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Qualitative Study

The persistent breach between evidence and practice in the prevention of surgical site infection. Qualitative study

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ABSTRACT

Background: Despite the dissemination of guidelines for surgical site infection (SSI) prevention, a gap between the theoretical measures and their compliance persists. Accurate estimates of the implementation of preventative measures is crucial before planning dissemination strategies.

Methods: A web-based survey was distributed to members of 11 Associations of operative nurses and surgeons. Questions aimed to determine their awareness of evidence, personal beliefs and actual use of the main preventative measures.

Results: Of 1105 responders, 50.5% receive no feed-back of their SSI rate. Responders show a moderate rate of awareness of the recommendations about not removing hair, hair clipping, skin antisepsis with alcoholic solutions, and normothermia. Antibiotic prophylaxis is given for more than 24 h by 18.8% of respondents. Screening for *S. aureus* is performed by 27.6%. Hair removal by shaving is used by 16.6% of responders. The most common

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antiseptic solutions are alcoholic chlorhexidine (57.2%) and aqueous povidone (23.3%). 62.8% of surgeons allow the solution to air dry before applying surgical drapes. Adhesive drapes in the surgical field are used routinely in 33.4% of cases. Perioperative normothermia, glucose control and hyperoxia are used in 84.3%, 65.9% and 23.3% of cases. Antimicrobial sutures and negative pressure therapy are used by 20.2% and 43.5% of teams, respectively. Prior to closing the incision, 83.9% replace surgical instruments always or selectively. Wound irrigation before closing is used in 78.1% of cases, mostly with saline. Check-lists, standardized orders, surveillance, feedback and educational programs were rated most highly by respondents as a means to improve compliance with preventative guidelines, but few of these strategies were in place at their institutions.

Conclusion: Gaps in the translation of evidence into practice remain in the prevention of SSI among different surgical specialities. Several areas for improvement have been identified, as some core prevention measures are not in common use.

1. Introduction

Postoperative infections continue to be the most common complication among patients undergoing any type of surgery, and can represent up to 25% of hospital-acquired infections globally [1–3]. The development of a surgical site infection (SSI) causes a substantial increase in the economic burden of surgery, due to prolonged hospitalisation, associated morbidity, diagnostic tests, and treatment [4].

More than fifty specific measures with the potential to reduce SSI rate have been investigated. Periodically, national and international health organizations analyse the evidence of these proposed preventative measures and grade it in the form of clinical practice guidelines. These guidelines should be the translation distillation of all this knowledge into recommendations based on systematic reviews and meta-analysis, and their dissemination should improve outcomes and infection rates in a uniform way among hospitals and among surgeons. However, the level of awareness of and compliance with preventative protocols for SSI seems to be highly variable, as gaining acceptance and compliance requires substantial individual, cultural and organizational changes.

Surgeons are often identified as being key factors in non-compliance; some being unable to change personal and professional behaviour to comply with protocols and checklists [5]. In previous studies among general [6] and colorectal surgeons [7] our group found a low level of awareness about some preventative measures and many areas for improvement were detected to be addressed by scientific societies and health organizations.

The present study was designed by the Observatory of Infection in Surgery to understand the current level of compliance with these guidelines by a range of surgical specialists, prior to grouping the most important preventative measures into bundles and planning a dissemination strategy that could increase their level of implementation at a national level.

2. Methods

A Web-based survey (SurveyMonkey; https://es.surveymonkey.com/r/BKSJG9D) was distributed to members of the association of perioperative nurses and 10 surgical associations of different specialities at a national level. A link to the site page containing the survey was distributed via email, newsletter and Twitter. The survey was open for 60 days. The questionnaire was designed by a core team with previous experience in conducting scientific surveys, and was submitted for evaluation to a panel of experts belonging to the 11 surgical societies participating in the study. The resulting survey contained 48 general questions aimed at evaluating the practices of perioperative nurses and surgeons in preventative measures of SSI prevention endorsed by international guidelines. The questions of the survey can be found in eAppendix 1. At the end of the questionnaire there were specific questions for each surgical specialty. Furthermore, the questions addressed the level of agreement between their beliefs and the protocols or the usual practice of their units. The agreement rate between the beliefs and the usual practice of all respondents was calculated on a scale from 0 to 100. Other questions were related to those policies already in place or that should be introduced to reduce SSI at respondents' hospitals.

The responses were compared with the recommendations of the most recent clinical practice guidelines: the WHO [8] and CDC [9] guidelines, plus The National Institute of Health and Clinical Excellence (NICE) Guideline (2008 [10] and 2019 update [11]); the Clinical Practice Guide for Surgical Patient Safety of the National Health System of Spain (2010) [12]; the Canadian Patient Safety Institute Guideline (2014) [13]; the 2014 update of the SHEA/IDSA Recommendation [14] the National

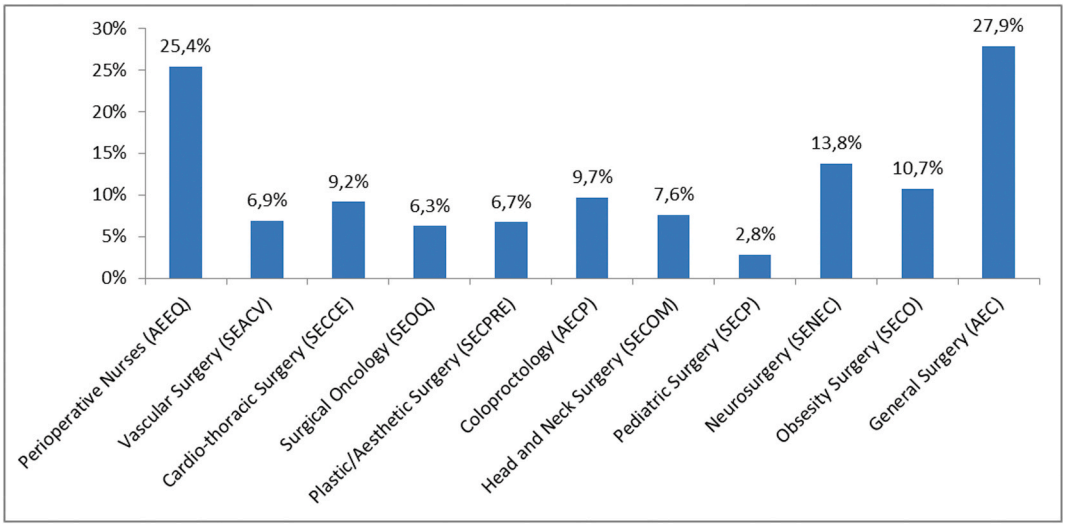

Fig. 1. Distribution of respondents according to their surgical society.

Table 1
Summary of results.

Demography of respondents		
Ownership of hospital	National Health Service	Private
	925/1092 (84.7%)	167/1092 (15.3%)
Type of hospital	Academic centre	Non-academic centre
	588/1092 (53.8%)	504/1092 (46.2%)
Size of the hospital	<500 beds	>500 beds
	548/1086 (50.5%)	538/1086 (49.5%)
Years of experience	<20 years	>20 years
	687/1087 (63.2%)	400/1087 (36.8%)
Feed-back SSI rates	Yes	Not
	388/784 (49.5%)	396/784 (50.5%)
Hospital protocols		
Safety policy/protocol in the operating theatre	Yes	Not/don't know
	602/786 (76.6%)	184/786 (23.4%)
Policy/protocol for prevention of SSI	Yes	Not
	684/785 (87.1%)	101/785 (12.9%)
Preoperative surgical prevention measures		
Preoperative nutritional assessment	Yes	Not
	281/758 (37.1%)	477/758 (62.9%)
Nutritional supplement in well-nourished	Yes	Not
	115/747 (15.4%)	632/747 (84.6%)
Antibiotic prophylaxis	<24 h	>24 h
	623/767 (81.2%)	144/767 (18.8%)
Screening for *Staphylococcus aureus*	Yes	Not
	194/704 (27.6%)	510/704 (72.4%)
Preoperative bath or shower	Yes	Not
	704/745 (94.5%)	41/745 (5.5%)
Place of bath or shower	Home	Hospital
	243/639 (38.0%)	396/639 (62.0%)
Product for bath or shower	Bar soap	Antiseptic soap
	269/697 (38.6%)	428/697 (61.4%)
Hair removal policy	Never	Always/sometimes
	76/744 (10.2%)	668/744 (89.8%)
Main method of hair removal	Razor	Clipper
	117/704 (16.6%)	587/704 (83.4%)
Place of hair removal	Inside the OR 157/726 (21.6%)	Outside the OR 569/726 (78.4%)
Product for first hand scrub	Antiseptic soap	Alcoholic solution
	671/744 (90.2%)	73/744 (9.8%)
Product for successive hand scrubs	Antiseptic soap	Alcoholic solution
	473/743 (63.7%)	270/743 (36.3%)
Product for patient skin antisepsis	Alcohol solution	Aqueous solution
	474/721 (34.3%)	247/721 (65.7%)
Method for skin antisepsis	Brushstroke	Single-use applicator
	632/723 (87.4%)	91/723 (12.6%)
Antiseptic bottle	Single-use (<50 ml)	Multiple-use (>250 ml)
	168/696 (24.1%)	528/696 (75.9%)
Method of application	Concentric circles	Back-and-forth
	459/679 (62.9%)	220/679 (30.1%)
Number of layers of antiseptic	One	Two or more
	374/730 (51.2%)	356/730 (48.8%)
Antiseptic drying and drapes applying	Apply drapes after air drying	Apply drapes after manual or no drying
	459/730 (62.9%)	271/730 (37.1%)
Surgical drapes	Plastic	Cotton
	686/731 (93.3%)	45/731 (6.7%)
Plastic adhesive drapes	Always/sometimes	Never
	520/682 (76.2%)	162/682 (23.8%)
Intraoperative surgical prevention measures		
Gloves	One pair	Two pairs
	522/680 (76.8%)	158/680 (23.2%)
Gloves changing	At end of anastomosis/operation	Never
	523/681 (76.8%)	158/681 (23.2%)
Normothermia	Yes	Not/unknown
	560/664 (84.3%)	104/664 (15.7%)
Hyperoxia 0,80	Yes	Not/unknown
	156/669 (23.3%)	513/669 (76.7%)
Glucose control	Yes	Not
	439/666 (65.9%)	227/666 (34.1%)
Drainages	Try to avoid	Routine use
	297/670 (44.3%)	373/670 (55.7%)
Cavity lavage at the end of surgery	Yes	Never
	576/666 (86.5%)	90/666 (13.5%)
Product for cavity lavage	Saline	Antiseptic/antibiotic solution

(*continued on next page*)

Table 1 (*continued*)

Demography of respondents		
	407/666 (87.2%)	60/666 (12.8%)
Antiseptic coated sutures	Sometimes	Never
	137/678 (20.2%)	541/678 (79.8%)
Replacement of surgical instruments prior to closing incision (contaminated surgery)	Yes	Never
	555/673 (83.9%)	108/673 (16.1%)
Wound lavage before closing	Yes	Never
	531/680 (78.1%)	149/680 (21.9%)
Product for wound lavage	Saline	Antiseptic/antibiotic solution
	295/500 (59.0%)	205/500 (41.0%)
Negative pressure wound therapy (high risk surgery)	Sometimes	Never
	291/669 (43.5%)	378/669 (56.5%)

Health Service Scotland Guideline (2015) [15], and the American College of Surgeons and Surgical Infection Society: Surgical Site Infection Guidelines, 2016 Update [16].

The project was registered with the ClinicalTrials.gov Identifier: NCT04310878, and has been reported in line with the "Consolidated criteria for Reporting Qualitative Research (COREQ)" criteria. The results are expressed in percentages of the total answers obtained. Responses were entered into a computerized database that was analysed using the SPSS program (v.10.0, Chicago, IL, USA). To analyse the relationship between two categorical variables, the chi-square test has been used. Statistical significance was defined at $p < 0.05$.

3. Results

A total of 1105 nurses and surgeons answered the survey. Their distribution according to their Association is shown in Fig. 1. Half of respondents work in high-volume teaching centres, most of them pertaining to the National Health Service. Demographics of the respondents and the actual level of use of preventative measures are summarized in Table 1.

Up to 50% of respondents have no regular institutional feed-back of their SSI rate, with significant differences among surgical specialities. Cardiac (77.5%; $\chi 2$ 18.86, $p < 0.001$) and Colorectal surgeons (68.4%; $\chi 2$ 8.85, $p < 0.001$) receive more feed-back, while Head and Neck surgeons receive less (29.8%; $\chi 2$ 8.78, $p < 0.05$.

Overall, respondents showed a moderate level of awareness of the recommendations of international guidelines, as some practices recommended in most guidelines were scarcely used, such as no hair removal (10.2%), preoperative nutritional assessment in major surgery (37.1%), alcohol solutions for skin preparation (65.7%) or perioperative normothermia (84.3%). There were significant differences in the use of preoperative nutritional supplements for well-nourished patients, which were more used by respondents from the Societies of Colorectal (44.7%; $\chi 2$ 52.85, $p < 0.001$), General (32.4%; $\chi 2$ 62.64, $p < 0.001$), Surgical Oncology (33.3%; $\chi 2$ 10.11, $p < 0.05$) and Bariatric Surgery (29.2%; $\chi 2$ 13.28, $p < 0.001$).

When comparing the awareness of evidence and actual practice (Fig. 2), two patterns of responses were found. First, a pattern of a good level of agreement, with less than a 15% difference between the perception and the implementation rate. For instance, the respondents know there is not enough evidence for the use of an increased fraction of inspired oxygen, negative pressure therapy on the closed wound or antiseptic coated sutures, and consistent with this perception, they are not using them. By contrast, a different pattern shows a high level of disagreement between the perception of evidence and the practice of the respondents. Many of them reported removing hair from the surgical field, and 27% still do it by shaving, even though more than 40% of them are aware of the evidence against these preventative measures. Similarly, the evidence supporting maintenance of preoperative normothermia, plastic wound retractors, alcoholic solutions for skin preparation, surgical site lavage, glove changing and wound irrigation are considered low, but they are widely used practices.

When asking not only about their awareness of scientific evidence, but also their personal beliefs, the results are slightly different (Fig. 3). If evidence perception and beliefs are considered together, many measures recommended by guidelines are also supported by respondents (no hair removal, clipping, alcoholic solutions), and many other measures with a low level of evidence, but based on common surgical good sense and included in several preventative bundles, have a high rate of acceptance (change of surgical instruments before closing the wound or glove changing).

Regarding antibiotic prophylaxis, Fig. 4 shows the perceived barriers preventing staff from following protocol appropriately. Most respondents felt that forgetting prescription or administration due to concurrent tasks, lack of hospital protocol, of precision on who is responsible for prescribing the antimicrobials, and lack of verbal communication among team or computerized decision support were the most common reasons for failing to administer antimicrobials properly.

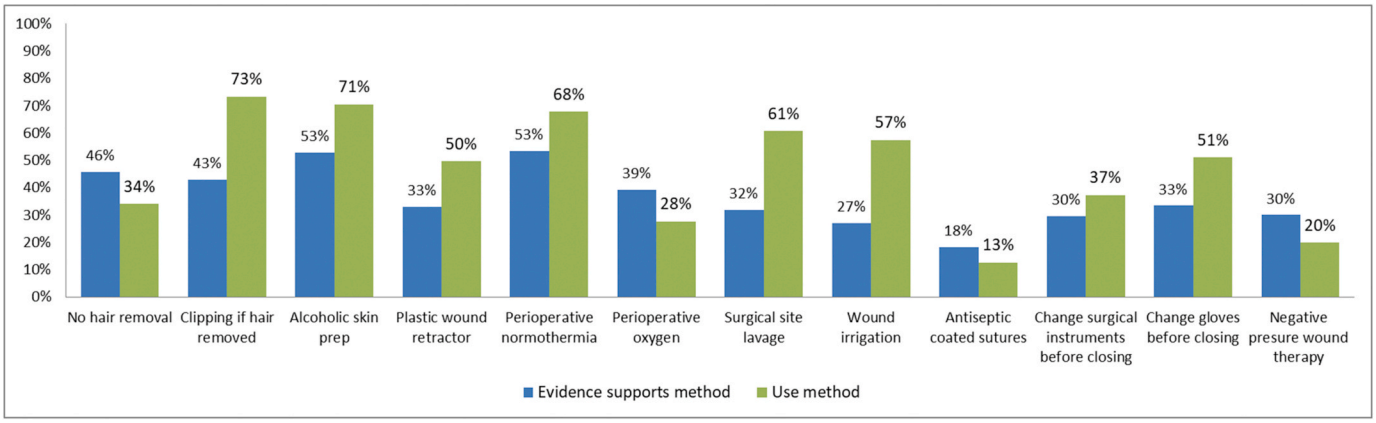

Fig. 2. Percentage of awareness of clinical evidence supporting each preventative measure, compared with the percentage of actual use.

The best adherents with the recommendations on a single preoperative dose were General (76.4%), Bariatric (73%), Surgical Oncology (76.6%) and Colorectal (69.7%) surgeons. Antimicrobials are administered always in the ward by 10.7% of respondent teams. Almost 19% of respondents extend prophylaxis for more than 24 or even 48 h, almost exclusively Head and Neck (42.5%), Cardiac (41.2%) or Paediatric (11.8%) surgeons (Figs. 5 and 6).

Screening for *S. aureus* is performed by 27.6% of surgical teams, in particular in Cardiac Surgery (60.3%). Only 2.6% of respondents have a hospital policy against hair removal, which is always performed by

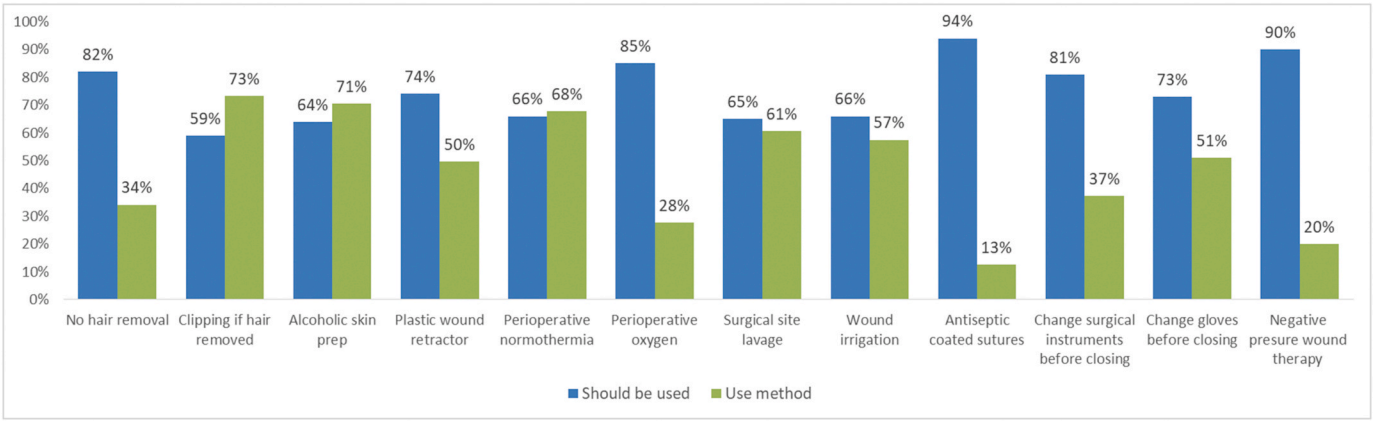

Fig. 3. Comparison between respondent's opinions (awareness of evidence + beliefs) and actual usage of preventative methods.

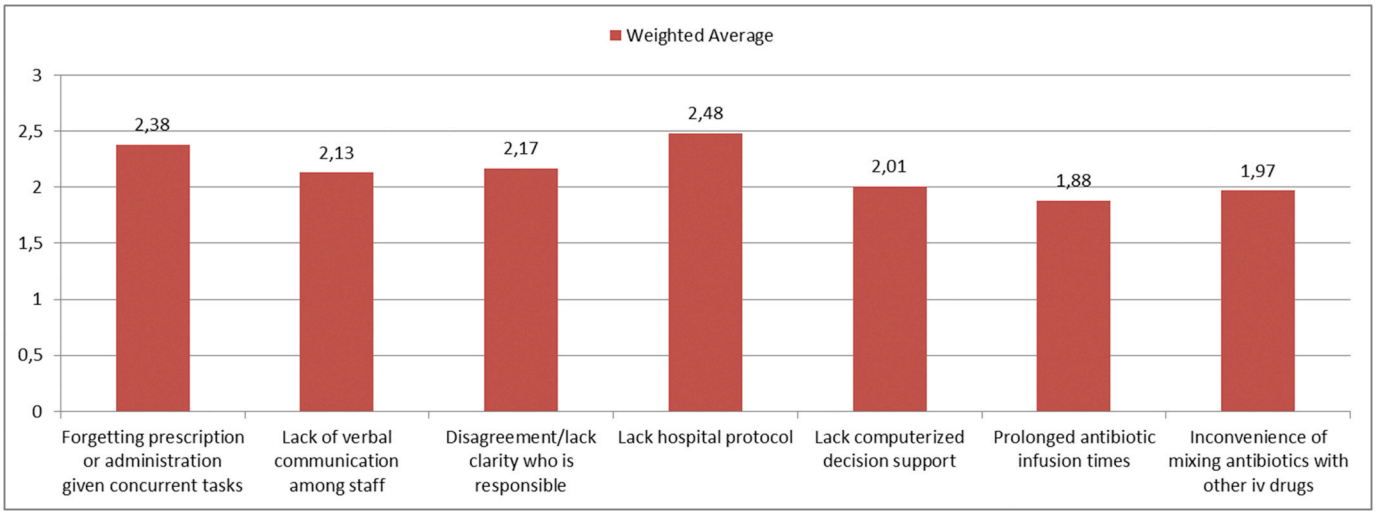

Fig. 4. Respondents' rating in a scale 0–3 for factors influencing the correct implementation of the antibiotic prophylaxis protocol. Scale: 0 less important, 3 very important.

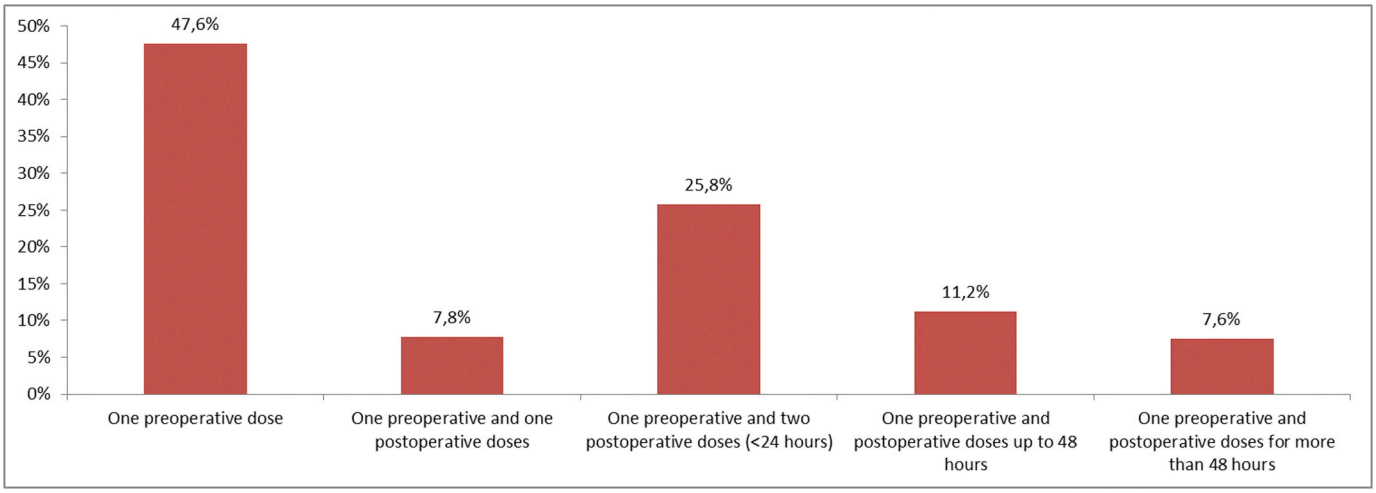

Fig. 5. Overall results on duration of antibiotic prophylaxis (all specialities).

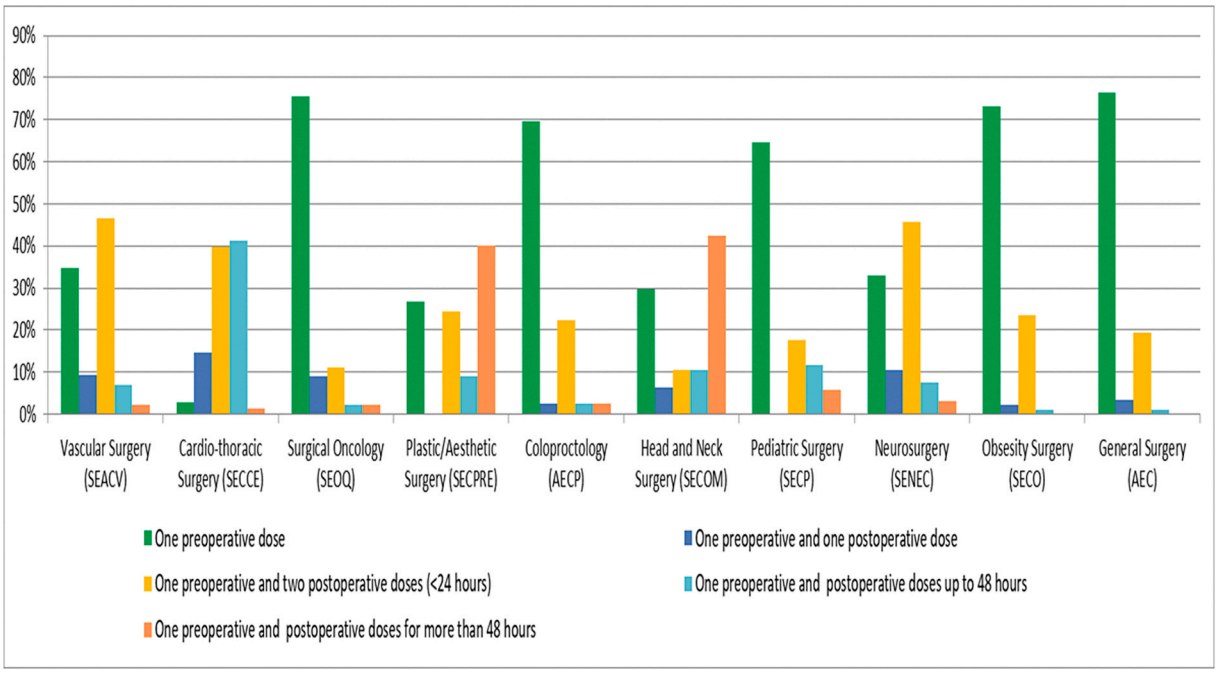

Fig. 6. Duration of antibiotic prophylaxis by different speciality.

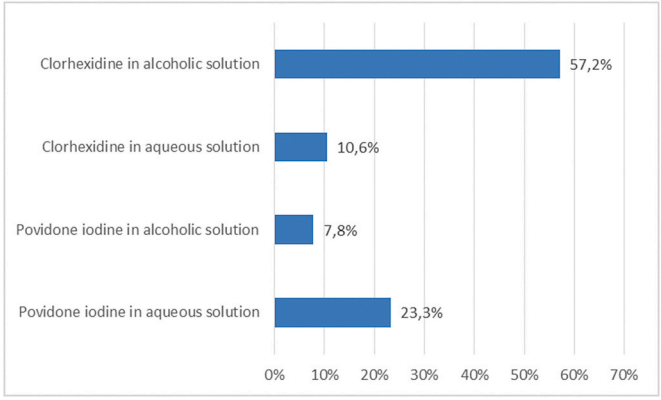

Fig. 7. Antiseptic solutions used for patient's skin preparation.

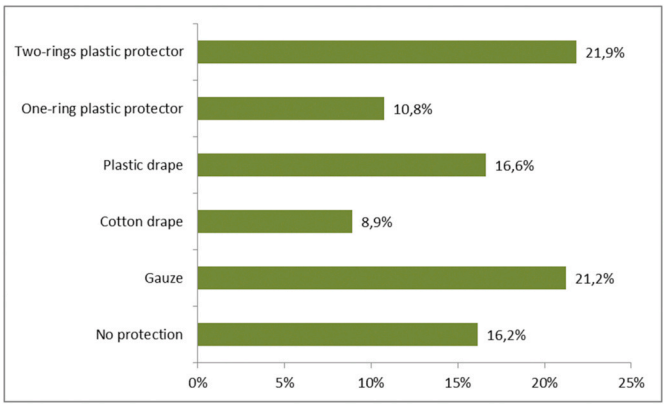

Fig. 8. Methods used for wound edge protection.

89.8% of them. Hair removal by shaving is still used by 16.6% of respondents, and is performed in 5.1% of cases by the patient and in 21.1% inside the operating theatre. The most common antiseptic solutions are alcoholic chlorhexidine (57.2%) and aqueous povidone (23.3%) (Fig. 7). Only 62.8% of surgeons allow solution to air dry before applying surgical drapes, 30.8% are in the habit of drying the antiseptic with gauze or absorbent paper, and 6.3% apply drapes before the solution is dry. At the same time, 32.6% of respondents knew about a safety problem or incident related to the use of alcoholic solution use in their theatres.

Adhesive drapes in the surgical field are used routinely in 33.4% of cases, and 76.8% of responders operate with a single pair of gloves. A non-impervious device for wound edge protection is used in 30.1% of operations, while 16.2% of respondents do not protect edges (Fig. 8). Perioperative normothermia, glucose control and hyperoxia are used in 84.3%, 65.9% and 23.3% of cases, respectively. Most teams combine different methods to warm patients, such as forced-air blanket (90%), warming mattress (25%) and liquid warming sets (50.8%).

Antimicrobial sutures are rarely used to prevent infection (20.2%), probably because 31% of surgeons believe there is no evidence for its use, and 19% are not aware of them. At the end of a clean-contaminated procedure, 34.2% of teams report always replacing surgical instruments before incision closure, 47.6% change them selectively and 16.1% never do so. Wound irrigation before closing is used in 78.1% of cases, mostly with a saline solution.

Most respondents felt that there was a high discrepancy between published guidelines and actual clinical practice, which translates into an overall disagreement rate of 70%. National and international guidelines have been mostly rated as important or very important by respondents (Fig. 9). As methods of bringing practice closer to evidence, educational programs (79.6%), Enhanced Recovery After Surgery (ERAS) protocols (75.5%), a specialty SSI coordinator (73%), provider specific feed-back (71.1%), standardized orders (62.5%), and surveillance of infection (50.6%), are most highly rated by respondents, but few of these strategies are in place at their institutions (Fig. 10).

4. Discussion

Surgical infections have become one of the most important health-

care associated infections (HAIs) and pose increased cost, morbidity and mortality. If SSI have such a big impact on patient outcomes, it would seem logical to apply any available measure to prevent them.

Anonymous surveys can be a very useful tool for identifying problems regarding compliance, or why staff fail to follow protocols in specific areas of interest. Despite the publication of several clinical guidelines for the prevention of SSI during the last decade, compliance with passively disseminated policies is poor [6,7,17]. This study was aimed at analysing not only the level of adherence to preventative measures by different surgical specialists, but also at knowing their beliefs and level of awareness of the published evidence.

4.1. Contributions of the study

It is quite astonishing that half of the respondent surgeons do not routinely receive feedback about their SSI rate. Significant differences were found among specialities, with cardiothoracic and colorectal being the specialities with the highest rate of feedback, and unfortunately some other specialities, such as head and neck, obesity and vascular surgery providing a very low level of feedback to their surgical teams.

Although guidelines have been considered important, in some topics a low rate of awareness and compliance of the recommendations of international guidelines has been shown. When not only the perceived level of evidence, but also the personal beliefs of respondents are added, the results are different, as many measures well considered by guidelines are better rated by respondents. The comparison of Fig. 2 with 3 illustrates these differences. Although this may be true, their level of implementation of the main recommendations is still low.

Particularly worrisome are the low rate of preoperative nutritional assessment before major surgery, the policies on hair removal (including a rate of 21% of hair removal inside the operating theatre), the high level of use of plastic adhesive drapes on the surgical field, and the products and methods for skin antisepsis (66% aqueous solutions, 87% of brushstroke application, 76% of multiple-use antiseptic bottles, 30.8% of manual drying after antiseptic application). It should be remembered that, regardless of the antiseptic used, allowing time for the preparation solutions to air dry is imperative to maximize its efficacy and prevent a fire hazard [9]. In addition, the habit of drying the antiseptic with absorbent paper can lead to a break of antisepsis if areas not treated with antiseptic are inadvertently touched. Likewise, fire safety policies

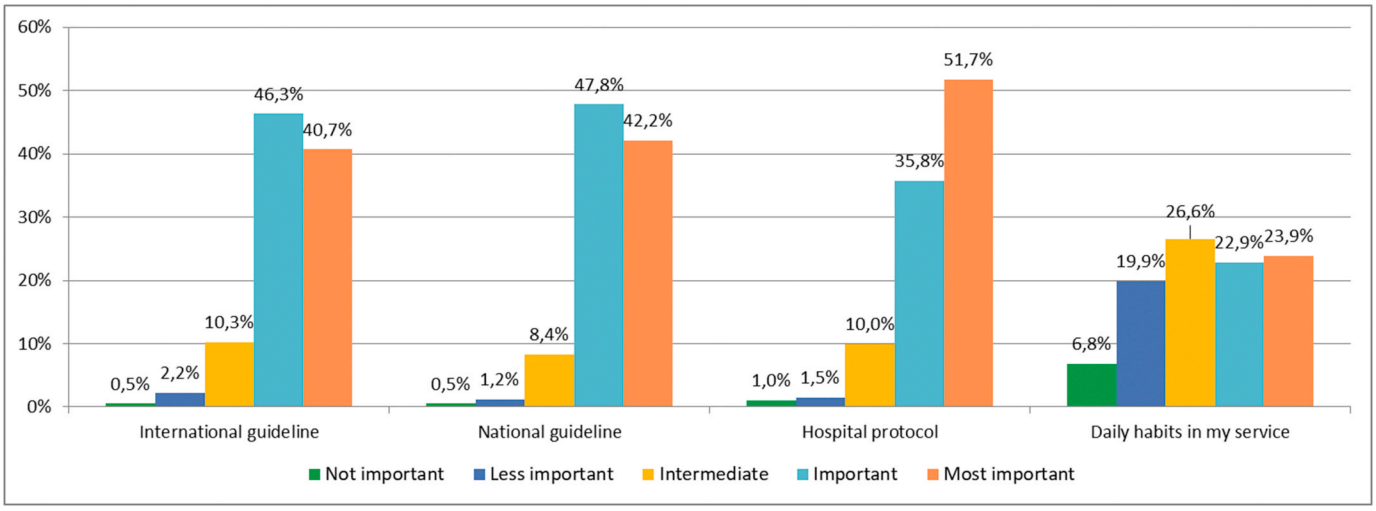

Fig. 9. Indicate how important each of the factors is when designing surgical site infection prevention strategies for your patients.

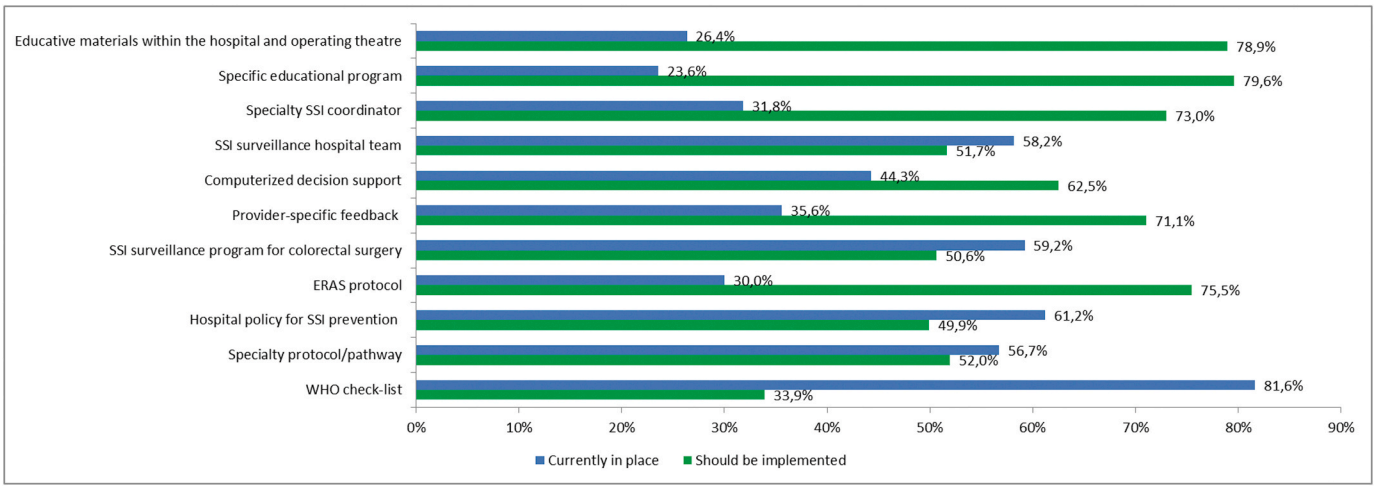

Fig. 10. Proportion of respondents who believe the prevention strategies should be implemented compared with their actual implementation. WHO = World Health Organization; SSI = surgical site infection.

should be reinforced, as only two thirds of respondents allow the solution to air dry and 6% apply drapes even when the solution is not dry. An excessive prolongation of antibiotic prophylaxis has been also detected, as some specialists extend prophylaxis for more than 24 h, in special Cardiac, Aesthetic and Head & Neck surgeons.

Not all prophylactic measures can be or have been sufficiently evaluated. Nonetheless, despite a lack of evidence some measures are universally accepted by the surgical community resulting from common sense and clinical practice. Among them, organ/space surgical site lavage and wound irrigation at the end of the procedure can be listed. Surgical site lavage at the end of operation is an unresolved issue and the recommendations of the guidelines are disparate [9–17], but our study shows a widespread custom of performing cavities and wound lavage with saline, and a less extended use of antiseptic or antibiotic solutions.

Few surgeons use double gloving in this study (23.2%). There is a high rate of perforation of the gloves during surgery, and it has been shown that the addition of a second pair of gloves reduces perforations of the innermost gloves [18]. However, there is no evidence to correlate glove perforation rate and incidence of SSI. Despite this, some institutions have included double gloving in their recommendations, including the Royal College of Surgeons of England (2005) and NICE (2008). Although there is no solid evidence in this regard, there seems to be room for improvement in the glove changing policy, given that only 30.4% of surgeons change them at the end of a digestive anastomosis, 34.8% do not do so before closing the incision and 23.2% never change them.

Replacement of surgical instruments and ancillary devices before closing the surgical wound in clean-contaminated surgery, although recommended by surgical common sense, has a low level of scientific evidence, with some bundles which include the measure having negative results [19,20]. The high rate of instrument replacement in the survey is noteworthy (83.9%).

Altogether, the results support our hypothesis that there is an actual breach between the recommendations of the main clinical guidelines and daily clinical practice in SSI prevention. Moreover, the comparison between the beliefs of the respondents and their usual practice also showed remarkable differences.

The literature on knowledge translation warns of the difficulties related to uptake and compliance with guidelines [21]. Studies have previously shown a significant mismatch between the best scientific evidence and clinical practice as far as SSI prevention is concerned. These results demonstrate that many senior surgeons fail to follow the best surgical practices despite being aware of the evidence underlying them. Most respondents of the survey are aware of the problems associated with converting knowledge into to surgical practice, and suggest different strategies to solve it. The Normalization Process Theory [22], is a descriptive model that may help researchers and clinicians to improve practice, and perhaps may facilitate the introduction of multifaceted processes and new technologies in health systems [23].

Some surveys with similar goals have been published, but most have been done in narrower fields [17,24,25], very specific procedures (such as coronary artery by-pass [26], caesarean sections [27], or arthroplasty [28]. A few surveys have been addressed to operating room nurses [29], and others to members of surgical societies, such as general [6], colorectal [7] or paediatric surgery [30]. The present study collects the opinions of perioperative nurses and surgeons from a range of specialities at a national level, and is also the one that with the highest number of responses.

4.2. Limitations of the study

This survey has several limitations. First, it is difficult to calculate accurately its response rate, given the uncertainty about the number of members of the different Societies who actually received the survey invitation. Online surveys are probably able to get a large number of responses at the expense of obtaining a low percentage of response. Nevertheless, the absolute number of respondents is high and seems sufficiently representative. Furthermore, there seems to be a balanced representation of different types of hospitals (size, teaching and ownership) and surgical specialities, which suggests that the results can be generalized to the reality of surgical practice in the area of interest. These results, although drawn from surgical specialists in a single country, may well represent the actual use of preventative measures in European countries. Secondly, the study may also be limited by self-report bias; as self-reporting has been shown to overrate performance [31].

In summary, it seems that preoperative shower, surgical hand scrub of the surgical staff, use of impermeable surgical drapes and perioperative normothermia are the measures where current practice guidelines are most closely followed by operative nurses and surgeons. Other measures, such as organ/space surgical site lavage and wound irrigation with saline are frequently used, probably mainly because of surgical tradition. On the other hand, other measures which are highly recommended by the main guidelines are only loosely followed. Practices that can be beneficially modified include: the common practice of routine elimination of hair and razor shaving; the infrequent use of alcoholic-based solutions for cutaneous antisepsis; not allowing antiseptic solution to air-dry; the policy of intraoperatively changing gloves; and the use of liquid and bacterial permeable wound edge protectors.

5. Conclusions

Knowing the level of implementation of preventative measures and the level of awareness of the providers of the available scientific evidence is essential. Our results suggest that gaps in the translation of best evidence into actual practice in the prevention of SSI in surgery are persistent, even within academic environments. A national platform, such as the proposed Observatory of Infection, could be a way of unifying all these findings (such as surgeons' negative attitudes or non-compliance of measures) and could provide a comprehensive forum to disseminate solutions and improve education and compliance of SSI prevention practices. The active diffusion of homogenous SSI prophylactic recommendations supported by strong scientific evidence ought to reduce instances of SSI consistently. Implementation policies must concentrate not only on the professionals, but also on the context in which they perform.

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Data statement

The research data is deposited on the website which was used for the survey (https://es.surveymonkey.com), and has a specific identifier (SurveyMonkey; https://es.surveymonkey.com/r/BKSJG9D).

All data will be made available on request.

CRediT authorship contribution statement

Josep M. Badia: Study conception and design, Analysis and interpretation of data, Drafting of manuscript, Critical revision of manuscript. **Inés Rubio-Pérez:** Study conception and design, Analysis and interpretation of data, Drafting of manuscript, Critical revision of manuscript. **José López-Menéndez:** Acquisition of data, Critical revision of manuscript. **Cecilia Diez:** Acquisition of data, Critical revision of manuscript. **Bader Al-Raies Bolaños:** Acquisition of data, Critical revision of manuscript. **Julia Ocaña Guaita:** Acquisition of data,

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Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijsu.2020.08.027.

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