicated that death rates are higher than previously estimated. Improving access to safe, affordable and timely surgical care is a public health priority[42]. As the global surgery community works towards increasing access to safe surgical care, it will be more critical to support the continued and sustained spread of the SSC effectively. Implementation and dissemination strategies should be developed to address the variability in SSC use observed in this study, with particular emphasis on improving use within low HDI countries, in emergency operations, in surgical obstetric and gynaecological care, and in countries whose official or common language is not one of the six WHO languages.

Collaborators

Members of ASOS, ISOS, SASOS, and GlobalSurg 1 and 2 can be found in *Appendices S1–S4* (supporting information).

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Supporting information

Additional supporting information can be found online in the Supporting Information section at the end of the article.