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Leveraging Syndromic Surveillance of Surgical Site Infections to Improve Infection Prevention and Control in Tanzania: A Quasi Experimental Study

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Abstract *Surveillance of surgical site infection (SSI) is key for improving Infection Prevention and Control (IPC). In Tanzania, it is unclear how primary health facilities (PHFs) that perform syndromic surveillance of SSI differ from those that do not. This quasi-experimental study, conducted from September to November 2024, evaluated how PHFs implementing syndromic surveillance differ in IPC adherence from those that do not. The quantitative sample included 905 surgical patients from surveillance conducting PHFs and 600 from non-conducting facilities. Results demonstrated that facilities practicing syndromic surveillance achieved significantly higher IPC adherence scores, with a mean of 400.1 (SD 138.9) compared to 263.1 (SD 99.88) in the control group. This marked difference of 137 points proved statistically significant (SE 54.12; CI 23.29–250.71; unpaired t = 2.5313; P < 0.0209). For the qualitative, researchers interviewed 49 Quality Improvement Team (QIT) members to triangulate the quantitative data. These sessions were transcribed verbatim on the same day and analyzed using NVivo version 20.2, utilizing a hybrid deductive and inductive coding approach. Reported via consolidated criteria for reporting qualitative research, the analysis generated four core themes. Participants reported that syndromic surveillance is a highly valuable tool for identifying operational gaps, understanding the true infection burden, and actively strengthening facility wide IPC measures. Ultimately, these findings provide suggestive evidence that syndromic surveillance directly aids in reducing surgical site infections. Because establishing surveillance systems improves care quality, the authors recommend that all healthcare facilities should monitor for healthcare-associated infections, including SSIs, to protect patient safety.*

Keywords *Healthcare Associated Infections, Infection Prevention and Control, Surgical Site Infection, Syndromic Surveillance.*

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Introduction

Surgical Site Infections (SSIs) account for about 20% of all healthcare-associated infections (HAIs) globally. While the average infection rate in high-income countries hovers around 1% to 3%, rates in low- and middle-income countries (LMICs) frequently exceed 10%. The global status of SSIs is characterized by this stark geographic divide and the growing challenge of antimicrobial resistance. The overall pooled global incidence rate for SSIs is approximately 2.5% [1, 2]. In settings like the US and the European Union, SSI incidence sits at 1% to 5%, though these infections still contribute to hundreds of thousands of extra hospital days and massive healthcare costs. In many parts of the world, up to 10% to 25% of patients who undergo surgery acquire an SSI. According to World Health Organization (WHO) data, the African Region historically reports the highest incidence, often exceeding 7.2% in pooled analyses, and up to 20% for specific procedures like caesarean sections [3, 4].

Inadequate access to sterile instruments, operating room ventilation systems, and safe water supplies are some of the issues surrounding the high magnitude of SSIs in low- and mid-income countries including Tanzania. The spread of resistant bacteria significantly complicates treatment, increases morbidity, and prolongs recovery. Many regions lack the robust surveillance required to accurately track and manage wound complications. Tanzania has established Syndromic Surveillance to track Surgical Site Infections from the patients who have undergone surgical intervention. Syndromic surveillance describes techniques that depend on identifying observable markers of community and individual health before formal diagnoses by diagnostic tests are established [5]. Specifically, individuals who are ill may show behavioral patterns, symptoms, indicators, or laboratory findings that can be monitored using a range of data sources, even before an infectious disease is confirmed in the laboratory [6]. Systems for syndromic surveillance are being developed at the local, regional, and national levels.

The primary focus of syndromic surveillance is to aid in the early identification of a disease, research, clinical care, general public health, quality improvement, and patient safety [7]. Syndromic surveillance is a useful early warning system for epidemic diseases. Such experience suggests that syndromic surveillance systems are not only feasible but also essential for the early identification of HAIs including SSI with potential health consequences. [8]. By tracking SSI rates and identifying specific areas where they are occurring, syndromic surveillance provides concrete data that can be used to improve IPC practices. This data can be used to identify areas where HCWs may be struggling with compliance and to tailor training and support accordingly. The process of implementing and monitoring syndromic surveillance itself can raise awareness among HCWs about the importance of IPC measures and the potential consequences of non-compliance. This heightened awareness can translate into better adherence to recommended practices.

When healthcare facilities track SSI rates and share this information, it can create a sense of accountability among HCWs. Knowing that their actions are being monitored can motivate them to take infection prevention seriously and comply with IPC guidelines. Tanzania is using syndromic surveillance to document and report Surgical site Infections (SSIs) as one type of HAIs. There are three SSI indicators which are being followed in Tanzanian syndromic surveillance namely, SSIs from cesarian section and SSI other than from cesarian section both operated in the reporting facility as well as all SSIs from patients operated from other facilities if referred. The reporting in done through District Health Information System 2 (DHIS2), which is an electronic system for routine data reporting in health facilities of Tanzania [9].

A total of 117 health facilities as of December 2023 are reporting in DHIS2. Data is being recorded daily in the registers and in each month the data is summarized onto the data set, which ultimately yields the proportion of patients that experienced SSIs in DHIS2. The syndromic surveillance shows the burden and trends of SSIs in the reporting health facilities. One of the areas which may be the cause of SSIs in the health facilities is inadequate compliance of infection prevention and control (IPC) measures.

The WHO defines IPC as a practical, evidence-based approach of preventing patients and health workers from being harmed by avoidable infections [10]. Effective IPC implementation requires ongoing activities from the whole healthcare system and all stakeholder's participation, including policy makers, facility managers, healthcare workers (HCWs), patients and community in general. Morbidity and mortality due to infection and sepsis may result from non-adherence to IPC. Additionally, without an efficient IPC measure, it is impossible to guarantee the provision of safe healthcare [11]. All facets of healthcare quality are impacted by effective IPC. In low- and middle-income countries (LMICs) specifically in the PHFs where the majority of people seek their health services, secondary infections may have a detrimental impact on medical hygiene standards, patients' health and the delivery of healthcare, hence programs to support IPC are especially crucial [12].

Also, efficient IPC measures are crucial because everybody has potential to carry infectious microbes and therefore, it is necessary to presume that all bodily fluids, including blood, can spread infection. The work procedures necessary to accomplish a minimal degree of IPC are known as standard precautions. The goal of using standard precautions is to reduce and, if feasible, completely eradicate the risk of infection, especially blood-borne infections. [13]. All patients, regardless of their diagnosis or suspected infection status, are subject to standard precautions. Standard precautions include cleaning of hands before and after handling patients, using gloves, impermeable gowns, plastic aprons, masks, face shields, and eye protection, using and disposing of sharp objects safely, Standard precautions are the minimum IPC practices that must be used at all times for all patients in all situations.

Healthcare workers in healthcare facilities where syndromic surveillance is being conducted are more likely that they comply with IPC measures because data from the surveillance will give them an alarm. It will also give some clue of the source of the infection which will again help them to take informed decision from the data on how to prevent the infection. Adherence to IPC will reduce chances of HAIs including SSIs to surgical patients. Hence, this study aims at comparing between PHFs that conduct syndromic surveillance and those which do not on IPC compliance PHCs of Tanzania.

Materials and Methods

Data Sources

The data source was from surgical registers and from Quality Improvement Teams (QIT) members. We extracted data from operating theatre and inpatient registers as well as interviewing the QIT members. We gathered the data from September, October and November 2024 in the selected PHFs of the Tanzania. These selected PHFs were sampled from all zones of Tanzania and a total of ten (10) out 26 regions were selected. Out of 10 regions five were those which conducted syndromic surveillance of SSI and the remain did not conduct the surveillance. From 10 regions, two PHFs were selected from each region to make 20 nationally representative PHFs and eventually the surgical patients from this level of health system of Tanzania. We had managed to collect a total of 1505 surgical patents. We excluded surgical patients with missing data, we also dropped some variable

(education and marital status of the patients) that had no data in the registers. However, the missing data and the dropped variables could not affect the power of the study. Data was also obtained from interview of HCWs using the guiding question tool.

Study Design

We conducted quasi-experimental study with both quantitative and qualitative to determine the effect of implementing Syndromic Surveillance of SSIs on IPC compliance. In quantitative part, we compared PHFs that conducted SSIs syndromic surveillance to controls PHFs that do not conduct. IPC assessment was conducted using WHO IPCAF tool in both intervention and control groups to determine the level of IPC measures compliance. The qualitative study, in-depth interviews (IDI) with health facility quality improvement teams as Key Informants were conducted using developed guiding questions.

Study Setting

The study was conducted at PHFs of Tanzania which it is located in the Eastern part of Africa. Tanzania has 26 Regions, 139 districts, 184 councils and 12,319 villages and more than 11,000 health facilities [14]. According to sampling done, the regions sampled as intervention group were Ilala (Mnazimmoja & Chanika hospitals), Lindi (Mtama & Nachingwea District Hospitals), Kagera (Muleba&Ngara district hospitals), Kigoma (Kasulu Tc& Uvinza district Hospitals) and Mbeya (Kyela&Tukuyu District Hospitals). Also, the control regions were Arusha (AICC and Nkoalonga Hospitals at district level), Morogoro (Kilosa&Gairo District hospitals), Shinyanga (Kishapu &Kahama District hospitals), Pwani (Bagamoyo & Rufiji District Hospitals) and Singida (manyoni&Kiomboi district Hospitals). These Districts Represent all Zones of Tanzania Mainland.

Study Population

The study group was surgical patients in selected PHFs who underwent surgery in September, October and November 2024 months. Study participants comprised of 905 from facilities that conduct SSI syndromic surveillance cases and 600 controls classified in the PHFs that do not conduct SSI. The other study population were PHFs represented by Quality Improvement Teams (QITs) from both groups and were participated for IPC compliance assessment and interview for the qualitative part. We recruited cases and controls into the study using the following definitions.

Intervention Group Definition

We defined an intervention group as surgical patients who were attended in September, October and November 2024 from the selected PHFs where syndromic surveillance was conducted and had complete data in the operating theatre register.

Control Group Definition

We defined a control group as surgical patients who were attended in September, October and November 2024 from the selected PHFs where syndromic surveillance was not conducted and had complete data in the operating theatre register. Identification of cases and recruitment of controls.

Selection Criteria

Inclusion

1. All surgical patients from PHFs in selected PHFs with complete data on SSIs in September, October and November 2024.
2. All patients undergoing any of the surgical procedures were eligible for inclusion in the surveillance even if the procedure was performed as an emergency, or if it was not the original, or main reason for surgery, e.g., abdominal hysterectomy performed due to complications during an explorative laparotomy.

3. All Members of QITs who were at Health Facility during the day when data collection was done as representatives of the PHFs which have theaters and conducted surgery**.**

Exclusion Criteria

1. All surgical patients from PHFs with non-open surgery and those with incomplete data of the previous three months in the time of data collection.
2. Procedures performed by endoscopy or laparoscopy. These procedures have a different risk of developing SSI and a short length of post-operative stay. Some laparoscopic-assisted bowel, bile duct and liver and vascular procedures where part of the procedure is performed endoscopically but the procedure is completed via an incision are included.
3. Procedures where primary closure of the incision is not completed in theatre (except cardiac surgery). For example, debridement and drainage of hematoma.
4. Diagnostic procedures performed in the operating theatre, e.g., biopsy, gastroscopy, aspiration, injection, or catheterization.
5. All PHFs with no theater or have not done surgeries in the past three months in the time of data collection.

Identification of Cases and Recruitment of Controls

We collected data through PHFs document reviews specifically operating theatre registers and interviews for the QIT members using an extraction form for the secondary data structured questionnaire [15] for the assessment of the facilities to determine the IPC compliance as well as the interview to gather opinion regarding the syndromic surveillance. We selected 600 controls versus 905 of the cases with the estimate ratio of one is to two. This happened just by chance because of the number of surgical cases that met inclusion criteria between the control group and that of the cases. We also interviewed QIT members to determine their perception, thinking and experience in effect of SSI syndromic surveillance on the improvement of IPC in the PHFs.

Study Instrument and Data Collection Techniques

We used extraction tool for secondary data, WHO IPCAP questionnaire for quantitative data and guiding question tool for qualitative data. All tools were translated in the Swahili language to interview HCWs both in intervention and in control PHFs. The extraction tool captured variables for the socio demographic information for surgical patients and the characteristics of the PHFs. The questionnaire captured socio-demographic information of the QIT members. Most of the extraction tool and questionnaire contents were adapted and adopted from previous studies on similar contexts and WHO tool.

Socio-demographic information for the surgical patients sought from participants included age, sex, Ownership (Public or Private), distance from referral hospital (50 km and below or >50 km), and place of residence (rural or urban). The extraction tool also, captured the characteristics of the PHFs namely Availability of HCWs as per MoH establishment, Availability of the patients attended both as out or in patients, Number of wards, Bed capacity, Number of QIT members, education of surgeons in the facility, Surgeon of the experience in years, Facility place of residency, Facility Ownership, Distance of PHF from the referral hospital, Level of IPC compliance score and Use of WHO safety check list. The other questionnaire was for QIT members which captured the Age, Sex, Education Level, Cadre/Profession and experience in years. We also had guiding question tool used to gather information for qualitative study.

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Main Comparative Outcome

Level of Compliance of IPC Measures by PHFs

The outcome was established by determining the level of compliance of IPC by PHFs. Compliance with IPC was established by using IPCAF at the facility level. Change in scores among each core component of IPC based on WHO categories. There were 8 IPC components namely; Core component 1: IPC programmes, Core component 2: National and facility level IPC guidelines, Core component 3: IPC education and training, Core component 4: HAIs surveillance, Core component 5: Multimodal strategies for implementing IPC activities, Core component 6: Monitoring/audit of IPC practices and feedback and control activities, Core component 7: Workload, staffing and bed occupancy at the facility level, Core component, 8: Built Environment, materials and equipment for IPC at the facility level. Cut points followed the recommendation of WHO as 0-200 Inadequate, 201-400 Basic, 401- 600 Intermediate, 601-800 Advanced [16].

Burden of SSIs in PHFs in Intervention Facilities vs Control Facilities

The checklist for the extraction of cases from the registers was used. That extraction form consisted of question that answered the number of all those who underwent surgery in the specified months in the time of data collection. For a positive response of each question coded as 1 and for negative response of each item gave 2. In this study the cut-off point was 5%. According to estimates by the WHO, the incidence of SSIs in HICs ranges from 1.2 to 5.2%, while that in LMICs is 10.8%. [17]. In this study we will use cut off point of 5%. The SSIs were also be categorized as superficial, deep and space/organ [18]. For our study the outcome was dichotomized as superficial versus deep/organ.

Sampling Technique

This study intended to use primary level of the health care provision (PHFS). Multistage cluster sampling procedure was used to select representative facilities from eight zones of Tanzania. The country had eight known admirative zones. The inclusion of these zones in the country was due to the geography and size of the country. However, the standard of healthcare provision was more or less homogeneous across the zones. Also, the health system of Tanzania had been divided into primary, secondary and tertiary levels of healthcare as described in item.

The eight administrative zones involved in sampling were: 1. central zone with 3 regions (Dodoma, Singida and Manyara), 2. Special Dar es Salaam Zone with 3 health sub-regions (Ilala, Temeke and Kinondoni), 3. Eastern zone with two regions (Morogoro and Pwani), 4. Lake zone which had six regions (Geita, Kagera, Mara, Mwanza, Shinyanga, and Simiyu), 5. Northen zone which had three regions (Arusha, Kilimanjaro, and Tanga), 6. Southen zone had three zones (Lindi, Mtwara and Ruvuma), 7. Southern highlands zones which had two regions (Iringa and Njombe), 8. South West highlands with two regions (Mbeya and Songwe) and 9. Western zone which had three regions (Rukwa, Katavi, Tabora and kigoma).

The first sampling stage involved creating two sampling frames of zones. The first zonal sampling frame included zones with regions conducting syndromic surveillance while the second zonal sampling frame involved other zones with region not participating in syndromic surveillance. In each zone one region was picked while in lake zone two regions were picked that is overall 10 regions out of 26 regions were sampled whereas 5 regions were for those conducting syndromic surveillance and 5 regions those did not conduct syndromic surveillance using simple random procedure. The simple random sampling was done by rotary method to pick regions names

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from each zone one by one.

The second sampling stage involved PHFs selection in the chosen regions selected. Two primary level health facilities sampling frames was created using district hospitals in which district hospitals within 50 km and the other one health facilities located more than 50 km in each sampled region in each zone one by one. One district hospital was randomly selected from each participating region using rotary method. The frame from sampled regions doing syndromic surveillance and regions not doing syndromic surveillance were used to randomly select facilities using rotary method. Hence in total there were 20 primary health facilities two per each region.

Third sampling stage used non-probabilistic sampling method to purposefully select individuals who will participate in the study from each selected health facility in the participating region. All patients who had undergone surgery in the September, October and November of the time of data collection were included in the study. Likewise, the same process was done for the regions that had not started to report syndromic surveillance as control groups which were used as control group. Also, QIT members were selected purposefully by including those who were available and consented during data collection days to be involved in IPC assessment using IPCAT WHO tool.

Sample Size Estimation

Estimation of sample size for surgical patients was based on two-sample comparison of proportions of SSIs in the facilities which conducted syndromic surveillance and PHFs that did not conduct syndromic surveillance as the control group. From previous studies, the prevalence of SSIs in the facilities that conducted syndromic surveillance was found to be (P1)6.6% (King et al., 2014) and Prevalence of SSIs in the facilities that do not conducts syndromic surveillance is (P2) was 10.9 [19] The formula which we are used for the sample size n, was according to [20]:

$$n = \frac{[Z\alpha/2 * (2p(1-p) + Z1 - \beta(P1(1-P1)\ P2(1-P2)]^2}{(P1-P2)^2}$$

where Zα/2 was the critical value of the Normal distribution at α/2 for a confidence level of 95%, α was 0.05 and the critical value was 1.96. The confidence level was 95%, then this means we had a 5% probability of incorrectly detecting a significant difference when one does not exist, i.e., a false positive result (type I error).

Zβ was the critical value of the Normal distribution at β for a power of 80%, β was 0.2 and the critical value was 0.84 and p1 and p2 were the expected proportions of the two groups events of interest (Outcome), p was (P1-P2)/2. The power is the probability of detecting a significant difference when one exists. If the power is 80%, then this means we have a 20% probability of failing to detect a significant difference when one does exist, i.e., a false negative result (type II error).

Hence, replacing the values in the above formula:

$$n = \frac{[1.96*(2*0.0215(1-0.0215)+0.84(0.109(1-0.109)*0.066(1-0.66)]^2}{(0.109066)^2}$$

$$n = \frac{[1.96 * 0.2051 + 0.84 * 0.2942]^2}{(0.043)^2}$$

$$n = \frac{[0.4020 + 0.0504]^2}{(0.043)^2}$$

$$n = \frac{0.4524}{0.0019}$$

n = 245 in each group to make it a total of 490 to meet the power of the study requirement, however we shall add 20% in each group to make it 300 per group for correction of unforeseen issues like missing data, etc., however, this study recruited all patients who undergone major surgeries in three months in all twenty (20) sampled PHFs and recruited an average of 75 patients per PHFs. The PHFs (District hospitals) conducts an average of 50 surgeries per month for both major and minor surgeries. Hence, about 1500 participants were recruited. The 49 HCWs were purposefully

sampled from the QITs members who were available at PHFs during data collection.

Data Management and Analysis

In quantitative part, the data were checked daily for completeness, cleared, edited, coded and double entered in spread excel sheet and then exported to Stata SE version 18 for analysis. Backup of the data was done. Filled questionnaires was stored in a safe place. Measure of Centre tendencies namely Median, range and standard deviation were calculated for continuous variable age. Histogram was also used to display the data. Frequencies and percentages were calculated for categorical variables. The prevalence of SSIs was obtained by computing percentage of SSIs among the intervention and control groups. A comparative analysis to determine difference between the average SSIs burden in PHFs conducting surveillance (exposure group) and those which do not conduct (Control group) was done. The difference of average SSIs burden was compared using independent paired t test. P value and Confidence intervals (95% CI) were reported. Similarly, comparative analysis was done to determine difference between the average Level of compliance of IPC measures by PHFs. The difference of average Level of compliance of IPC measures by PHFs was compared between the group with intervention versus the control group using independent unpaired t test. P value and Confidence intervals (95% CI). Furthermore, the same was repeated for other variables.

In qualitative part, the interviews were transcribed verbatim on the same day of the interview to prevent the loss of information. Transcripts were reviewed by another person to decrease bias and increase interpretive credibility. NVivo version 20.2 (NVivo.exe) was used to derive in vivo codes organized and analyze text and audio data through the process of qualitative coding using a hybrid approach for both deductive and inductive. The codes were used to develop categories, which eventually were used to come up with thematic content, which derived the subthemes and themes. The findings were reported by using consolidated criteria for reporting qualitative research [36]. The result of qualitative was used to triangulate the quantitative results. The recorder for the qualitative data was well stored.

Results

Univariate Analysis

Description of the Study Participants

The data collection was conducted between February and May 2025 at in the selected PHFs of Tanzania. A total of 20 PHFs were sampled and 1505 patients who underwent surgery between September and November 2024 were recruited into the study in order to assess for effect of Syndromic Surveillance of SSIs on infection prevention improvement in PHFs. The semi structured questionnaires were used to collect the information. Of the 1505 surgical patients recruited 124 (8.2%) had SSIs and out of them 37 (04.09) came from the intervention group and 87 (14.5%). This means an estimate of nine [9] people out of hundred gets SSIs when undergo surgery in PHFs of Tanzania.

In the KII, it was reported that the syndromic surveillance is essential in determining the burden or prevalence, as well as the incidence of the SSIs. The primary purpose of SSI surveillance in the aspect of IPC is tracking and reporting infections that arise following surgery. Also, it is used to obtain knowledge on the source of infection in patients who undergo surgery. *One of the respondents said "... SSI surveillance is used in determining the magnitude of SSI cases and assessing the results of SSI prevention initiatives" (AM-1 Nurse practitioner).* Some other participants said "….. *SSI surveillance is used as a crucial component of safe surgery practices since it helps track and reduce the incidence and prevalence of SSIs and enhances patient outcomes, particularly to risk patients like children and the elderly*" (JM -2 Nurse Officer,

SDM-1 Medical practitioner).

By tracking SSI rates, hospitals can identify areas for improvement, plan to rectify the problems, implement targeted treatments, and assess the effectiveness of their IPC strategies. Some respondents reported "…. *SSI surveillance is mostly used for determining the etiology in terms of cause and source of infections, as well as the number of those who get infected*" (JM-3 Nurse practitioner, SB-1 Lab technician). One of the respondents thought that….. "*Another usefulness of SSI surveillance is on the data that presents an alarming picture of the incidence of rates of SSI, highlighting the necessity of heightened awareness, prevention initiatives, and continuing with strong surveillance systems to lessen the impact of these SSI on our surgical patients*…" (SDM-1 Medical practitioner).

A Description of the Participants' Demographics between Study Groups

The sample consisted of two groups namely the one with intervention (n=905) and the control group (n=600). Table 1 below shows the distribution of the participants to either the control group or the intervention group. Majority of the participants were from the facilities with the intervention. Also, there were more female participants 53 (05.9) in intervention group and males in control group 72 (12.0). In extreme age groups the majority were in the control group while that of (20–34) were majority of the participants 673 (74.4%) were in the intervention side, 673 (74.4) in the intervention group while the males where 340(56.7) in control group. Also, occurrences of SSIs were more in control group 87 (14.5) Furthermore, many participants were from rural health facilities 551 (60.9). Majority of other demographic characteristic were more in the intervention group than in the control group as depicted in Table 1.

Table 1. Table showing Description of the Participants' Demographics between Study Groups

Participants' Characteristics	**Study Groups**		**Total**
Variables	**Intervention Group (N=905) n (%)**	**Control Group (N=600) n (%)**	**Total (N=1505) n (%)**
Sex			
Male	53 (05.9)	72 (12.0)	125
Female	852 (94.1)	528 (88.0)	1380
Age			
19 years and below	94 (10.4)	115 (19.2)	209 (13.9)
20 – 34	673 (74.4)	340 (56.7)	1013 (67.3)
35+	138 (15.2)	145 (24.1)	283 (18.8)
Residency			
Rural	551 (60.9)	323 (53.8)	874 (58.1)
Urban	354 (39.1)	277 (46.2)	631 (41.9)
Distance from referral Hospital			
50 km or more	375 (41.4)	309 (51.5)	839 (55.7)
Less than 50km	530 (58.6)	291 (48.5)	666 (44.3)
Ownership			
Public	853 (94.6)	518 (86.3)	1317 (91.1)
Private	375 (41.4)	82 (13.7)	134 (08.9)

SSI			
Yes	37 (04.09)	87 (14.5)	124 (8.2)
No	868 (95.91)	513 (85.5)	1381(91.8)
Type of SSI			
Superficial	06 (16.2)	14 (16.1)	20 (16.1)
Deep/organ	31. 83.8)	73 (83.9)	104 (83.9)

Description of the Characteristics of the Selected Primary Health Facilities

In this study the variables came from both patients and the health facilities where the patients were getting surgical services. In this section we have described the characteristics of the PHFs. The selected PHFs were 20 which had been sampled from across the zones and regions of Tanzania. Out of those selected PHFs 10 (50%) were the facilities which conducts SSI syndromic (intervention site) surveillance while the other half do not (control side). In terms of availability of work force, in these PHFs majority 11 (50%) had less than 50% of the required number according the level and the population they serve. Also, 13 (65%) of them were attending more than 1500 patients in a month. Furthermore, number of wards were above six in 10 (50%) of them and on the other hand, some of them 08 (40%) had bed capacity of more than 150. The team that oversees quality in majority PHFs 11 (55%) had below 15 members. Other details of those facilities are found in Table 2 below.

The KII reported that surveillance of SSIs is used for determining the relationship of risk factors, infection rate patterns, trends and who is affected the most in terms of age, sex, etc., pinpointing regions that need work, and assessing how well IPC measures are working. The respondents reported that *"…. By gathering and evaluating SSI data, HFs can compare, relate, and monitor trends over time, assess their performance against standards, and carry out focused actions to lower infection rates and enhance patient outcomes"* (SDM-2 medical Officer). Another respondent said "……*It assists in comparing, relating and evaluating the success of preventative measures, and directing initiatives to lower the risk of SSIs as well as to make wise decisions and enhance patient outcomes. This information is essential*…." (HVM-1 assistant physiotherapist).

Table 2. Description of the Selected Health Facilities (N=20)

Variable	Total (N=20)	Percent (%)	Confidence interval at 95%
Availability of healthcare workers as per MoH establishment			
50% and more	09	45.0%	24.2% - 67.7%
Less than 50%	11	55.0%	32.3% - 75.8%
Average number of patients attended in a Month (OPD&IPD)			
1500 and bellow	07	35.0%	16.7% - 58.9%
More than 1500	13	65.0%	41.0% - 83.3%
Number of wards			
Six and Bellow	10	50.0%	28.2% - 71.8%
Above six	10	50.0%	28.2% - 71.8%
Bed capacity			
150 or bellow	12	60.0%	36.5% - 79.5%

More than 150	08	40.0%	20.4% - 63.4%
Number of Quality Improvement Members			
15 and above	9	45.0%	24.2% - 67.7%
Less than 15	11	55.0%	32.3% - 75.8%
Education level of the surgeons in the selected PHFs			
One degree and bellow	13	65.0%	41.0% - 83.3%
More than one degree	07	35.0%	16.7% - 58.9%
Level of the surgeon Experience			
Five years and above	04	20.0%	07.2% - 44.6%
Less than five years	16	80.0%	55.4% - 92.8%
Facility Ownership			
Public	18	90.0%	65.4% – 97.7%
Rural	02	10.0%	2.28% – 34.5%
Residency of PHF			
Urban	08	40.0%	20.4% - 63.4%
Rural	12	60.0%	36.5% - 79.5%
Distance of PHF from referral hospital			
More than 50km	14	70.0%	45.6% - 86.6%
50km or bellow	06	30.0%	13.3% - 54.3%
Level of IPC Compliance			
Inadequate/Basic	13	65.0%	41.0% - 83.3%
Intermediate/Advanced	07	35.0%	16.7% - 58.9%
Use of WHO Safe Surgery Checklist			
Yes	13	65.0%	41.0% - 83.2%
No	07	35.0%	16.8% - 59.9%

Description of the Selected Health Facilities between Groups

In this table 3 below, comparison between PHFs has been done based on either they belong to intervention or control group. It was identified that majority of the PHFs in the control group 6 (60%) had less than 50% healthcare workers while the PHFs in the intervention group had only in 5 (50%) PHFs. Meanwhile, in the control group 8 (80) attended more than 1500 patients while in the intervention on in 5 (50%) attend more than 1500 patients in the month. Also, the control group had PHFs 7 (70) with wards more than six while those with intervention group had only 3 (30%) with more than six wards. Furthermore, in control group no health facility had surgeon's experience more than five years while in the intervention group 4 (40%) of PHFs had. The details are shown in the table 3 below.

Table 3. Comparison Description of the Selected Health Facilities between Groups (N = 20)

Variable	Study Groups		Total
	Intervention Group (N=10) n (%)	Control Group (N=10) n (%)	
Availability of healthcare workers as per MoH establishment			
50% and more	5 (50)	4(40)	9 (45)
Less than 50%	5 (50)	6 (60)	11 (55)
Average number of patients attended in a Month (OPD&IPD)			
1500 and bellow	5 (50)	2 (20)	7 (35)
More than 1500	5 (50)	8 (80)	13 (65)
Number of wards			
Six and Bellow	7 (70)	3 (30)	10 (50)
Above six	3 (30)	7 (70)	10 (50)
Bed capacity			
150 or bellow	6 (60)	6 (60)	12 (60)
More than 150	4 (40)	4 (40)	8 (40)
Number of Quality Improvement Members			
15 and above	5 (50)	4 (40)	9 (45)
Less than 15	5 (50)	6 (60)	11(55)
Education level of the surgeons in the selected PHFs			
One degree and bellow	8 (80)	5 (50)	13 (65)
More than one degree	2 (20)	5 (50)	7 (35)
Level of the surgeon Experience			
Five years and above	4 (40)	0 (00)	4 (20)
Less than five years	6 (60)	10 (100)	15 (80)
Facility Ownership			
Public	9 (90)	9 (90)	18 (90)
Rural	1 (10)	1 (10)	02 (10)
Residency of PHF			
Urban	3 (30)	5 (50)	08 (40)
Rural	7 (70)	5 (50)	12 (60)
Distance of PHF from referral hospital			
More than 50km	7 (70)	7 (70)	14 (70)
50km or bellow	3 (30)	3 (30)	06 (30)
Level of IPC Compliance			
Inadequate/Basic	4 (40)	9 (90)	13 (65)
Intermediate/Advanced	6 (60)	1 (10)	07 (35)
Use of WHO Safe Surgery Checklist			
Yes	7 (70)	6 (60)	13 (65)
	3 (30)	4 (40)	07 (35)

The Mean Difference between the PHFs that Conduct SSI Surveillance Versus Those Which don't Conduct

The analysis to evaluate different variables to understand the differences between the study groups was conducted. Many variables were

not different as seen in the table 4 and hence justifying to be the sister groups for the intervention and the control. The comparison between two groups in terms of IPC adherence score showed there was difference between the groups. The group where syndromic surveillance is being conducted had higher mean score of 400.1 SD 138.99 than the control group had mean score of 263.1 SD 99.8. There was statistically significant difference between those two groups 137 SE 54.12; CI = 32.3–250.7 and unpaired t = 2.531; p > 0.011. Other variables which had statistically significant difference were two, namely: burden of SSI (high in control group) and number wards in the facility (were more wards in control group). The detail for other parameters has been displayed in Table **4**.

Table 4. Mean Difference between Study Groups' Variables

Variable	**Study Groups**		**Unpaired t**	**Mean Difference (SE)**	**P value Ha: diff > 0**	**95 CI of the Mean Difference**
	Intervention Group (N=10) n (%)	**Control Group (N=10) n (%)**				
Score Level of IPC Compliance						
Inadequate/Basic	4 (40)	9 (90)				
Intermediate/Advanced	6 (60)	1 (10)				
Mean (SD)	400.1 (138.99)	263.1 (99.8)	2.531	137 (54.12)	0.011	23.3–250.7
Number of SSIs						
Superficial	06 (16.2)	14 (16.1)				
Deep/organ	31. 83.8)	73 (83.9)				
Mean (SD)	3.7 (2.5)	8.7 (7.9)	1.902	5.0 (2.6)	0.037	−0.5–10.5
Average number of patients attended in a Month (OPD&IPD)						
1500 and bellow	5 (50)	2 (20)				
More than 1500	5 (50)	8 (80)				
Mean (SD)	22658.3 (4.6*104)	4848.9 (5.5*103)	1.229	17809.4(1.4*104)	0.235	−12641.65–48260.45
Number of wards						
Six and Bellow	7 (70)	3 (30)				
Above six	3 (30)	7 (70)				
Mean (SD)	5.5	7.7	1.917	2.2 (1.1)	0.037	−0.2–4.6
Bed capacity						
150 or bellow	6 (60)	6 (60)				
More than 150	4 (40)	4 (40)				
Mean (SD)	126.4	153.4	0.915	27 (29.5)	0.372	−35.0–89.0
Number of Quality Improvement Members						
15 and above	5 (50)	4 (40)				
Less than 15	5 (50)	6 (60)				
Mean (SD)	14.1	15.3	0.489	1.2 (2.4)	0.630	−3.9–6.4
Availability of healthcare workers as per MoH establishment						
50% and more	5 (50)	4 (40)				
Less than 50%	5 (50)	6 (60)				

Mean (SD)	57.8 (28.4)	46.7 (19.43)	1.0197		0.3214	−11.77–33.97

It was reported by KII that the health facilities that conduct SSI surveillance were more likely to reduce the chances of SSIs happening than those that don't. The main usefulness of syndromic SSI surveillance is detecting and treating the organisms immediately, since it can serve as an early warning system for possible outbreaks, consequently mitigating the burden compared with those who do not conduct surveillance. One participant reported "…. *Surveillance is useful because instead of putting broad, sometimes ineffectual measures into place, healthcare facilities may concentrate their resources and efforts on the areas that most require improvement and hence intensifying adherence to IPC and improve more and more*…." (SM-1 Medical officer). Some other participants said *"…. SSI surveillance's usefulness is in prioritizing hospital cleanliness, especially in the operating room and wards. That is what one of the participants emphasized*…." (ADE- 21 Nurse Practitioner). *With an emphasis on keeping the hospital environment clean, successful SSI surveillance necessitates monitoring infections, determining risk factors, and assessing the success of preventative actions another respondent reported*…" (KGH-22 Nurse Practitioner).

Discussion

The Effect of Syndromic Surveillance on IPC Compliance

Syndromic surveillance for SSIs can positively impact healthcare worker (HCW) compliance with IPC measures in PHFs. When HCWs see the impact of their practices on infection rates, they may be more motivated to adhere to IPC guidelines, leading to better compliance. The surveillance data can inform targeted training programs for HCWs, addressing specific areas where knowledge gaps or compliance issues exist. This study has found the PHFs that conduct syndromic surveillance have high score of HCWs to comply with IPC principles with mean (SD) difference of 137 (54.12); $p > 0.011$ compared to those which do not conduct. These results are matching with the results reported around the world. Based on systematic reviews, meta-analyses, and GRADE approaches, the WHO and CDC have created and released SSI prevention guidelines [21-23]. These were the first significant SSI guidelines to shift from advice based on expert opinion to supported by research. These culturally evidence-based healthcare intervention strategies offer the best possibility for an IPC program to be implemented successfully. This is also well-matched with the study that elaborated the IPC core component four on HAI surveillance. (10). It states that Surveillance systems are generally well-known for their ability to assess the local burden of HAIs and for their role in early detection of HAIs, including bundle and outbreak identification.

Based on the local HAIs condition and adherence to IPC procedures, IPC activities ought to address the healthcare facility's realistic needs. For these reasons, both national and facility IPC programs must include surveillance systems for HAIs. Also, Puro V, et al in 2022 documented that Surveillance of HAIs is critical to inform and guide IPC strategies [24]. Furthermore, A fundamental component of IPC is infection surveillance which assists ongoing quality improvement, process metrics and clinical outcomes, such HAI detection, measure of its magnitude [25]. By providing timely data on infection rates, syndromic surveillance can highlight areas where IPC practices may be lacking, prompting targeted interventions and education to improve HCW compliance. Syndromic surveillance systems, especially those focused on SSIs, can quickly identify potential outbreaks or clusters

of infections. The data from syndromic surveillance can pinpoint specific IPC practices that need improvement, such as hand hygiene, proper wound care, or use of personal protective equipment (PPE).

In addition to syndromic surveillance this study had evaluated other factors between PHFs in intervention and control groups. One of the factors is number of patients attended in the health facilities and how it impacts the adherence of IPC to HCWs. It is the fact that HCWs' compliance with IPC procedures can be adversely affected by overcrowding in healthcare facilities. This is because overcrowding makes it difficult to maintain appropriate patient separation, physical distance, and availability to essential services like handwashing stations, PPE. Overcrowding in health care facilities is recognized as being a public health issue that is associated with disease transmission. A combination of factors was considered when determining the patient-to-bed ratio and the health care worker-to-patient ratio, including number of beds, number of wards, and the availability of a trained workforce. These factors may interfere with providing optimal staff-to-patient ratio, which could potentially lead to increased rates of HAI and the spread of AMR [10]. However, our study has found the managing patient less or more than 1500, bed capacity of less or more than 150 at PHFs had no difference between PHFs. The difference in the IPC score could be explained by the SSI syndromic surveillance conducted by the intervention group.

On the other side, the number of wards in a healthcare facility significantly impacts IPC adherence, with larger facilities facing greater challenges in maintaining consistent practices. This is due to increased workload, potential overcrowding, and logistical hurdles in ensuring adequate resources and training across all areas. Larger facilities with more wards have a more complex infrastructure, making it harder to manage resources, maintain consistent protocols, and ensure all staff are adequately trained and equipped. Larger facilities often experience higher patient volume, potentially leading to overcrowding in wards. This can strain resources, increase the risk of cross-contamination, and make it more difficult for staff to adhere to IPC guidelines. Increased patient volume and the complexity of larger facilities can lead to increased workload and staff burnout, potentially impacting the quality of care and IPC practices. Distributing resources like PPE, hand hygiene supplies, and cleaning materials effectively across multiple wards can be challenging. Ensuring that all staff in all wards receive consistent and adequate IPC training and that adherence to protocols is regularly supervised, becomes more difficult in larger facilities. This study is in keeping with the above facts. Majority of facilities in the intervention group had six or a smaller number of wards in their PHFs and was statistically different with the control group.

Implementation of syndromic activities and IPC interventions need to be overseen by experts and managers. IPC at the facility level receives support from the highest-level public health authorities with a planned and effective national IPC structure [16]. Having a robust structure and capacity in IPC at national and local levels strengthens the ability to plan and implement IPC and respond to communicable disease emergencies [16]. This is reflected in the World Health Organization’s (WHO) Core Components of IPC [16], in which the first six components have requirements at the national and facility levels. In Tanzania QIT through IPC committee in the facilities is responsible for that obligation. They significantly impact IPC adherence by implementing evidence-based strategies, monitoring performance, and fostering a culture of safety. This collaborative approach, often integrated into quality assurance programs, helps reduce HAIs and improve overall patient safety. QITs work to create and update IPC policies and procedures based on the latest scientific evidence and best practices. These policies should be clearly

communicated to all staff and stakeholders. QITs track and analyze infection rates, identify areas of concern, and assess the effectiveness of implemented interventions. This data-driven approach helps pinpoint areas needing improvement and tracks progress over time. QITs play a vital role in educating healthcare workers on proper IPC practices, including hand hygiene, proper use of PPE, and sterilization techniques. A QIT ensures that healthcare facilities have the necessary resources and equipment to implement IPC practices effectively. QITs promote a culture of safety where staff feel empowered to report errors, participate in improvement initiatives, and prioritize patient safety. By integrating IPC activities into broader quality assurance programs, QITs ensure that IPC is not a separate initiative but rather a core component of the overall quality of care. Contrary to the findings of this study, the intervention group and the control group were not different in terms of number of QIT members. The difference in IPC score could be attributed to the syndromic surveillance conducted by the intervention group.

Syndromic surveillance data can be used to identify specific areas or procedures where SSIs are most common. This allows for the development of targeted interventions, such as tailored training programs or the implementation of specific preventative measures, to address these areas. Overall, syndromic surveillance plays a crucial role in improving IPC compliance by providing a framework for early detection, data-driven improvement, increased awareness, accountability, and targeted interventions. Effective syndromic surveillance requires well-trained staff to identify, document, and report cases, as well as to interpret the data and implement appropriate interventions. Adequate resources, including staff time, training materials, and appropriate infrastructure, are essential for successful implementation. Effective surveillance relies on strong collaboration between different departments within the healthcare facility, as well as with public health agencies. In essence, syndromic surveillance provides a feedback loop, helping to identify areas where IPC practices need improvement and motivating HCWs to enhance their compliance, ultimately leading to a safer environment for patients. By improving HCW compliance with IPC measures, syndromic surveillance can ultimately contribute to a reduction in SSI rates, improving patient outcomes. For example, if syndromic surveillance data shows a spike in SSIs following a particular type of surgery, it might trigger an investigation into the surgical technique, instrument sterilization, or hand hygiene practices of the involved HCWs. This could lead to targeted training on proper surgical technique, increased emphasis on hand hygiene before and after the procedure, or changes in the sterilization process.

The Effect of Syndromic Surveillance on Burden of SSI

HAI detection is key in planning the IPC measures. The detection will provide the magnitude which will eventually provide the clear picture of the interventions in place and the need to adjust. This study has shown that, the health facilities which conduct syndromic surveillance have the potential of having reduced number of SSIs compared with the facilities that do not conduct the syndromic surveillance with mean (SD) of 5.0 (2.6); $p > 0.037$. This is marching with the systemic review done in Africa which showed the prevalence of HAIs is higher than in the developed world where HAIs surveillance is being done [26]. Also, according to the large, international cohort study, pooled SSI rates were associated with a stable and sustainable decrease after joining an SSI surveillance network; a causal relationship is possible, although unproven. There was heterogeneity in procedure-specific trends. These findings support the pivotal role of surveillance in

reducing infection rates and call for widespread implementation of hospital-based SSI surveillance in high-income countries [27].

Syndromic surveillance can significantly impact the burden of SSIs by enabling early detection and response, potentially leading to reduced infection rates and improved patient outcomes. By monitoring trends in symptoms rather than waiting for confirmed cases, syndromic surveillance can trigger timely interventions to prevent further spread and mitigate the impact of SSIs. Furthermore, the use of SSI surveillance which have been stipulated in several papers has shown use of surveillance has helped in reduction of SSI burden [28-32]. The basis for hospital-level initiatives aimed at SSI reduction is provided by these suggestions and related implementation strategies. The best way to introduce important structural changes, procedural modifications, and behavioral skills for all healthcare staff is to establish IPC programs with SSI surveillance components. One of the strategies to mitigate HAIs is using the teams from throughout the health system that are in charge of surgical patient care in the identification of SSIs, which may be less challenging than other HAIs. SSIs may be addressed by the surgeon and a range of other healthcare providers. Surveillance is crucial to reducing SSI rates, and to achieve this, a trained team is necessary to examine at-risk wounds and support the dissemination of results.

Syndromic surveillance gives early warning system that allow for faster identification of potential outbreaks or clusters of SSIs, enabling healthcare facilities to implement targeted interventions sooner [33]. By detecting potential SSIs early, syndromic surveillance facilitates prompt implementation of infection control measures, such as enhanced hand hygiene protocols, antibiotic stewardship, and isolation procedures [34, 37]. This proactive approach can prevent the spread of infection to other patients and healthcare workers, reducing the overall burden of SSIs. Early detection and intervention associated with syndromic surveillance can lead to reduced severity and duration of SSIs [35]. This can result in fewer complications, shorter hospital stays, and decreased mortality rates related to SSIs. Syndromic surveillance can help optimize the allocation of resources by focusing on areas with higher rates of infection. By identifying trends and hotspots, resources can be directed towards specific surgical procedures, departments, or patient populations at higher risk for SSIs.

The overall effect of syndromic surveillance is an improvement in patient safety by minimizing the risk of SSI development and its associated complications. This can lead to greater patient satisfaction and trust in healthcare services. By reducing the incidence and severity of SSIs, syndromic surveillance can contribute to lower healthcare costs associated with prolonged hospital stays, additional treatments, and potential legal liabilities. Syndromic surveillance can be integrated with existing surveillance systems, such as interpreted Disease Surveillance and Response (IDSR) and DHIS2, to enhance data collection and analysis. This integration can provide a more comprehensive picture of SSI burden and facilitate more effective interventions. Syndromic surveillance plays a crucial role in mitigating the burden of SSIs by facilitating early detection, enabling timely interventions, and ultimately contributing to improved patient outcomes and resource optimization.

Conclusion

Syndromic surveillance of SSI plays important role in improving IPC in the PHFs through provision of data that is being used by HCWs to develop interventions to mitigate or eradicate SSI from the surgical patients. Although the effects are less remarkable, syndromic surveillance may be associated with improvement of IPC that in turn reduce the burden of SSI. Less SSI has been observed in

PHFs that conduct syndromic surveillance compared to those which do not. Further well-designed studies involving larger samples involving may countries and a follow up study may help to reliably quantify the risks of SSI and inform professional guidelines to help PHFs provide evidence-based advice on SSI.

Conflict of Interest

There was no conflict of interest among the authors.

Data Availability

The corresponding author can provide the data that is supporting the study's conclusions upon request at any time.

Author Contributions

JCH: Conceptualization, Methodology, Writing of Original Draft, Funding Acquisition data collection, analysis and report writing.

BFS: Supervision, editing of both proposal and the report.

AC: Supervision, editing of both proposal and the report.

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Ethics Statement

The research plan was approved by the Tanzanian Ministry of Health (reference number PA 131/142/01/412) and the President's' Office - Regional Administrative and Local Government (reference number AH. 161/323/01/50). Also, the National Institutional for Medical Research granted ethical clearance (reference number NIMR/HQ/R.8a/Vol. IX/4687). In addition, study identification numbers were used instead of using the participants' names to maintain their anonymity. The gathered data were safely preserved on a password-protected computer and in physical copy in a lockable drawer.

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References

[1]. Rezaei AR, Zienkiewicz D, Rezaei AR. Surgical site infections: a comprehensive review. J Trauma Inj. 2025;38(2):71-81. doi:10.20408/jti.2025.0019.

[2]. Farsakoury R, Sartelli M, Zughaier SM. Tackling the disparities in surgical site infections and related antimicrobial resistance in low- and middle-income countries. Surg Pract Sci. 2025;23:100315. doi:10.1016/j.sipas.2025.100315.

[3]. Guanche Garcell H, Al-Ajmi J, Villanueva Arias A, Abraham JC, Fernandez Hernandez TM. Incidence of surgical site infection among appendectomy, herniorrhaphy and caesarean section patients in Qatar. East Mediterr Health J. 2025;31(1):42-9. https://doi.org/10.26719/2025.31.1.42

[4]. Bahru TT, Gobena MA, Anteneh BT, Meskelu HA, Legese AT, Berhanu HT, et al. Prevalence of surgical site infection and associated factors among post-operative patients. Int Wound J. 2025;22(7):e70730. doi:10.1111/iwj.70730.

[5]. Al Hossain F, Tonmoy MTH, Nuvvula S, Chapman BP, Gupta RK, Lover AA, et al.

Syndromic surveillance of population-level COVID-19 burden with cough monitoring in a hospital emergency waiting room. Front Public Health. 2024;12:1279392. doi:10.3389/fpubh.2024.1279392.

[6]. Mandl KD, Wagner MM, Pavlin JA, Gesteland PH, Buckeridge DL, et al. Implementing syndromic surveillance: a practical guide informed by the early experience. J Am Med Inform Assoc. 2004;11(2):141-50. https://doi.org/10.1197/jamia.M1356

[7]. Mandl KD, Overhage JM, Wagner MM, Lober WB, Sebastiani P, Mostashari F, et al. Implementing syndromic surveillance: a practical guide informed by the early experience. J Am Med Inform Assoc. 2004;11(2):141-50.

[8]. Scales D. Opportunities and challenges for developing syndromic surveillance systems for the detection of social epidemics. Online J Public Health Inform. 2020;12(1). https://doi.org/10.5210/ojphi.v12i1.10579

[9]. Simba D, Sukums F, Kumalija C, Asiimwe SE, Pothepragada SK, Githendu PW. Perceived usefulness, competency, and associated factors in using District Health Information System data among district health managers in Tanzania: cross-sectional study. JMIR Form Res. 2022;6(5). https://doi.org/10.2196/29469

[10]. Storr J, Twyman A, Zingg W, et al. Core components for effective infection prevention and control programmes: new WHO evidence-based recommendations. Antimicrob Resist Infect Control. 2017;6:6. https://doi.org/10.1186/s13756-016-0149-9

[11]. Ministry of Health, Community Development, Gender, Elderly and Children. National infection prevention and control guidelines for healthcare services in Tanzania. 2018. https://policyvault.africa/wp-content/uploads/policy/TZA263.pdf

[12]. Abalkhail A, Alslamah T. Institutional factors associated with infection prevention and control practices globally during the infectious pandemics in resource-limited settings. Vaccines (Basel). 2022;10(11). https://doi.org/10.3390/vaccines10111811

[13]. Broussard IM, Chadi, Kahwaji I. Universal precautions. StatPearls. 2023. https://www.ncbi.nlm.nih.gov/books/NBK470223/

[14]. Ministry of Foreign Affairs and East African Cooperation. Tanzania country profile. 2024. https://www.foreign.go.tz/tanzania/tanzania-country-profile

[15]. World Health Organization. Infection prevention and control assessment framework at the facility level: introduction and user instructions. Geneva: WHO; 2018. https://www.who.int/publications/i/item/WHO-HIS-SDS-2018.9

[16]. World Health Organization. Guidelines on core components of infection prevention and control programmes at the national and acute healthcare facility level. Geneva: WHO; 2016. https://www.who.int/publications/i/item/9789241549929

[17]. Lakoh S, Yi L, Sevalie S, Guo X, Adekanmbi O, Smalle IO, et al. Incidence and risk factors of surgical site infections and related antibiotic resistance in Freetown, Sierra Leone: a prospective cohort study. Antimicrob Resist Infect Control. 2022;11(1):1-12. https://doi.org/10.1186/s13756-022-01078-y

[18]. Lawson EH, Hall BL, Ko CY. Risk factors for superficial vs deep/organ-space surgical site infections: implications for quality improvement initiatives. JAMA Surg. 2013;148(9):1-10. https://doi.org/10.1001/jamasurg.2013.2925

[19]. Bayardorj D, Promsatit P, Chirangi BM, Mahmoud E. Surgical site infections at Shirati KMT Hospital in Northeastern Tanzania. Cureus. 2023. https://doi.org/10.7759/cureus.34573

[20]. Suresh KP, Chandrashekara S. Sample size estimation and power analysis for clinical research studies. J Hum Reprod Sci. 2012;5(1):7-13. doi:10.4103/0974-1208.97779.

[21]. Allegranzi B, Bischoff P, de Jonge S, Kubilay NZ, Zayed B, Gomes S, et al. New WHO recommendations on preoperative measures for surgical site infection prevention: an evidence-based global perspective. Lancet Infect Dis. 2016;16(12):e276-87. doi:10.1016/S1473-3099(16)30398-X.

[22]. Allegranzi B, Zayed B, Bischoff P, Kubilay Z, de Jonge S, de Vries F, et al. New WHO recommendations on intraoperative and postoperative measures for surgical site infection prevention: an evidence-based global perspective. Lancet Infect Dis. 2016;16(12):e288-303. doi:10.1016/S1473-3099(16)30402-9.

[23]. Berríos-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR, et al. Centers for Disease Control and Prevention guideline for the prevention of surgical site infection. JAMA Surg. 2017;152(8):784-91. doi:10.1001/jamasurg.2017.0904.

[24]. Puro V, Coppola N, Frasca A, Gentile I, Luzzaro F, Peghetti A, et al. Pillars for prevention and control of healthcare-associated infections: an Italian expert opinion statement. Antimicrob Resist Infect Control. 2022;11(1):87. doi:10.1186/s13756-022-01125-8.

[25]. Shenoy ES, Branch-Elliman W. Automating surveillance for healthcare-associated infections: rationale and current realities (Part I/III). Antimicrob Steward Healthc Epidemiol. 2023;3(1):e25. doi:10.1017/ash.2022.312.

[26]. Abubakar U, Amir O, Rodríguez-Baño J. Healthcare-associated infections in Africa: a systematic review and meta-analysis of point prevalence studies. J Pharm Policy Pract. 2022;15:99. https://doi.org/10.1186/s40545-022-00500-5

[27]. Abbas MEA, de Kraker MEA, Aghayev E, Astagneau P, Aupee M, Behnke M, et al. Impact of participation in a surgical site infection surveillance network: results from a large international cohort study. J Hosp Infect. 2019;102(3):267-76. https://doi.org/10.1016/j.jhin.2018.12.003

[28]. Allegranzi B, Aiken A, Nthumba P, Barasa J, Okumu G, et al. A multimodal infection control and patient safety intervention to reduce surgical site infections in Africa: a multicentre, before-after cohort study. Lancet Infect Dis. 2018;18(5):507-15. doi:10.1016/S1473-3099(18)30107-5.

[29]. Allegranzi B, Donaldson LJ, Kilpatrick C, Syed S, Twyman A, Kelley E, et al. Infection prevention: laying an essential foundation for quality universal health coverage. Lancet Glob Health. 2019;7(6):e698-700. doi:10.1016/S2214-109X(19)30174-3.

[30]. Allegranzi B, Kilpatrick C, Storr J, Kelley E, Park BJ, Donaldson L. Global infection prevention and control priorities 2018-22: a call for action. Lancet Glob Health. 2017;5(12):e1178-80. doi:10.1016/S2214-109X(17)30427-8.

[31]. Ariyo P, Zayed B, Riese V, Anton B, Latif A, Kilpatrick C, et al. Implementation strategies to reduce surgical site infections: a systematic review. Infect Control Hosp Epidemiol. 2019;40(3):287-300. doi:10.1017/ice.2018.355.

[32]. Tartari E, Muthukumaran P, Peters A, Allegranzi B, Pittet D. Monitoring your institution: the WHO Hand Hygiene Self-Assessment Framework—is it worth it? Clin Microbiol Infect. 2019;25(8):925-8. doi:10.1016/j.cmi.2019.04.009.

[33]. Mwanja H, Waswa JP, Kiggundu R, Mackline H, Bulwadda D, Byonanebye DM, et al. Utility of syndromic surveillance for the surveillance of healthcare-associated infections in resource-limited settings: a narrative review. Front Microbiol. 2024;15:1493511. doi:10.3389/fmicb.2024.1493511.

[34]. Meckawy R, Stuckler D, Mehta A, et al. Effectiveness of early warning systems in the detection of infectious disease outbreaks: a systematic review. BMC Public Health. 2022;22:2216. https://doi.org/10.1186/s12889-022-14625-4

[35]. Hughes E, Edeghere O, O'Brien J, et al. Emergency department syndromic surveillance systems: a systematic review. BMC Public Health. 2020;20:1891. https://doi.org/10.1186/s12889-020-09949-y

[36]. Horan D, Delahunt E, Roe M, Hägglund M, Blake C, Kelly S. "More than likely the men come first. That's just very frustrating." A qualitative exploration of contextual factors affecting the implementation of injury prevention initiatives and the provision of effective injury management in elite-level women's club. Br J Sports Med. 2023. https://doi.org/10.1136/bjsports-2022-106548

[37]. Allegranzi B, Bagheri S, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet. 2011;377(9761):228-41. doi:10.1016/S0140-6736(10)61458-4.