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Original Article

Standardized aseptic dressing change procedure: Optimizations and adherence in a prospective pre- and postintervention cohort study

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Abstract

Background: The "HygArzt" project investigated the effectiveness of hygiene measures introduced by an infection prevention link physician (PLP).

Objective: To investigate whether the introduction of a standardized aseptic dressing change concept (ADCC) by a PLP can increase hand hygiene adherence and adherence to specific process steps during an aseptic dressing change (ADC) in a trauma surgery and orthopedic department.

Methods: We defined 4 required hand disinfection indications: (1) before the preparation of ADC equipment, (2) immediately before the ADC, (3) before the clean phase, and (4) after the ADC. A process analysis of the preintervention phase (331 ADCs) was used to develop a standardized ADCC. The ADCC was introduced and iteratively adopted during the intervention phase. The effect was evaluated during the postintervention phase (374 ADCs).

Results: Hand hygiene adherence was significantly increased by the introduction of the ADCC for all indications: (1) before the preparation of the ADC equipment (from 34% before to 85% after, P <.001), (2) immediately before an ADC (from 32% before to 85% after; P < .001), (3) before the clean phase (from 42% before to 96% after; P < .001), and (4) after an ADC (from 74% before to 99% after; P < .001). Overall hand hygiene adherence was analyzed before the indications for an ADC (from 9.6% before to 74% after; P < .001). The same strategy was applied to the following process parameters: use of a clean work surface, clean withdrawal of equipment from the dressing trolley, and appropriate waste disposal.

Conclusions: A PLP sufficiently implemented a standardized concept for aseptic dressing change during an iterative improvement process, which resulted in a significant improvement in hand hygiene and adherence to other specific ADCC process steps.

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Surgical site infections (SSIs) have a devastating impact on patient outcome.[1] In trauma surgery and orthopedics, SSIs may result in additional surgeries, limited mobility, fracture non-union, and death.[2-4] Furthermore, SSIs add a burden on healthcare systems by increasing direct and opportunity costs. In Germany, direct costs resulting from SSIs have been estimated at 2 billion euros (~US$2.4 billion) each year.[5]

Thus, various campaigns have been initiated, and infection prevention bundles have been proposed to decrease SSI rates. In most cases, the aim was to improve hand hygiene.[6-9] Additionally, numerous guidelines have been developed in recent years.[9-11] The Five Moments of Hand Hygiene published by the World Health Organization (WHO) offer a mental framework for correct hand hygiene and defined the indications for hand disinfection.[12] The hand hygiene indications before clean or aseptic procedures, such as an aseptic dressing change (ADC), play key roles in infection prevention. However, the indications before clean or aseptic procedures have the lowest adherence among the Five Moments of Hand Hygiene.[8]

Additionally, since the 1960s, worldwide rates of SSI have not substantially dropped.[13] The proportion of SSIs of all nosocomial infections has increased since the 1990s in Germany,[14,15] but no conclusive reasons have been recognized. However, it has been proposed that ineffective implementation of hygiene measures and guidelines may have played a role.[16,17]

The structure of infection prevention teams in German hospitals is defined by the German Commission for Hospital Hygiene and Infection Prevention (KRINKO). Every hospital has to be supervised by a hospital hygienists who is supported by infection prevention nurses. Additionally, KRINKO recommends nominating 1 authorized medical specialist in every medical department as the infection prevention link physician (PLP) to facilitate implementation. That physician serves as an intermediary between the respective medical department and the infection prevention and control team and acquires the necessary skills and knowledge during a 40-hour course.

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The present study is part of the prospective cohort study "Hygarzt," which examines whether a PLP can introduce new hygiene measures and reduce infection rates in a trauma surgery and orthopedic department. To the best of our knowledge, no published research data are available regarding this topic.

In this study, we investigated whether the PLP can introduce a standardized ADC concept (ADCC) adopted to the local situation in everyday medical practice, thus increasing adherence to hand hygiene and other process steps during ADC to protect surgical wounds from bacterial contamination.

Methods

Study design

We compared the initial situation (preintervention phase) before any intervention was made with results after interventions (postintervention phase) on 3 orthopedic and trauma surgery general wards of a single hospital (level 1 trauma center). The preintervention phase and postintervention phase each lasted 6 months, separated a 4-month intervention phase. Hand hygiene adherence according to the WHO and decisive ADC process steps were considered in the preintervention and postintervention phases, and a standardized ADCC was implemented as the intervention.

Study population

During the study period, all patients admitted to the study department's general wards who underwent surgery were included. Only ADCs conducted from Monday to Friday during the morning shift (6:00 A.M. to 2:00 P.M.) were considered. For organizational reasons, these observation periods were chosen because most ADCs were performed during these periods on included wards.

Intervention

In the study institution, ADCs were conducted by physicians and were partly supported by medical students or nurses. At the end of the preintervention phase, in which an analysis of the ADC processes was conducted, the PLP and infection prevention team worked out a standardized best-practice ADC procedure on the basis of international guidelines and preintervention phase results. The procedure was tailored to local conditions and was supported by members of the trauma surgery and orthopedics team including the head of the department (Table 1).

The weaknesses in the ADC process identified in the preintervention phase were directly addressed during the intervention phase by specific and unspecific implementation tools (Table 1) to achieve behavioral changes.

After the first half of the postintervention phase, feedback was provided to the entire trauma surgery and orthopedics team.

Data collection

For the standardized recording of hand hygiene and process parameters of ADCs in the preintervention and postintervention phases, a modified step-by-step procedure checklist was created during the trial preparation, partly based on existing literature (Supplementary Material 1 online).[8,11,18]

With this checklist, adherence was recorded for 4 hand disinfections and 10 process steps of the ADC (observation steps according to KRINKO[10]) several times per week (Supplementary Material 1 online).[18] We considered 4 required hand disinfection indications: (1) before preparation of the ADC equipment, (2) immediately before the ADC, (3) before the clean phase, and (4) after the ADC. Additionally, the frequency of ADCs, during which all "before" indications were performed, was considered (ie, overall before indications for ADCs). Glove disinfection was permitted between the unclean and clean phases of ADCs.

Hand disinfection before the clean phase was only demanded for the first ADC after surgery and for wounds with discharge. Additionally, we recorded the following data: number of present medical staff and persons performing the ADC, the professional groups performing ADCs (physicians or nurses), wards, duration of the ADC, and interruption of the ADC process by the person(s) performing it.

Adherence to hand hygiene and process steps of the ADCC was calculated as the number of "yes" responses divided by the sum of "yes" and "no" responses on the checklist. If an activity was incorrectly conducted, it was considered a "no" response. Also, 4 persons, all of whom were previously trained in the use of the documentation checklist to ensure interobserver reliability, performed the ADCC observations. They were exclusively specialists with experience conducting compliance observations.

In the preintervention phase, the persons performing the ADC were informed that the ADC process would be observed and were asked to ignore the observers and to continue their daily routines. Additional instructions on how to correctly perform the ADC were not given. In the intervention phase after off-the-job training had occurred, the ADC was attended by members of the infection prevention team to aid the ADC process at the patient's bedside. In the postintervention phase, no assistance was given during the ADC process. Occasionally, possible errors were discussed after the ADC with the infection prevention team observer, if demanded by a performer. If this was the case, observations of the whole team were not continued for the day.

Statistical analysis

A χ^2 test was performed to calculate the statistical differences in ADCC adherence between the preintervention and postintervention phases. For the analysis of the duration of ADC in the before-and-after comparison, a 2-sided t test was performed for independent samples. A β regression with logit-link was used to investigate the influence of the intervention, the number of persons performing the ADC, mixed gender, and mixed professional groups performing the ADC on the ADCC adherence during the whole ADC, including all necessary hygiene steps.[19] ADCC adherence was determined as the proportion of correctly executed necessary hygiene steps during an ADC. Hence, the ADCC adherence ranged between 0 (all hygiene steps were not or wrong executed) and 1 (all hygiene steps were executed correctly). In the β regression with logit link, the odds ratio is used as a measure of association between exposure (ie, intervention) and ADCC adherence. An odds ratio >1 indicates an increased occurrence of an ADCC adherence of exposed ADCs compared to nonexposed ADCs. An odds ratio <1 indicates decreased ADCC adherence during exposed ADCs compared to nonexposed ADCs. The significance level was set at $P < .05$. Cohen d and the ϕ values were calculated as measures of the effects.

Results

To facilitate the implementation and the performance of the defined ADCC, the sequence of process steps was standardized, and various tailoring measures were accomplished (Table 2). Process interruptions did not occur throughout the study phases.

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Table 1. Implementation Tools for Tailoring Hygiene Measures for Local Conditions and Increasing Adherence to Process Steps during ADC[a]

Tool	Process Step
Targeted implementation tools for tailoring	
Bed dispensers for hand disinfectants at the respective patient's bedside	Hand disinfection
Taking the dressing trolley into the patient's room	Ensure an aseptic storage area
Sterile disposable trays for the transport of dressing material into isolation rooms	Ensure an aseptic storage area in isolation rooms
Bin for used dressing material	Disposal of dressing material in appropriate waste
Allowance of glove disinfection between unclean and clean phases of dressing change	Hand disinfection
General implementation tools for tailoring	
Catchy names for implementation tools (eg, Hygpress = bed dispenser, Hygtab = sterile disposable trays, Hygweg= bin for used dressing material)	All
Strict standardisation of the dressing change process based on adherence rates of the preintervention phase (focus on improving poorly process steps)	All
Tailoring to local conditions of the dressing change process by using preintervention-phase data	All
Creation of awareness of difficulties by medical staff by using preintervention-phase data	All
Infection prevention link physician on ward level	
Feedback adherence of hand hygiene and process parameter of aseptic dressing change	All
Training program off and on the job only in intervention phase	All
Theoretical training in large groups off the job only in intervention phase	All
Practical training in small group off the job only in intervention phase	All
Individual training on the job	All

[a]The targeted implementation tools serve to support concrete process steps, and general implementation tools improve the overall process.

The ADCC was introduced and iteratively adopted during the intervention phase. The implementation was organized by theoretical and practical ADCC training for physicians off and on the job during the intervention phase. The theoretical and off-the-job training was performed by the PLP and was supported by the infection prevention team, which was also responsible for the on-the-job training of the routine. After one-half of the post-intervention phase, an additional off-the-job training session was held to discuss the results and to once again point out existing difficulties.

During the preintervention phase (March–August 2018), 331 ADCs with 1,655 hand hygiene indications and 3,310 process steps were observed; during the intervention phase (September–December 2018), 60 ADCs with 300 hand hygiene indications and 600 process steps were observed. During the postintervention phase (January–June 2019), 374 ADCs with 1,870 hand hygiene indications and 3,370 process steps were observed.

Preintervention-phase observations revealed the lowest hand hygiene adherence rates for the indications before the preparation of the ADC equipment (34%) and directly before the ADC (32%). The introduction of the ADCC significantly increased the hand hygiene adherence of all indications (Table 2). Similarly, the overall hand hygiene adherence of "all before indications" increased significantly from 10% before the intervention to 74% after the intervention ($P < .001$). The overall adherence of all necessary hand disinfections increased from 8% before the intervention to 74% after the intervention ($P < .001$) (Table 2). If all 3 "before" hand disinfections were conducted, hand disinfection was always conducted after an ADC.

Most process steps of ADC were improved by the standardized ADCC. Adherence significantly increased for dressing material was removed from the dressing trolley with disinfected hands, creating an aseptic storage area for filling of sterile dressing material, and handing out the wound dressing material directly by another person (Table 2).

The analysis of the ADCC adherence with the β regression shows that the odds of ADCC adherence during the ADC were 5.497 times greater during the intervention than before the intervention started ($P < .001$). After the intervention, the odds of ADCC adherence were 6.146 times greater than before the intervention ($P < .001$). The increase of the dressing team by 1 additional person results in 1.223 times greater odds of ADCC adherence ($P < .001$). We detected neither a significant effect of mixed-gender teams ($P = .387$) nor an effect of mixed professional groups (nursing with physician compared to physician alone) ($P = .368$), on the odds of the ADCC adherence (Supplementary Material 2 online).

The time needed to complete 1 ADC in the defined manner was measured during 24 preintervention-phase and 83 postintervention-phase ADC procedures, respectively. With the standardized ADCC, the duration in minutes of an ADC in the postintervention phase (mean $[M]_{minutes}$, 2.07 (2 minutes 4 seconds); 95% CI, 1.89–2.25; standard deviation [SD], 0.855) compared with that in the preintervention phase ($M_{minutes}$, 2.21 (2 minutes 13 seconds); 95% CI, 1.51–2.91; SD, 1.76) did not change significantly [$t(107) = .548$; $P = .585$; Cohen $d = -.101$].

Descriptive but not significant temporal training effects were identified in the postintervention phase for the duration of an ADC between the first 3 months ($M_{minutes}$, 2.41; SD, 0.63) and last 3 months ($M_{minutes}$, 2.01; SD, 0.87; [$t(82) = 1.488$; $P = .070$]). The number of people involved in ADCs in the postintervention phase (mean $[M]_{people}$, 2.12; 95% CI, 2.05–2.19; SD, 0.625) compared with that in the preintervention phase (M_{people}, 1.50; 95 % CI,

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Table 2. Preintervention Versus Postintervention Phase Comparison of Adherence to Hand Hygiene and Process Steps of an ADC[a]

Process Step	Process Parameters and Indications	Phase	Sum of Required Situations	Times Done	Adherence, %	*P* Value	χ^2	ϕ
Hand hygiene during dressing change	Before preparation of aseptic dressing change equipment	Pre	331	112	34	<.001	193.400	−.541
		Post	374	318	85			
	Immediately before aseptic dressing change	Pre	331	105	32	<.001	219.792	−.558
		Post	374	323	86			
	Before clean phase	Pre	331	139	42	<.001	240.618	−.584
		Post	374	357	95			
	Overall adherence to all before indication of aseptic dressing change	Pre	331	32	10	<.001	291.306	−.643
		Post	374	275	74			
	After aseptic dressing change	Pre	331	246	74	<.001	99.481	−.378
		Post	374	371	99			
	Overall adherence to all necessary hand disinfections of aseptic dressing change	Pre	331	25	8	<.001	312.673	−.666
		Post	374	275	74			
Process steps of unclean phase	Creation of aseptic storage area	Pre	331	44	13	<.001	143.769	−.514
		Post	214	134	63			
	Don low-germ gloves	Pre	331	238	72	<.001	7.177	.101
		Post	374	301	80			
	Removal of the old dressing without contamination of the wound and environment	Pre	331	236	71	<.001	39.435	−.237
		Post	374	336	90			
Process steps of clean phase	Cleaning of wound	Pre	106	66	62	.254	1.295	.075
		Post	124	68	55			
	Dressing material was removed from the dressing trolly with disinfected hands	Pre	331	25	8	<.001	130.121	−.360
		Post	374	288	77			
	Handing out the dressing wound material directly by another person (not deposited on the storage area)	Pre	306	73	24	<.001	340.959	−.719
		Post	353	332	94			
	Handing out the dressing wound material with disinfected hands	Pre	61	31	51	<.001	23.815	−.246
		Post	331	265	80			
	Application of sterile dressing material without contamination	Pre	331	270	82	<.001	39.836	−.238
		Post	374	360	96			
Process steps of postprocessing	Disposal of dressing material in appropriate waste	Pre	331	13	4	<.001	123.925	−.419
		Post	374	146	39			
	Wipe disinfection of aseptic storage area	Pre	331	10	3	<.001	90.236	−.468
		Post	81	31	38			

Note. Pre, preintervention; Post, postintervention.
[a]Adherence is measured for each step. The process steps are divided into necessary hand disinfections during dressing changes and steps of the unclean and clean phases.

1.44–1.56; SD, 0.586) significantly increased [$t(677) = -13.245$; $P < .001$; Cohen $d = 1.03$].

Discussion

In this intervention, we aimed to increase adherence to hand hygiene indications and performance of the ADC process, as well as the correct execution of the individual process steps through a new aseptic ADCC tailored to an orthopedic and trauma surgery department. The ADCC was implemented by a PLP. As a result of introducing the standardized ADCC, hand hygiene adherence in all 4 indications significantly increased compared to the preintervention phase and exceeded 80% in the postintervention phase. Again, the hand hygiene adherence for the overall before indications for an ADC significantly increased from 10% in the preintervention phase to 74% in the postintervention phase, thus exceeding the German average of 66% before clean or aseptic procedure on general wards.[8]

The increase in adherence was achieved by implementing an ADCC developed by an interdisciplinary team from the departments of trauma surgery and infection prevention and control. The concept was tailored to the local setting to structure, simplify, and standardize the difficult and complex ADC process. Implementation was managed by an interdisciplinary team led by the PLP and included on- and off-the-job training and regular feedback to physicians in the trauma surgery and orthopedics

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department by the infection prevention team. Our findings were consistent with previous studies reporting that monitoring, feedback, and off-the-job training could increase hand hygiene adherence.[20-23] Furthermore, the tailoring and facilitating efforts may have increased hand hygiene adherence. Additionally, patient beds were equipped with hand disinfectant dispensers in the intervention phase, which have been proven to promote hand hygiene adherence by increasing disinfectant availability and indirectly reminding staff to perform hand hygiene.[24,25]

Process observations during the preintervention phase showed that several employees were not aware of the incorrect implementation of hygiene measures or the omission of hand disinfection in the hygienic process.[26] The targeted training with theoretical and practical components efficiently addressed knowledge gaps and integrated the standardized ADCC in the daily working routine.

The process steps that showed a significant increase in adherence were (1) creating an aseptic storage area, (2) removal of dressing material from dressing trolleys with disinfected hands, (3) handing of dressing material by another person, and (4) applying the dressing materials with disinfected hands. In the preintervention phase, creating an aseptic storage area was mostly neglected. Therefore, creating an aseptic storage area became an important part of the standardized ADCC and was intensively discussed during training and process support. The medical staff was given several options to generate this storage area: bringing the dressing trolley into the patient's room and cleaning it with a surface disinfectant, covering it with a sterile cloth before use, or using a disposable tray for isolation rooms and being given the dressing material by another person with disinfected hands. The procedure of being given the dressing material directly from the dressing trolley by another person was used more frequently in the postintervention phase than the creation of a sterile storage area (Table 2). One reason for this could be that it saved wipe disinfection of a storage area at the beginning and end of the ADC process, allowing the process to be more quickly completed. Moreover, this procedure required a brief coordination of the division of tasks before the start of the ADC and probably increased team building. In the postintervention phase, more persons were actively involved in the ADC process than in the preintervention phase. The involvement of several individuals in the ADC process may have facilitated the provision of sterile dressing material. Additionally, the unclean and clean work steps could be divided between persons performing the ADC, leading to a seamless transition between those phases. While one person performed the unclean phase of the ADC, the second person had already disinfected their hands and awaited the end of the disinfectant's reaction time to continue with the clean phase without any process interruptions.

During the presentation of the standardized ADCC, the medical staff was concerned that adopting the new concept would require additional process time. Required time for individual ADCs was measured in the preintervention and postintervention phases. No significant differences in ADC performance time were observed, although up to 2 additional hand disinfections were conducted in the postintervention phase, which could be due to the high level of standardization and the involvement of more persons in the ADC process. Time measurements in the postintervention phase were randomly documented throughout postintervention phase. No significant differences in the duration of ADCs were identified between the preintervention phase and the postintervention phase or within the postintervention phase. This could be due to the fact that the number of process steps remained the same and the duration of the individual process steps was so short that there was no significant time savings due to a training effect.

Our results show that the implementation of infection prevention measures by a PLP is a promising strategy to significantly increase adherence to hand disinfection and process parameters. Along with the basic conditions, personnel conditions such as abilities and attitudes, leadership support, commitment to change, and the initiator of the aspired changes play important roles. Local champions who propose and organize the implementation are important for the introduction of new measures.[27-30] Our results also show that the use of a surgeon as PLP, primary stakeholder, and local champion for the implementation of infection prevention measures is beneficial and can potentially be transferred to any setting worldwide.[31]

Our study has several limitations. The ADCs were only observed on weekdays during the early shift. More mistakes may have been made in the postintervention phase during weekend and late shifts. On weekends, there is usually only 1 physician on duty, so that person is responsible for the ADC, and clean versus unclean steps cannot be divided among several people. However, on-the-job dressing change training by the PLP also includes training on how to perform an ADC alone. Fewer ADCs are performed on weekends and late shifts than during the week because fewer patients are admitted as inpatients and no elective operations are performed. Thus, the proportion of ADCs may not have had a large impact on the study results. Another limitation is that the staff may have been influenced by the presence of the observer and may have unintentionally improved hand hygiene adherence (Hawthorne effect).[32,33] To reduce this effect as much as possible, observers remained in the background. The observed study participants were also asked to ignore the observers and continue their normal routine. Additionally, 15-month duration of the study may have weakened this effect as being observed became routine. ADC is an extraordinarily complex activity, which is difficult to perform by nature, and it tends to be unstructured and ambiguous.[34,35] This high level of complexity was challenging and may have led to some mistakes. For this reason, observations in the preintervention and postintervention phase were conducted by the same, trained persons to ensure accuracy and interrater reliability. This was a single-center study, and it is unclear whether the adopted ADCC can be transferred to other surgical departments or to other medical procedures.

After the introduction of the standardized ADCC, significant increases in hand hygiene adherence in all indications of the ADC were achieved. The ADCC was based on continuous process observations and was successfully introduced and customized during the intervention phase through theoretical and practical training by the PLP.

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