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A systematic review of surgical hand antisepsis using an alcohol preparation compared to traditional products*

REVISÃO SISTEMÁTICA SOBRE ANTISSEPSIA CIRÚRGICA DAS MÃOS COM PREPARAÇÃO ALCOÓLICA EM COMPARAÇÃO AOS PRODUTOS TRADICIONAIS

REVISIÓN SISTEMÁTICA SOBRE ANTISEPSIA QUIRÚRGICA DE MANOS CON PREPARACIÓN ALCOHÓLICA COMPARADA A PRODUCTOS TRADICIONALES

Karen de Jesus Gonçalves[1], Kazuko Uchikawa Graziano[2], Julia Yaeko Kawagoe[3]

ABSTRACT

Surgical hand antisepsis aims at preventing surgical site infections, an important cause of postoperative morbidity and mortality and escalating hospital costs. The objectives of this study were to compare the efficacy of alcohol preparations with traditional surgical hand antisepsis products by means of a systematic review of the literature. Primary and secondary studies were included, considering the microbial count or surgical site infection rates as outcomes. The search was performed on the BVS Portal, PubMed, Ask and MEDLINE. Twenty-five studies were selected (two systematic reviews, nineteen experimental and four cohort studies). The alcohol preparations promoted a microbial reduction equal to and/or greater than traditional products in 17 studies, and a lesser reduction in four studies; similar surgical site infection rates were identified. Therefore, there is scientific evidence that support the safety of alcohol preparations for surgical hand antisepsis.

DESCRIPTORS

Antisepsis
General surgery
Handwashing
Infection control
Operating Room Nursing

RESUMO

A antissepsia cirúrgica das mãos visa à prevenção de infecções do sítio cirúrgico, importante causa de morbimortalidade pós-operatória e aumento dos custos hospitalares. Este estudo teve como objetivo comparar a eficácia de preparações alcoólicas com os produtos tradicionais na antissepsia cirúrgica das mãos por meio de uma revisão sistemática da literatura. Foram considerados estudos primários ou secundários, tendo como desfecho a contagem microbiana das mãos ou taxas de infecções do sítio cirúrgico. A busca foi realizada no Portal BVS, PubMed, Ask e MEDLINE. Foram selecionados 25 estudos (2 revisões sistemáticas, 19 experimentais e 4 de corte). As preparações alcoólicas tiveram uma redução microbiana igual e/ou maior aos produtos tradicionais em 17 estudos e inferior em 4; as taxas de infecções do sítio cirúrgico foram similares. Portanto, existem evidências científicas que suportam a segurança das preparações alcoólicas para antissepsia cirúrgica das mãos.

DESCRITORES

Antissepsia
Cirurgia geral
Lavagem de mãos
Controle de infecções
Enfermagem de Centro Cirúrgico

RESUMEN

La antisepsia quirúrgica de manos apunta a prevenir infecciones en el sitio quirúrgico, causa importante de morbi-mortalidad postoperatoria y aumento de costos hospitalarios. El estudio objetivó comparar la eficacia de preparaciones alcohólicas con los productos tradicionales de la antisepsia quirúrgica de manos, mediante revisión sistemática de la literatura. Fueron considerados estudios primarios o secundarios, teniendo como objetivo el recuento microbiano en manos o tasas de infecciones del sitio quirúrgico. La búsqueda fue realizada en las bases BVS, PubMed, Ask y MEDLINE. Fueron seleccionados 25 estudios (2 revisiones sistemáticas, 19 experimentales y 4 de cohorte). Las preparaciones alcohólicas consiguieron una reducción microbiana igual y/o mayor que los productos tradicionales en 17 estudios, e inferior en 4; las tasas de infección del sitio quirúrgico fueron equivalentes. Por lo tanto, existen evidencias científicas que dan soporte a la seguridad de las preparaciones alcohólicas para la antisepsia quirúrgica de las manos.

DESCRIPTORES

Antisepsia
Cirugía general
Lavado de manos
Control de infecciones
Enfermería de quirófano

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INTRODUCTION

Surgical site infections are the major cause of postoperative morbidity and mortality and represent large costs to hospitals[1]. In spite of the multifactorial cause, molecular biology-based studies have correlated the surgical site infections to the surgical team's hand surgical antisepsis, which may even include outbreaks[2-4].

The surgical attire is a well established measure toward preventing surgical site infections and it comprehends the use of sterilized gowns and gloves, besides caps and masks[5]. Despite the use of surgical gloves, the transmission of microorganisms from the hands of the surgeon to the patient may occur due to microperforations that happen at an average of 18% (5-82%) at the end of the surgery. In over 80% of cases, such perforations are not perceived by surgeons[6], and microperforations can double the risks of infection in the surgical site[7], thus turning the prior preparation of the hands into an crucial step.

The surgical hand antiseptic must be able to completely eliminate transient and significantly reduce resident hand flora in the onset of the procedure, and inhibit their growth under gloved hands, up to the end of the surgery[8-13]. The most currently used antiseptics are the chlorhexidine (CHG) and the povidone-iodine (PVPI). The agents are applied with a sponge and/or brush, although the World Health Organization (WHO) does not recommend the use of brushes to such purpose due to its abrasive effect[14].

The turning point of the alcohol in comparison with other antiseptic agents is its rapid action speed, in addition to its excellent antimicrobial activity against Gram-positive and Gram-negative bacteria, fungi, mycobacteria and viruses.

The WHO[14] recommends alcohol preparations (AP) between 60 and 80% concentrations and the American Centers for Disease Control and Prevention (CDC)(13) recommend 60 and 95% concentrations as a choice for hand antisepsis and as an alternative for traditional products (TP) toward surgical hand antisepsis. Such alternative is justified by the agent's antimicrobial efficacy, easy application, lower skin damage and time saving profile[13-14]. The turning point of the alcohol in comparison with other antiseptic agents is its rapid action speed, in addition to its excellent antimicrobial activity against Gram-positive and Gram-negative bacteria, fungi, mycobacteria and viruses[8,13].

Around thirty years ago, alcohol preparations were used in Europe for surgical hand antisepsis[15]. European countries follow the EN 12791 of the Comité Européen de Normalisation (CEN)[16] in vivo antimicrobial efficacy testing of surgical hand antisepsis in 20 healthy subjects by adopting the 60% v/v n-propanol applied for 3 minutes as a reference product. Microbial samples are collected after the hand washing process with soap with no antimicrobial activity (baseline), immediately after the end of the hand antisepsis (immediate effect) and after 3 hours of gloved hands (sustained effect). Samples are collected by rubbing the fingertips for 1 minute on the base of a Petri dish containing a culture medium and neutralizers, one for each hand. Expressed in colony forming units (CFU)/mL and transformed into decimal logarithms (log) values, the results should not be significantly lower than those obtained with the reference product. For products with a claim of having a sustained effect, the mean log reduction should be significantly larger than the reference product. There are other norms in Europe aimed to determine the antimicrobial spectrum of antiseptics in in-vitro tests, preceded by in-vivo tests.

In the United States (US), the standard test method required to evaluate the activity of surgical hand scrub formulations is the American Society for Testing and Methods ASTM E1115[17], which counts on in-vitro tests aimed at measuring the antimicrobial spectrum against a specific amount of different microorganisms and in-vivo tests. In in-vivo tests, products are used for 5 consecutive days, being applied once a day on the Day 1 and 5, and three times a day on Days 2, 3 and 4. A specific equation should be used in order to define the sample size. In summary, baselines samples are collected at the Day 1, prior to the antisepsis. The measurement of immediate effect is made immediately after a single scrub. Sustained effect may be measured by collecting samples after 3 and or 6 hours of glove wear. The cumulative effect could be measured with the continuous using of the product on the five days of the study, as cited previously. The glove juice method, in which hands are randomly distributed in 1-minute, 3-hour and 6-hour times after the antisepsis, is used to collect samples. The samples are taken aseptically and cultured quantitatively expressed in CFU/hand and transformed into log10. The tested product must achieve the following results: on the Day 1, bacterial reduction of 1-log after 1-minute product application; after 6 hours, it should not exceed the baseline. At the end of the Day 2, a reduction of 2-log after 1-minute application. At the end of the Day 5, a reduction of 3-log after 1-minute application.Despite these movements in Europe and in the US, as well as the recommendations of the WHO and CDC, the use of alcohol for surgical hand antisepsis in Brazil is not a common practice. Many believe that the vigorous scrubbing of hands and forearms is essential for surgical hand preparation[15]. Besides, such traditional method is deemed to be a preparatory ritual to the surgery[18] and a moment the surgery team uses to be more concentrated. The evidence-based practice may be a relevant step in order to overcome such resistance against the use of alcohol, provided that the efficacy of these products is proved.

This present study is based on the following research question: *Is it safe to replace traditional surgical hand an-*

tisepsis for the use of alcohol preparations? The aim of this study is to provide scientific evidence toward changing such practice in our country.

OBJECTIVE

To compare the antimicrobial efficacy of alcohol preparations to the traditional products in surgical hand antisepsis through a systematic review.

METHOD

According to Evidence Based Medicine Work Group (Canada), the evidence-based practice is a process of systematically discover, assessment and application of research findings as a basis for clinical decision-making processes[19]. The systematic review, in which information related to a given problem is collected, categorized, assessed and synthesized[20], is a relevant resource in the practice.

This study was carried out from June to September 2010. We searched public domain databases: VHL Portal (Latin American and Caribbean Center on Health Sciences Information), also known by its original name Regional Library of Medicine (RLM), which includes the LILACS (Latin-American and Caribbean Health Science Literature Database), IBECS portal (Índice Bibliográfico Español en Ciencias de la Salud), MEDLINE (National Library of Medicine/NLM), The Cochrane Library and SciELO (Scientific Eletronic Library Online); PubMed (National Library of Medicine/NLM); and AskMEDLINE. Cross-reference searches were also carried out in publications referred to in the databases, aiming to find other studies that could not be located by the electronic search.

We searched health descriptors in both English and Portuguese languages. In Portuguese the keywords, with the Boolean connectors, were: antissepsia or lavagem de mãos and salas cirúrgicas or centros de cirurgia or cirurgia and etanol or 1-propanol or 2-propanol or feniletil álcool and povidona-iodo or clorexidina. In English, the Medical Subject Headings (MeSH) terms used were: surgical hand disinfection OR surgical hand antisepsis OR surgical hand rub OR surgical hand rubbing OR surgical hand scrub OR surgical hand scrubbing AND alcohol hand rubs OR alcohol-based hand rub OR alcohol OR n-propanol OR 1-propanol OR 2-propanol OR isopropanol OR ethanol AND chlorhexidine OR povidone iodine. In the AskMEDLINE, the following question was formulated: Could alcohol replace traditional surgical hand antisepsis?

The study's inclusion criteria were: primary or secondary studies that addressed the efficacy of the surgical hand antisepsis with alcohol preparations in comparison to traditional products and techniques which used CHG or PVPI; field or lab research; with volunteers or health professionals; outcomes should present a reduction in the hand microbial count or the surgical site infection rates; English, Portuguese or Spanish language studies; and regardless the publication date.

The exclusion criteria were: reflexive articles; narrative literature reviews; hygienic hand antisepsis – hand washing or hand rub with alcohol aiming to transient flora reduction; articles that did not compare the efficacy of alcohol preparations to traditional products; articles that used traditional products prior to the application of alcohol preparation; and articles in which alcohol was not the major active element on the formulation.

The studies were analyzed by three researchers. Two of them were specialists in this field and in the research methods. The analysis and selection of studies were carried out in three phases. On the first phase, carried out by a single researcher, studies were analyzed and preselected according to inclusion and exclusion criteria pinpointed in the abstracts; whenever the abstracts were not available, the article was fully read. Following the pre-selection process, the studies were analyzed by a data collection instrument based on the Mendonça model[21], including: type of research, objectives, sample, method, outcomes, results and conclusion. On the third phase, the studies were independently assessed by all three researchers, counting on the expansion of the data collection, which broadened the specification of the objectives of the systematic review, thus coming across the selected studies for the research. Some meetings were held aiming to discuss and to achieve mutual consensus among the researchers concerning the studies, as well as to define inclusions or exclusions.

Then, the studies were classified according to their internal validity and evidence level, in compliance with the model proposed by the U.S. Preventive Services Task Force (USPSTF/Task Force)[22], in five levels of evidence: I – at least one properly randomized controlled clinical study; II-1 – well-designed controlled trials without randomization; II-2 – well-designed cohort or case-control analytic studies; II-3 – multiple time series, with or without intervention; and III – opinions of respected authorities, based on clinical experience, descriptive studies and case reports, or reports of expert committees. Each level was subdivided into three categories – *good*, *fair* and *poor* – according to internal validity criteria defined for each type of study, including the systematic reviews.

RESULTS AND DISCUSSION

Initial electronic database search provided 132 articles and a further 25 from the analyses of the search references of these, thus totaling 157 articles. From this amount, 26 studies were excluded due to repetition and 79 for not meeting the research inclusion criteria. Hence, 52 articles were pre-selected. Seventeen articles were also excluded as their full texts were not successfully found. Following the full text analysis and the consensus meetings, 10 ar-

ticles were excluded for not meeting the inclusion criteria or due the exclusion criteria. Thus, 25 studies were finally selected, chronologically identified from S1 through S23, R1 and R2, these last ones refer to two systematic reviews. Chart 1 presents the selected studies and their respective authors, country of origin, year of publication, title and source of publication. Chart 2 shows a brief summary of the articles concerning the type of research, level of evidence, method, applied technique toward obtaining the microbial sample, time to obtain the sample, alcohol preparations and traditional products used, and major results.

So far, there is no published study on this issue found in data sources in Brazil. The hygienic hand rub with alcohol, quite a widely known effectiveness measure to prevent microorganism transmission, has been highly resisted by some healthcare professional in the country.

Official methodologies, published by recognized organizations, concerning the assessment of the efficacy of the antiseptics in surgical hand preparation processes were fundamental for this present systematic review. The use of standardized and official tests provided reliable result comparisons. From the 25 analyzed studies, six (24.0%) applied official methodologies: four belonging to the ASTM (S6, S8, S11, S18) and two belonging to the prEN 12791 or EN 12791 (S13 and S15, respectively).

Although both systematic review studies (8.0% - R1 and R2) were not exclusively related to surgical hand antisepsis with alcohol preparations in comparison to traditional products, they assessed controlled randomized field studies and had the same objectives of this present research.

The microbial count, or its reduction, represented the outcomes analyzed by the majority of selected studies (78.3%). Twelve studies (60.0%) analyzed the immediate and sustained effects of products (S3B, S4, S5, S6, S7, S8, S10, S11, S13, S18, S19, S22); five (25.0%) studies analyzed the immediate effect (S2, S3A, S9, S15, S20); three (15.0%) studies analyzed only the sustained effect (S1, S3C, S16); eight (40.0%) studies analyzed the cumulative effect (S3A, S4, S5, S6, S8, S9, S11, S18); and four (20.0%) studies did not collect any sample prior to the antisepsis for comparison purposes (S1, S3C, S16, S20). Five studies (21.7% - S12, S14, S17, S21, S23) used the surgical site infection rates as a final outcome.

Methods of microbial samples to evaluate antimicrobial efficacy of formulations for surgical hand preparation presented variations, being the *glove juice* and the rubbing/contact of fingertips with the culture medium the major variations. Former studies used hand washing with the Ringer solution and the aliquot culture of that solution.

Fourteen studies reported hand preparation prior to the application of the product (60.9%). In eight of these studies (34.8% - S5, S6, S8, S10, S11, S14, S18, S19) subungual spaces were cleaned using a brush or nail stick prior to the surgical antisepsis procedure. There is no current consensus about the use of a brush or nail stick to clean the subungual space prior to the application of the alcohol preparations due to their skin-abrasive characteristic, according to the authors. The impact of such procedure on the reduction of skin flora following chemical antisepsis is not yet clear in the selected studies. This region is known to accumulate dirt and consequently microorganisms[13]; however, a study that used the modified official European methodology (EN 1500) showed that alcohol preparations, either gel or liquid, have antimicrobial activity even in the presence of organic matter, simulated by using sheep blood and artificial contamination of the hands with S. macescens ATCC 14756[23]. The WHO recommends the use of the nail stick, but does not recommend hand scrub with a brush, due to its abrasive characteristic[14].

The application/contact time of traditional products was 2-10 minutes. On their turn, the contact time of alcohol preparations varied from 1.5 to 5 minutes. It is worth highlighting that in the description of the product application process, many emphasized the application/contact time over the quantity, which may vary with the size of the surface that receives the application. Only one study (S2) showed tests with lower times, for instance, 30 seconds.

Alcohol preparations present lower application/contact time compared to traditional products due to its rapid antimicrobial effect, which optimizes both healthcare professionals time and hospital resources (S1)[15], an aspect that may become quite useful in minor surgeries (ophthalmologic, for instance), which are subsequently carried out by the surgical team. In some countries where the practice of using the alcohol preparation in surgical hand antisepsis is already accepted, specific studies aim at assessing the reduction of the contact time with these products; however, these studies were not included here for not meeting this research's inclusion criteria.

Although Europe accepts the alcohol preparations in surgical hand antisepsis, a research carried out in the United Kingdom (2007) showed that the traditional method is still the most used one (representing 90% of the day's first antisepsis); moreover, the alcohol preparation is repeatedly used in only 20% of cases[24].

Alcohol preparation has the advantage of saving water and reducing costs. It simplifies application method (rubbing hands and forearms, with no need of rinsing, it avoids rigorous water quality controls, such as the use of filters, and does not require the use of sterilized towels/pads). The study S9 showed that alcohol preparations resulted in up to 67% cost reduction per procedure comparing to traditional products[25]. From the ecological standpoint, there is considerable water saving. Furthermore, this method could avoid the use of surgical washbasin structure in the surgical theatre. A study carried out in the United Kingdom reported the amounts of water used for surgical hand antisepsis with CHG or PVPI: 18.5 L per procedure and 931.938 L yearly[26].

Chart 1 – Selected studies on surgical hand antisepsis by alcohol-based antiseptic in replacement for traditional products.

Study	Author(s)	Country	Year	Title	Publication Source
S1	Lowbury EJ, Lilly HA.	UK	1960	*Disinfection of the hands of surgeons and nurses*	Br Med J
S2	Lowbury EJ, Lilly HA, Bull JP.	UK	1964	*Methods for disinfection of hands and operation sites*	Br Med J
S3	Lowburry EJL, Lilly HA, Ayliffe GAJ.	UK	1974	*Preoperative disinfection of surgeons' hands: use of alcoholic solutions and effects of gloves on skin flora*	Br Med J
S4	Jarvis JD, Wynne CD, Enwright L, Williams JD.	UK	1979	*Handwashing and antiseptic-containing soaps in hospital*	J Clin Pathol
S5	Larson EL, Butz AM, Gullette DL, Laughon BA.	US	1990	*Alcohol for surgical scrubbing?*	Infect Control Hosp Epidemiol
S6	Hobson DW, Woller W, Anderson L, Guthery E.	US	1998	*Development and evaluation of new alcohol-based surgical and scrub formulation with persistent antimicrobial characteristics and brushless application*	Am J Infect Control
S7	Pietsch H.	Germany	2001	*Hand antiseptics: rubs versus scrubs, alcoholic solutions versus alcoholic gels*	J Hosp Infect
S8	Mulberry G, Snyder AT, Heilman J, Pyrek J, Stahl J.	US	2001	*Evaluation of a waterless, scrubless chlorexidine gluconate/ethanol surgical scrub for antimicrobial efficacy*	Am J Infect Control
S9	Larson, Aiello, Heilman, Lyle, Cronquist, Stahl, Della-Latta.	US	2001	*Comparison of different regimens for surgical hand preparation*	AORN
S10	Bryce EA, Spence D, Roberts FJ.	Canada	2001	*An in-use evaluation of an alcohol-based pre-surgical hand disinfectant*	Infect Control Hosp Epidemiol
S11	Sigler M, Bastyr J, Stahl J, Pyrek J.	US	2001	*Comparison of a waterless, scrubless CHG/ethanol surgical scrub to traditional CHG and povidone-iodine surgical scrubs*	3M Health Care.
S12	Parienti JJ; Thibon P; Heller R; Le Roux Y; von Theobald P; Bensadoun H; Bouvet A; Lemarchand F; Le Coutour X.	France	2002	*Hand-rubbing with an aqueous alcoholic solution vs traditional surgical hand-scrubbing and 30-day surgical site infections rates – a randomized equivalence study*	JAMA
S13	Marchetti MG, Kampf G, Finzi G, Salvatorelli G.	Italy, Germany	2003	*Evaluation of the bactericidal effect of five products for surgical hand disinfection according to prEN 12054 and prEN 12791*	J Hosp Infect
S14	Berman M.	US	2004	*One hospital's clinical evaluation of brushless scrubbing.*	AORN J
S15	Rotter M, Kundi M, Suchomel M, Harke H-P, Kramer A, Ostermeyer C, Rudolph P, Sonntag H-G, Werner H-P.	Germany, Austria	2006	*Reproducibility and workability of the European Test Standard EN 12791 regarding the effectiveness of surgical hand antiseptics: a randomized, multicenter trial*	Infect Control Hosp Epidemiol
S16	Hajipour L, Longstaff L, Cleeve V, Brewster N, Bint D, Henman P.	UK	2006	*Hand washing rituals in trauma theatre: clean or dirty?*	Ann R Coll Surg Engl
S17	Palmer JS.	US	2006	*Use of Avagard in pediatric urologic procedures*	Urology
S18	Gupta C; Czubatyj AM; Briski LE; Malani AK.	US	2007	*Comparison of two alcohol-based surgical scrub solutions with an iodine-based scrub brush for presurgical antiseptic effectiveness in a community hospital*	J Hosp Infect
S19	Carro C, Camilleri L, Traore O, Badrikian L, Legaula B, Azarnoush K, Dualé C, De Riberolles C.	France	2007	*An in-use microbiological comparison of two surgical hand disinfection techniques in cardiothoracic surgery: hand rubbing versus hand scrubbing*	J Hosp Infect
S20	Wongworawat MD, Jones SG.	US	2007	*Influence of rings on the efficacy of hand sanitization and residual bacterial contamination*	Infect Control Hosp Epidemiol
S21	Marchand R, Theoret S, Dion D, Pellerin M.	Canada	2008	*Clinical implementation of a scrubless chlorhexidine/ethanol pre-operative surgical hand rub*	Can Oper Room Nurs J
S22	Kac G, Masmejean E, Gueneret M, Rodi A, Peyrard S, Podglajen I.	France	2009	*Bactericidal efficacy of a 1.5 min surgical hand-rubbing protocol under in-use conditions*	J Hosp Infect
S23	Weight CJ; Lee MC; Palmer JS.	US	2010	*Avagard hand antisepsis vs. Traditional scrub in 3600 pediatric urologic procedures.*	Urology
R1	Hsieh HF, Chiu HH, Lee FP.	Taiwan	2006	*Surgical hand scrubs in relation to microbial counts: systematic literature review.*	J Adv Nurs
R2	Tanner J, Swarbrook S, Stuart J.	UK	2008	*Surgical hand antisepsis to reduce surgical site infection.*	Cochrane Database Syst Rev

Chart 2 - Métodos e resultados da eficácia antimicrobiana de antissépticos para antissepsia cirúrgica das mãos a base de álcool e tradicionais.

Study	Type of Research */Level of Evidence	Sample/ Losses or Exclusions	Method	Technique to obtain the microbial sample	Time to obtain the sample	Alcohol-based product	Traditional product	Results
S1	SClL (A) and SC (B) A: Level II-1 – Fair B: Level II-1 – Poor	5 people (A) and 20 gloves (B)	Other [assesses microorganisms that pass through the perforations in the gloves (A) and those left in the glove after use (B).	Scrubbing finger tips with gloved hands [previously perforated on the tips] after washing with ordinary soap (A) and used glove juice (B)	After 1 and 3 hours with gloved hands (A) and at the end of the surgery (B)	Bar of soap for 5 min, followed by the application of 70% v. alcohol for 3 min (A). Bar of soap for 5 min, followed by the application of 70% alcohol containing 0.5% CHG for 3 min (A). Bar of soap for 5 min, followed by quick mopping with a swab soaked in alcohol (A and B).	Simple washing (quickly) with water and soap (A). Bar soap for 5 min. Bar soap for 5 min followed by the use of gloves with 5 mg neomycin sulphate powder and 5 mg bacitracin per gramme of powder (A). Hexachlorophane soap in all hand washing and baths during the week before the experiment and for 5 min to the experiment (A). Phisohex® in all hand washing and bath cleaning processes in the week prior to the experiment and for 2 min to the experiment (A).	*Neomycin and bacitracin > Phisohex® > alcohol 70% + 0.5% CHG > alcohol 70% > 2% hexachlorophane > alcohol swab > soap* *Note: results are based on absolute scores.*
S2	SClRL A: Level I – Fair B: Level II-1 – Poor	A: 6 people B: 8 people to CHG or Icohol+CHG and 2 to laurolinium	Other	Hand washing with Ringer solution	Prior to and after antisepsis	A: 70% ethyl alcohol + 0.5% CHG, 5% laurolinium acetate + 70% ethyl alcohol for 2 min B: 70% alcohol + 0.5% CHG, 5% laurolinium + 70% alcohol for 30, 60, 90 and 120 sec.	A: PVPI, 5% aqueous laurolinium acetate solution, 5% laurolinium spray for 2 min. Control: quick hand washing with water. B: 0.5% water-based CHG, 5% aqueous laurolinium for 30, 60, 90 and 120 sec.	A: 70% ethyl alcohol 70% + 0.5% CHG = 5% laurolinium acetate + 70% ethyl alcohol = 5% water-based laurolinium acetate > PVPI = spray laurolinium > control. B: 0.5% CHG + 70% alcohol = 0.5% CHG in all application times. CHG solutions > laurolinium after 30 and 120 min applications.
S3	SClL A: Level II-1 – Fair B: Level II-1 – Poor C: Level II-1 – Poor	A: 6 people B: not quoted C: not quoted	A: Other B: Other (use of gloves) C: Other (sustained effect)	Hand washing with Ringer solution	A: prior to, immediately after antisepsis – 1st and 6th applications (3x/day for 2 days). B: prior to, immediately after and 3 hours after antisepsis. C: 3 hour after antisepsis (with previous contamination)	A: 95% ethyl alcohol + 0.5% CHG, 95,3% ethyl alcohol + 0.1% tetrabrom-o-methyl phenol, 95% ethyl alcohol; all for 2 min (2x5mL). B: 70% ethyl alcohol + 0.5% CHG, 70% isopropyl alcohol + 0.5% CHG, 70% isopropyl alcohol, 70% ethyl alcohol; all for 2 min. C: 95% ethyl alcohol + 0.5% CHG, 95.3% ethyl alcohol + 0.1% tetrabrom-o-methyl phenol, 70% ethyl alcohol.	A: 0.5% water-based CHG, 4% CHG; both for 2 min (2x5mL), bar of soap and water for 2 min. B: 0.5% water-based CHG, PVPI (Disadine®), 2.5% water-based chloroxylenol, 4% detergent CHG, bar of soap with no antimicrobial activity; all for 2 min. C: 2% DP 300® detergent Irgasan, soap.	A: 95% ethyl alcohol + 0.5% CHG = 95.3% ethyl alcohol + 0.1% tetrabrom-o-methyl phenol > 95% ethyl alcohol = 4% CHG > 0.5% CHG > control. 95% Ethyl alcohol + 0.5% CHG > 4% CHG. 95.3% ethyl alcohol + 0.1% tetrabrom-o-methyl phenol = 4% CHG B: 70% isopropyl alcohol + 0.5% CHG > 4% CHG > 70% isopropyl alcohol > 70% ethyl alcohol 70% + 0.5% CHG > 70% ethyl alcohol > PVPI > 0.5% CHG > 2.5% chloroxylenol > soap with no antimicrobial activity. 4% CHG with enhanced sustained effect, 70%, ethyl alcohol, 70% isopropyl alcohol and PVPI with lower sustained effects. Note: results based on absolute scores. C: 95% ethyl alcohol + 0.5% CHG > 95.3% ethyl alcohol + 0.1% tetrabrom-o-methyl phenol > 2% DP 300 Irgasan > bar of soap. 70% ethyl alcohol with no sustained effect. Note: results based on absolute scores.
S4	SClL Nível II-1 – Poor	6 people	Other	Hand washing with Ringer solution	Prior to, immediately after and 90 min after the 1st and 6th antisepsis (3x/day for 2 days).	95% alcohol + 0.5% CHG for 2 min (2x10mL).	PVPI, CHG and alcoholic PVPI for 2 min (2x10mL), plain bar soap and bar soap with PVPI for 2 min.	95% alcohol + 0.5% CHG > alcoholic PVPI > PVPI > CHG > soap with PVPI > simple bar soap. Note: results based on absolute scores.
S5	SClRL Level I - Fair	60 people (12 per group)	Other	Glove juice	Prior to, immediately after and 4 hours after the antisepsis on the 1st and 5th days.	70% ethyl alcohol + 0.5% CHG 6x5mL.	1% Triclosan, 4% CHG, Betadine®2, soap with no antimicrobial activity, all for 2x5mL (5 min).	70% ethyl alcohol + 0.5 CHG > Betadine®2 > 4% CHG > 1% Triclosan = soap with no antimicrobial activity.

* S=Study; SRev= Systematic Review; Cl=Clinical; Co= Cohort; R=Randomized; Bl= Blind; pBl=Partially Blind; Re = Retrospective; SC=in the Surgical Center environment; AS=in the Ambulatory Surgical environment; L=Laboratory.

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Study	Type of Research */Level of Evidence	Sample/ Losses or Exclusions	Method	Technique to obtain the microbial sample	Time to obtain the sample	Alcohol-based product	Traditional product	Results
S6	SClRL Level II-1 – Fair	90 people (18 per group)	ASTM	Glove juice	Prior to, 1 min, 3h and 6h after on the Days 1, 2 and 5.	Triseptin® for 3 min.	Betadine®2 por 10 min ou Hibiclens® for 6 min.	Day 1 and 2: Triseptin® > Betadine®2 and Hibiclens® Day 5: Triseptin® = Hibiclens® > Betadine®2 Betadine®2 with no cumulative effect. Triseptin® applied with a brush = sponge = only with hands.
S7	SClRSC Level I – Fair	75 surgeons	Other	Glove juice	Prior to, immediately after and at the end of the surgery.	Sterillium® (time not quoted).	Hibiscrub® (time not quoted).	Immediate effect: Sterillium® > Hibiscrub® Sustained effect: Sterillium® = Hibiscrub®
S8	SClRBlL Level I - Fair	A:52 people B:85 people	ASTM	Glove juice	Prior to, 1 min, 3h and 6h after the Days 1, 2 and 5.	Avagard® 3x2mL, 61% ethyl alcohol 3x2mL.	Hibiclens® 2x5mL (2x3 min).	Avagard® > Hibiclens® > 61% ethyl 61% ethyl alcohol did not meet the ASTM criteria on the Days 2 and 5.
S9	SClRSC Level I - Fair	27 people of the surgical team/2	Other	Glove juice	Prior to and immediately after the 1st and 5th days of the first week and on the last day of the 3rd week.	61% ethyl alcohol + 1% CHG 3x2mL.	4% CHG for 6 min.	61% ethyl alcohol + 1% CHG = 4% CHG Sustained effect of 4% CHG > 61% ethyl alcohol + 1% CHG
S10	SClSC Level II-1 – Fair	25 people of the surgical team (in surgeries <2h) and 16 (in surgeries>3h)	Other	Rubbing fingertips and glove juice	Prior to, immediately after and at the end of surgery.	Manorapid® for 3 min (3x5mL).	4% CHG or 7.5% PVPI for 3 min.	Surgeries <2h: Manorapid® = 7.5% PVPI or 4% CHG Surgeries >3h: Manorapid® > 7.5% PVPI or 4% CHG
S11	SClRpBlL Level I - Fair	124 people (41 in the Hibiclens® and AP group and 42 in the Betadine®2 group)	ASTM	Glove juice	Prior to, 1 min, 3h and 6h after on the Days 1, 2 and 5.	61% ethyl alcohol + 1% CHG 2x3mL.	Hibiclens® for 6 min (2x5mL), Betadine®2 for 10 min (2x5mL).	61% ethyl alcohol + 1% CHG > Hibiclens® and Betadine®2 Cumulative effect: 61% ethyl alcohol + 1% CHG > Betadine®2 and = Hibiclens® Note: Betadine only met the ASTM criteria after 1 min on the Day 1; Hibiclens only met the criteria on the Days 1 and 5; 61% ethyl alcohol + 1% CHG met all the criteria.
S12	SClRSC Level I – Good	4823 patients/436	Other	Surgical site infection rate	(in 30 days)	Sterillium® 2x5mL (total of 5 min).	Betadine®1 or Hibiscrub® for 5 min.	Sterillium® = Betadine® or Hibiscrub®
S13	SClRL Level I – Fair	20 people for prEN 12791	prEN12054 and prEN12791	Rubbing fingertips	Prior to, 1min and after 3h.	Sterillium®, Softa Man®, 60% n-propanol for 5 min in the in-vitro test and 3 min (3mL as much as necessary) in the in-vivo test.	Derman Plus®, Hibiscrub®, Betadine®2 for 5 min in the in-vitro test and 3 min (3mL) in the in-vivo test.	prEn12054: Sterillium®, Softa Man®, Derman Plus®, Hibiscrub®, Betadine® = meet the prEN12791 criteria: 60% n-propanol = Hibiscrub® and Softa Man® 60% n-propanol > Betadine® and Derman Plus® Sterillium® > 60% n-propanol
S14	SCoReSC Level II-2 – Poor	75 patients and all surgical team members who decided to participate/ several patients, 4 professionals	Other	Surgical site infection rate	-	70% ethyl alcohol + zinc pyrithione for 3 min.	Not quoted.	70% ethyl alcohol + zinc pyrithione = traditional product

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Study	Type of Research */Level of Evidence	Sample/ Losses or Exclusions	Method	Technique to obtain the microbial sample	Time to obtain the sample	Alcohol-based product	Traditional product	Results
S15	SClRL Level I – Fair	20 people in each of the 5 labs	EN12791	Rubbing fingertips	Prior to, after 1min.	70% v/v 2-propanol, 85% v/v ethyl alcohol, 60% v/v 1-propanol for 3 min.	4% CHG for 3 min.	60% 1-propanol > 85% ethyl alcohol > 70% 2-propanol > 4% CHG.
S16	SClRpBlSC Level I – Poor	41 surgeries and 82 hand antisepsis/2 antisepsis	Other	Rubbing fingertips	At the end of surgery.	70% alcohol + 0.5% CHG (gel) for 3 min.	CHG for 5 min in all first antisepsis, and for 3 min in all others.	CHG > 70% alcohol + 0.5% CHG (gel)
S17	SCoReSC Level II-2 – Poor	1100 patients (550 per group) 1 surgeon	Other	Surgical site infection rate	-	Avagard® 2x3mL (2 min).	Impregnated hand-brush with traditional product (2 to 5 min).	Avagard® = Impregnated hand-brush with traditional product.
S18	SClRpBlSC Level I – Fair	18 surgical team members/2	ASTM	Glove juice	Prior to, 1 min and after 6h on the Days 1, 2 and 5.	Avagard® 3x 2mL, Triseptin® for 3 min.	7.5% PVPI for 6 to 10 min.	Avagard® and Triseptin® = PVPI Only Avagard® presented cumulative effect.
S19	SClSC Level II-1 – Fair	54 patients 18 surgical team professionals	Other	Rubbing fingertips	Prior to, immediately after, after 2h, 4h and at the end the surgery.	Sterillium® 2x6mL + 3mL in the replacement of gloves.	Hibiscrub®, Betadine®1 for 3 min.	Sterillium® = Hibiscrub® = Betadine®1
S20	SClRpBlL Level I – Fair	60 people (surgical team members)	Other (compare microbial count after the antisepsis with and without the use of the ring)	Glove juice	Immediately after.	Triseptin®, Avagard®.	BD E-Z Scrub 205®.	Avagard® with ring = Avagard® without ring Triseptin with ring = Triseptin® without ring BD E-Z Scrub 205 with ring > BD E-Z Scrub 205® without ring. With and without ring: Avagard® > Triseptin® = BD E-Z Scrub 205®
S21	SCoReSC Level II-2 – Fair	2084 surgeries for TP, 2175 surgeries for AP, all surgical team members	Other	Surgical site infection rate	-	70% ethyl alcohol + 0.5% CHG.	Not quoted.	70% ethyl alcohol + 0.5% CHG 0,5% = traditional product
S22	SClpBlAS Level II-1 – Fair	19 surgeons, 25 surgeries in each product	Other	Rubbing fingertips and palm of the hand	Prior to, 1min after and at the end of surgery.	Sterillium® por 3 min (10,5mL) and 1,5 min (6mL).	Betadine®1 for 3 min.	Appplication for 3 min: Sterillium® > Betadine®1 Sterillium® por 3min = Sterillium® por 1,5 min
S23	SCoReSC Level II-2 – Poor	3600 patients (1800 in each group) 1 surgeon	Other	Surgical site infection rate	-	Avagard® 2x3mL (2 min).	Impregnated hand-brush with traditional product (6 min).	Avagard® = impregnated hand-brush with traditional product
R1	SRev (SClRSC) Fair	3 studies [2 comparing the alcohol preparation with traditional product (S9 and S10)]						
R2	SRev (SClRSC) Good	10 studies [1 analyzing surgical site infection with alcohol-based and traditional preparation (S12), 6 comparing alcohol preparation with traditional product (S7, S12, S16, S18; studies were not selected for this research for using CHG prior to the alcohol preparationa; study not found by authorsb)] a. Pereira LJ, Lee GM, Wade KJ. An evaluation of five protocols for surgical hand washing in relation to skin condition and microbial counts. Journal of Hospital Infection 1997; Vol. 36:49-65. b. Herruzo Cabrera R, Vizcaino Alcaide MJ, Fdez Acinero MJ. Usefulness of an alcohol solution of NDuopropenide for the surgical antisepsis of the hands compared with hand washing with iodine povidone and chlorhexidine. Journal of Surgical Research 2000; Vol. 94:6-12.						

Triseptin®: 70% ethyl alcohol + zinc pyrythione
Sterillium®: 45% 2-propanol + 30% 1-propanol + 0.2% mecetronium ethylsulphate

Avagard®: Álcool etílico 61% + CHG 1%
Manorapid®: Isopropanol 70% + butanodiol 0,1% + lanolina 0,06%
Softa Man®: Álcool etílico 45% + 1-propanol 18%

Phisohex®: hexaclorofeno 3% com creme + detergente aniônico
Disadine®: não cita formulação
Irgasan 2% DP 300®: não cita formulação
Betadine®1: PVPI 4%

Betadine®2: PVPI 7,5%
Hibiclens®: CHG 4%
Hibiscrub®: CHG 4%
Derman Plus®: Triclosan 1%
BD E-Z Scrub 205®: 1% PVPI disponível

The main disadvantage of alcohol is its drying effect on the skin, which can be solved by the addition of emollients, humectants or other related products[8,15]. Studies that assessed the effects of alcohol preparations compared to traditional products on the skin showed that alcohol with emollients – or even those that did not count on such products (S8) – generally presented a similar or enhanced effect on the skin in comparison to traditional products (S7, S8, S9, S10, S12, S18, S19). For this reason, and due to the application method, professionals accepted the alcohol-based method in a better way (S9, S12, S18, S19). Some negative characteristics related to alcohol reported were: its odor and its burning/abrasive sensation on the hands (S18), which may occur if the product is applied in skin presenting integrity break[8]. In most cases, traditional products, on their turn, worsened the skin aspects and in some cases provoked adverse effects (S7, S8, S9, S12, S18, S19). Other disadvantages of alcohol preparations are: its volatile nature, which demands special attention to the product's container and storage site; need to dry completely following the application; and the absence of a surfactant action, demanding hands to be washed with water and soap whenever they are visibly dirty (S18).

Finally, concerning the antimicrobial efficacy, 90.5% of the studies reported that the alcohol preparations generated higher (17 studies - S1, S2A, S3A, S3B, S3C, S4, S5, S6, S7, S8, S9, S10 for surgeries > 3 hours, S11, S13, S15, S18, S22) or equal (six studies – S2B, S3A, S10 for surgeries < 2 hours, S13, S19, S20) microbial reductions compared to traditional products. Four of these studies showed variable higher than/equal to results, depending on the type of the traditional product used and/or the type of alcohol preparation (S2A, S2B, S3A, S13). Four studies (19.0% - S1, S3B, S8, S16) showed the inefficacy of the alcohol compared to the traditional product; however, in S1, the traditional product is the hexachlorophene, currently prohibited in Brazil due to its toxic effects. The S3B did not present a statistical analysis (only absolute scores); in S8, the results of the 61% ethyl alcohol used as the single active principle showed lower results than the 4% CHG, the 61% ethyl alcohol combined with the 1% CHG presented higher results; on its turn. The S16 did not employ a neutralizer in the culture medium, thus characterizing a relevant bias in the study.

Taken in isolation, the alcohol does not present any sustained effect; in spite of that, the recovery of the skin flora occurs very slowly by the continuous death of microorganisms and probably due to the sub-lethal effect of some skin bacteria[8,14-15]. However, the addition of small concentrations of other antiseptics to alcohol preparations gives alcohol a sustained effect, thus creating a synergetic action – such as quaternary ammonium compounds, hexachlorophene or chlorhexidine – that is employed in most of the analyzed studies.

All studies that showed surgical site infection rates as a final outcome measure (S12, S14, S17, S21, S23) presented results that provide evidence of the lack of statistically significant differences between the alcohol preparations and traditional products.

The antimicrobial efficacy of alcohol preparations in the surgical hand antisepsis depends on the type of alcohol used, its concentration and contact time. In this sense, in order to be employed nationwide, it is important to elaborate norms and validation tests for the antimicrobial efficacy of these products, and also to register them under National Sanitary Surveillance Agency (ANVISA), as there is no current national regulation that addresses the alcohol preparations toward such objective. Current discussions on the alcohol products for hand hygiene processes (such as the compulsoriness of the alcohol preparation for hand antiseptic processes in Brazilian Health services[27]) must be expanded to the field of surgical hand antisepsis.

Some studies (S6, S11, S18) that adopted the ASTM methodology showed that the traditional products did not meet all the criteria (microbial reduction levels) demanded by the method, which generates enquiries on the efficacy of these broadly used and accepted products, or on the microbial reduction standards demanded by such methodology.

As for the quality of the studies, between systematic reviews (6.9%), the R1 was classified as *fair* due to the small amount of studies and for not presenting the alcohol-based formulations used in the studies; and the R2 presented a *good* classification. Twelve studies were classified in Level I (41.4%), several internal validity variations were presented and one study (S12) was classified in the *good* category; ten studies (S2A, S5, S7, S8, S9, S11, S13, S15, S18, S20) were classified in the *fair* category; and one study (S16) was classified in the *poor* category because it did not use a neutralizer in the culture medium. Eleven studies were classified in Level II-1 (37.9%), being six in the *fair* category (S1A, S3A, S6, S10, S19, S22) and five in the *poor* category (S1B, S2B, S3B, S3C, S4) for not presenting a statistical analysis.

In this type of experiment, which tests products with different application characteristics (only friction for the alcohol or the traditional technique for traditional products containing detergent), it is very difficult to carry out double-blinded research, a reason that justifies the small amount of studies in *good* category on Levels I and II-1. Moreover, only one study (S12) carried out an intent-to-treat analysis. All other studies (four - 13.8%) were classified as Level II-2, being one *fair* (S21) and three on the *poor* category (S14, S17, S23), as they did not take surgical site infections variables into account.

CONCLUSION

This systematic review showed that there are plenty of scientific evidences related to the safety use of alcohol preparations for surgical hand antisepsis; therefore, it can replace the traditional technique that uses detergent-based CHG or PVPI. It is worth highlighting that the efficacy of alcohol depends on its type, concentration and contact time. These results reinforce the current recommendations of the WHO and CDC and endorse the results of other studies, such as the two systematic reviews included in this research.

In order to foster a practical change, scientific evidence-based information on the benefits must be disclosed by new researches. Surgical hand antisepsis using alcohol preparations, besides encompassing the effectiveness of this product for that objective, the awareness of the professionals must also entail the benefits related to cost reduction, water saving, lower application time, lower skin damaging effects, and ecological gains.

REFERENCES

1. Sparling KW, Ryckman FC, Schoettker PJ, Byczkowski TL, Helpling A, Mandel K, et al. Financial impact of failing to prevent surgical site infections. Qual Manag Health Care. 2007;16(3):219-25.
2. Grinbaum RS, Mendonça JS, Cardo DM. An outbreak of hand-scrubbing-related surgical site infections in vascular surgical procedures. Infect Control Hosp Epidemiol. 1995;16(4):198-202.
3. Isenberg HD, Tucci V, Cintron F, Singer C, Weinstein GS, Tyras DH. Single-source outbreak of Candida tropicalis complicating coronary bypass surgery. J Clin Microbiol. 1989;27(11):2426-8.
4. McNeil SA, Nordstrom-Lerner L, Malani PN, Zervos M, Kauffman CA. Outbreak of sternal surgical site infections due to Pseudomonas aeruginosa traced to a scrub nurse with onychomycosis. Clin Infect Dis. 2001;33(3):317-23.
5. Monteiro CEC, Lacerda RA, Paz MSO, Conceição VP. Paramentação cirúrgica: avaliação de sua adequação para a prevenção de riscos biológicos em cirurgias. Parte II: os componentes da paramentação. Rev Esc Enferm USP. 2000;34(2):185-95.
6. Widmer AF, Rotter M, Voss A, Nthumba P, Allegranzi B, Boyce J, et al. Surgical hand preparation: state-of-the-art. J Hosp Infect. 2010;74(2):112-22.
7. Misteli H, Weber WP, Reck S, Rosenthal R, Zwahlen M, Fueglistaler P, et al. Surgical glove perforation and the risk of surgical site infection. Arch Surg. 2009;144(6):553-8.
8. Brasil. Ministério da Saúde; Agência Nacional de Vigilância Sanitária (ANVISA). Segurança do paciente em Serviços de Saúde: higienização das mãos. Brasília; 2009.
9. Trampuz A, Widmer AF. Hand hygiene: a frequently missed lifesaving opportunity during patient care. Mayo Clin Proc. 2004;79(1):109-16.
10. Widmer AF. Replace hand washing with use of a waterless alcohol hand rub? Clin Infect Dis. 2000;31(1):136-43.
11. Weber WP, Reck S, Neff U, Saccilotto R, Dangel M, Rotter ML, et al. Surgical hand antisepsis with alcohol-based hand rub: comparison of effectiveness after 1.5 and 3 minutes of application. Infect Control Hosp Epidemiol. 2009;30(5):420-6.
12. Department of Health and Human Services; Food and Drug Administration. Tentative final monograph for health care antiseptic products; proposed rule. Federal Register [Internet]. 1994 [cited 2011 May 25];59(116):31401-52. Available from: http://www.fda.gov/ohrms/dockets/ac/05/briefing/2005-4098B1_02_03-FDA-TAB1.pdf
13. Boyce JM, Pittet D; Healthcare Infection Control Practices Advisory Committee. Guideline for Hand Hygiene in Health-Care Settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. MMWR Recomm Rep. 2002;51(RR-16):1-45.
14. World Health Organization (WHO). WHO guidelines on hand hygiene in health care. First global patient safety challenge. Clean care is safe care. Geneva; 2009.
15. Gruendemann BJ, Bjerke NB. Is it time for brushless scrubbing with an alcohol-based agent? AORN J. 2001;74(6):859-73.
16. European Standards. CSN EN 12791. Chemical disinfectants and antiseptics - Surgical hand disinfection - Test method and requirements (phase2/step2). Brussels; 2005.
17. International Standards Worldwide. ASTM E 1115 - 11. Standard Test Method for Evaluation of Surgical Hand Scrub Formulations [Internet]. West Conshohocken; 2011 [cited 2011 May 26]. Available from: http://enterprise.astm.org/filtrexx40.cgi?+REDLINE_PAGES/E1115.htm
18. Greer RB 3rd. The ritual at the scrub sink. Orthop Rev. 1994;23(2):97.
19. Evidence-Based Working Group. Evidence-based medicine: a new approach to teaching the practice of medicine. JAMA. 1992;268(17):2420-5.
20. Galvão CM, Sawada NO, Trevizan MA. Revisão sistemática: recurso que proporciona a incorporação das evidências na prática da enfermagem. Rev Latino Am Enferm. 2004;12(3):549-56.
21. Mendonça SHF. Impacto do uso de conectores sem agulha para sistema fechado de infusão na ocorrência de infecção de corrente sanguínea relacionada ao cateter venoso central: evidências de uma Revisão Sistemática [dissertação]. São Paulo: Escola de Enfermagem, Universidade de São Paulo; 2008.
22. Harris RP, Helfand M, Woolf SH, Lohr KN, Mulrow CD, Teutsch SM, et al.; Methods Work Group, Third US Preventive Services Task Force. Current methods of the US Preventive Services Task Force: a review of the process. Am J Prev Med. 2001;20(3 Suppl):21-35.
23. Kawagoe JY, Graziano KU, Martino MDV, Siqueira I, Correa L. Bacterial reduction of alcohol-based liquid and gel products on hands soiled with blood. Am J Infect Control. 2011;39(9):785-7.
24. Tanner J, Blunsden C, Fakis A. National survey of hand antisepsis practices. J Perioper Pract. 2007;17(1):27-37.
25. Tavolacci MP, Pitrou I, Merle V, Haghighat S, Thillard D, Czernichow P. Surgical hand rubbing compared with surgical hand scrubbing: comparison of efficacy and costs. J Hosp Infect. 2006;63(1):55-9.
26. Jehle K, Jarrett N, Matthews S. Clean and green: saving water in the operating theatre. Ann R Coll Surg Engl. 2008;90(1):22-4.
27. Brasil. Ministério da Saúde; Agência Nacional de Vigilância Sanitária. Resolução n. 42, de 25 de outubro de 2010. Dispõe sobre obrigatoriedade de disponibilização de preparação alcoólica para fricção antisséptica das mãos, pelos serviços de saúde do País, e dá outras providências. Diário Oficial da União, Brasília, 26 out. 2010. Seção 1, p. 27.

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