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Aims and Scope

대한수술감염학회지(*Journal of Surgical Infection*)는 2016년 3월, 대한수술감염학회의 공식 학술지로 창간되어 연 1회 발행되었으나, 2018년부터는 연 2회 3월 30일, 9월 30일에 발행한다. 국내외 보건의료의 전문가들에게 수술과 연관된 감염성 질환과 관련된 여러 영역의 연구를 출판하여 그 결과를 공유하고 논의하고 하고자 한다. 본 학술지는 수술과 관련된 의사, 간호사, 약사 등의 보건의료 종사자와 공공보건 연구자 등을 대상으로 한다.
대한수술감염학회지는 외과적 감염성 질환의 자연사, 병인, 진단, 치료, 역학, 예방 등의 다양한 주제에 대한 원저, 종설, 증례보고 등을 게재하며, 높은 수준의 연구를 출판하여 궁극적으로 수술감염 질환을 예방하고 치료하는 것을 그 목적으로 한다.

Journal of Surgical Infection (J Surg Infect) was launched in March 2016 as an official publication of the Korean Surgical Infection Society. It was published annually. It will be pubilshed biannually in the 30th day of March and September from 2018. The journal provides the health provider associated with surgery from a great opportunity to promote, share, and discuss various new issues and developments in different areas of infectious diseases related with all surgery via publishing their research results. The journal aims to present an academic platform for physicians, medical scientists, allied health scientists and public health workers, especially those related with surgery.
The editors welcome original research articles, review articles, case reports, and clinical studies in all aspects of surgical infectious diseases (natural history, pathology, pathogenesis, diagnosis, treatment, epidemiology, prevention, and health promotion). We aim to publish the highest quality research, and then to prevent and cure surgical infectious diseases.

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Review Articles

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REVIEW ARTICLE

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일차성 상피성 난소암/난관암/복막암에서 종양감축술 후 발생한 수술부위 감염의 임상적 결과

신수귀, 이은주

중앙대학교 의과대학 산부인과교실

Clinical Outcomes Associated with Surgical Site Infection in Epithelial Ovarian, Fallopian, and Peritoneal Cancer Patients Undergoing Cytoreductive Surgery

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The most common cause of postoperative morbidity is surgical site infection (SSI). Because certain SSIs can be avoided, risk factors should be assessed prior to surgery, and modifiable ones should be addressed. SSI occurs in approximately 6%-20% of women undergoing surgical cytoreduction for epithelial ovarian/fallopian/peritoneal cancer (EOFPC). This high rate is due to the highly complex nature of cytoreductive surgery and the risk of contamination with ascending microorganisms in vaginal, cervical and gastrointestinal operative sites. Accumulated evidence showed that SSI worsens survival by delaying the initiation of adjuvant chemotherapy. As a result, SSI should be avoided as much as possible, and gynecologic surgical teams should be aware of how to prevent it. This review examines the prevalence, risk factors, clinical significance, and likelihood of SSI following cytoreductive surgery for EOFPC.

Key Words: Surgical wound infection, Ovarian cancer, Prevalence, Risk factor, Prevention

Introduction

One of the most common causes of healthcare-associated morbidity is surgical site infection (SSI). It extends hospital stays and enhances readmission and reoperation rates, as well as medical costs.[1] Potential pathogenic bacteria can arise from the vagina, endocervix, and skin during gynecologic procedure, which is a unique element. These microorganisms have the ability to ascend from the vagina to the pelvic cavity, causing morbidity.[2] As a result, SSIs are one of the leading causes of readmission after hysterectomies.[3]

Ovarian cancer is the most lethal gynecologic neoplasm, and its prevalence is steadily rising in Korea.[4] Because ovarian cancer has no distinctive symptoms and no reliable screening method, over 70% of patients are found to have advanced disease at the time of diagnosis.[5] Cytoreductive surgery, which removes all primary and metastatic diseases directly, or with multi-organ resection, which debulks down to a minimal residual disease, is the basis

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of treatment for patients with advanced disease.[6] Because patients with minor residual tumors have a better survival rate, intensive surgical procedures with larger incisions and high complexity are unavoidable; thus, the risk of SSI is substantial.[7-11]

Although the incidence of SSI in ovarian cancer in Korea is unknown, SSI rates for women undergoing cytoreductive surgery have been previously reported to vary from 6% to 20%.[7-11] SSI is linked to higher postoperative mortality and chemotherapy delays. Furthermore, SSIs cause patients to have a lessened chemotherapy response and a higher likelihood of developing platinum-resistant malignancies, making SSI an independent risk factor for overall survival. Therefore, its occurrence and treatment measures have the potential to improve perioperative quality.

In this review, we evaluated the occurrence and outcomes of SSI in patients with epithelial ovarian/fallopian/peritoneal cancer (EOFPC) and identified risks to help reducing SSIs after cytoreductive surgery.

Definition of SSI

SSIs are infections that occur within 30 days of a surgical operation or within 90 days if an implant is left in place after the procedure, and affect either the incision or tissues deep into the operation site, according to the Centers for Disease Control and Prevention (CDC). A wound is considered infected if it meets any of the CDC definitions, which include the pathogen isolation from an aseptically obtained fluid or tissue culture from the wound; purulent drainage from the incision, with or without laboratory confirmation of infection; local signs and symptoms of infection, such as erythema and warmth; and a surgeon's diagnosis of wound infection.[1]

Classification of SSI after a Gynecologic Surgery

SSIs are divided into three categories: superficial, deep, and organ/space incisional. After a gynecologic procedure, this rule is applied to SSI. Vaginal cuff cellulitis is a superficial SSI that affects the superficial tissues at the vaginal surgical margin after a vaginal hysterectomy. Pelvic cellulitis is a deep incisional SSI that contains an infected fluid collection or hematoma that surrounds the retroperitoneal area at the vaginal apex without abscess formation. Organ/space SSIs include adnexal infection and pelvic abscess.[1,2]

According to the American College of Surgeons' National Surgical Quality Improvement Program (ACS NSQIP), a bowel leak itself is not considered an organ/space SSIs unless it is accompanied by an abscess or purulence. However, because bowel contents pushed into the peritoneal cavity necessitate further operation and act as a nidus for possible infection, bacteremia, and sepsis, some studies included these patients in organ/space SSIs.[7] Because bowel surgery has become more common in cytoreductive surgery for EOFPC, and bowel leakage could potentially lead to infections, a broader definition may be required to prevent SSIs.

Incidence of SSI in Cytoreductive Surgery

Following cytoreductive surgery for epithelial ovarian cancer, the rate of SSI was reported to be 6%-20% (Table 1).[7-12] In comparison to the general incidence of SSIs, which was according to CDC is expected to be 2.8%,[13] the incidence of SSIs after cytoreductive surgery is substantially greater. As previously stated, the substantial surgical aspect of cytoreductive surgery for EOFPC could be the reason.

Table 1. SSI incidence following a cytoreductive surgery

Study	SSI (%)	Sample size (n)	Group	Study design
Tran et al.[7]	10.8	888	USA	Retrospective review
Matsuo et al.[8]	15.9	276	USA	Retrospective review
Lippitt et al.[9]	20.0	219	USA	Prospective quality improvement study
Mahdi et al.[10]	6.5	2,231	USA	Retrospective review
Johnson et al.[11]	6.0	635	USA	Prospective quality improvement study
O'Donnell et al.[12]	15.9	339	UK	Prospective quality improvement study

SSI, surgical site infection.

Table 2. Risk factors of SSI following a cytoreductive surgery, which was proven with multivariate analysis

Risk factors		OR or HR (95% CI)	Reference
Non-modifiable factor	Older age	1.23 (1.13-1.34)	7
		1.03 (1.002-1.06)	8
	ECOG performance status (1)	1.32 (1.05-1.66)	7
	ECOG performance status (2+)	2.53 (1.86-3.43)	7
	Body mass index (kg/m^2)	1.41 (1.12-1.76)	7
		1.09 (1.04-1.13)	12
	ASA level >2	1.68 (1.07-2.64)	7
	Diabetic requiring insulin	4.16 (1.37-12.6)	8
		5.00 (1.61-15.5)	12
	Hypertension	3.49 (1.77-6.9)	8
	Dyslipidemia	2.21 (1.08-4.53)	8
	Peripheral vascular disease	3.82 (1.09-13.37)	7
	Gastroesophageal reflux disease	2.13 (1.23-3.71)	7
	Advanced stage disease	4.49 (1.05-19.3)	8
	Nodal metastasis	2.36 (1.23-4.54)	8
	Operating time (per hour)	1.18 (1.03-1.36)	7
	High surgical complexity (vs. low)	4.19 (1.61-10.88)	7
	Bowel resection	2.31 (1.01-5.3)	8
	Suboptimal surgery	1.85 (1.40-2.45)	7
Modifiable factor	Wound drain (vs. none)	3.23 (1.68-6.19)	12
	Staples (vs. subcuticular suture)	3.58 (1.84-6.97)	12
	Decreased bicarbonate at postoperative day 3	0.86 (0.75-0.99)	8

SSI, surgical site infection; OR, odds ratio; HR, hazard ratio; CI, confidence interval; ECOG, European Cooperation Oncology Group; ASA, American Society of Anesthesiology.

Risk Factors of SSIs in Cytoreductive Surgery

Three earlier studies looked back at the risk variables for SSI after cytoreductive surgery for EOFPC and discovered a slew of them.[7,8,12] Table 2 summarizes the risk factors identified by multivariate analysis. Although identifying modifiable risk factors is crucial, the majority are difficult to change.[13]

Notably, the majority of SSIs are caused by the patients'

own risk factors. Infections are more prevalent in patients with a high body mass index,[7,10] which is a well-recognized etiological risk for SSI.[13,14] Obesity is also linked to a higher 30-day morbidity and 90-day mortality rate after cytoreductive surgery in women with epithelial ovarian cancer.[15] SSIs in the organ and spaces are independently associated with a history of gastroesophageal reflux disease history.[7] Despite the ambiguous link between surgical complexity and postoperative complications,[10] it was shown that surgical complexity is an independent predictor of SSI.[7] Additionally, bowl resection, which is essential for complete cytoreduction in up to 40% of cytoreductive surgery, has a 10% SSI rate.[8,16-18] A longer surgery time is linked to a higher rate of SSI.[7,10] Postoperative drainage, on the other hand, is still a point of contention.[7,10,12] Despite the diverging results of this practice, drainage has been assumed to reduce SSI by assisting in the early diagnosis of anastomotic leak following a bowel resection; hence, surgeons find it difficult to operate without it. The use of staples to close wound is also linked to an increased risk of SSI.[12] Most risk factors for SSI are not controllable, and there is not enough time to address these issues just before surgery. Therefore, a deliberate strategic alternative approach beyond recognizing of risk factors is required to reduce SSIs.

SSI after a Cytoreductive Surgery is Associated with Postoperative Mortality and Readmission

SSI induces sepsis, which is the second most prevalent cause of mortality within 30 days after a primary cytoreductive surgery, according to a meta-analysis of 23 studies involving 2,352 patients. Sepsis is directly responsible for 15% of deaths in patients with advanced-stage EOFPC.[19] Additionally, SSI is linked to an increased risk of readmission and a10-day increase in hospital stay.[8,19-21] Therefore, lowering the SSI could contribute to decrease the mortality and morbidity rates.

SSI after a Cytoreductive Surgery is Significantly Associated with Poor Prognosis of Patients with EOFPC

Patients with EOFPC, who have SSI, have poor survival outcomes. Two retrospective studies revealed that superficial and organ/space SSIs are independently linked to lower overall survival rate (Table 3).[7,8]

There are three explanations for this. First, SSI frequently leads to rehospitalization and extended hospital stays, delaying adjuvant treatment and potentially lowering cancer-specific survival rates.[7,12,22] Second, the existence of SSI could indicate a weakened cancer immune system. Because the innate immune system is fight against tumors is co crucial in disease progression,[23] a weakened immunity has a negative impact on survival. Third, SSI stimulates the proliferation of cancer cells. SSI causes tumor growth by producing proinflammatory cytokines, such as interleukin 1 and tumor necrotic factor alpha.[24] Moreover, bacterial endotoxins, such lipopolysaccharides induce tumor growth directly via Toll-like receptor 4 and nuclear factor kappa β.[25]

To enhance the overall survival of patients who had cytoreductive surgery for EOFPC, SSI must be controlled. More studies on consequences of SSI on patients with

Table 3. Effect of SSI on the survival of patients with epithelial ovarian/fallopian/peritoneal carcinoma

Study	Sample size (n)	SSI, number (%)	Statistical analysis	HR (95% CI)	Survival
Tran et al.[7]	888	96 (10.8)	Multivariate	Superficial SSI: 1.69 (1.12-2.57)	OS
				Organ/space SSI: 1.46 (1.07-2.00)	OS
Matsuo et al.[8]	276	44 (15.9)	Univariate	2.2 (1.5-3.2)	PFS
			Univariate	1.8 (1.1-3.0)	OS

SSI, surgical site infection; HR, hazard ratio; CI, confidence interval; OS, overall survival; PFS, progression free survival.

EOFPC are urgently needed, as are evidence-based interventions to reduce it.

Interventions to Minimalize the SSI in Cytoreductive Surgery

The Surgical Care Improvement Project (SCIP) started in 2006 with the goal of lowering SSI rates. The SCIP program aimed to standardize antibiotic therapy, including the time, type, and duration of antibiotics' administration, as well as glycemic control, hair removal, and normothermia.[26] Despite high compliance, there was little evidence that it reduce SSI rates.[27] Consequently, despite rigorous adherence to the SCIP guidelines, the baseline SSI rate in the preintervention cohort was as high as 16.8%; additionally, the SSI rate following cytoreductive surgery with intestinal resection was 58.5%.[28] Therefore, the need for additional interventions is indicated.

A perioperative SSI reduction bundle of therapies beyond SCIP was designated based on gathered evidence to lower SSI rates and demonstrated their preventive effects. The SSI rate was reduced by approximately half due to a comprehensive bundle addressing the pre-, intra-, and postoperative treatment, as reported in Table 4.[9,28-31] Preoperative chlorhexidine wash, oral antibiotics with/without mechanical bowel preparation, separate fascial closure tray, gown and gloves change, and postoperative daily bathing with chlorhexidine solution were all included to cytoreductive surgery.

In gynecological cancer surgery, prophylactic use of a vacuum-assisted wound closure device could minimize SSI by 33%.[32] After a cytoreductive surgery for ovarian cancer, the use of a subcutaneous negative-pressure wound drain was found to be a useful strategy for achieving clearer wound healing and less wound complications (12.9% vs. 27.0%; p=0.032).[33] Furthermore, when compared to the controls, the SSI rate was significantly reduced from 32.0% to 8.3% in patients who underwent

Table 4. Summary of interventions recommended for SSI prevention in cytoreductive surgery

Phases	Intervention	Reference
Preoperative	Patient's education about SSI prevention	31
	4% Chlorhexidine gluconate shower night before and day of surgery	9, 28, 31
	Chlorhexidine cloths at morning admission	31
	Mechanical bowel preparation with oral antibiotics using MiraLax powder, Bisacodyl tablets, antibiotics	9
Intraoperative	Antibiotics admission	9, 31
	Complete coverage of incisional area with 2% chlorhexidine gluconate and 70% isopropyl alcohol solution or 4% chlorhexidine solution	9, 28, 31
	Redose of cefazolin within 3-4 hours after incision	9, 28, 31
	Sterile closing tray for fascia and skin closure	28, 31
	Glove change before fascia closure, gown and Instruments change if soiled	9, 28, 31
Postoperative	Good hand hygiene	28, 31
	Hand-cleansing agent readily	28, 31
	Ensure dressing removal within 24-48 hours	9, 28, 31
	Patient shower with 4% chlorhexidine gluconate after dressing removal	28, 31
	Patient education on wound care and infection symptoms	9, 28, 31
	Strict glycemic control to keep blood sugars less than 180 mg/dL	9
Post dismissal	Dismiss patient with 4-oz of 4% chlorhexidine gluconate	28, 31
	Follow-up phone call within 24-72 hours	28, 31

SSI, surgical site infection.

general surgery, colorectal or gynecologic procedure, and received negative-pressure therapy.[34] This intervention, when taken as a whole, is worth exploring for this high-risk population. Further study would be considered necessary to confirm its effectiveness.

Education for Surgeons and Perioperative Personnel

A coordinated structure to facilitate surgical strategies is one of the most significant components in limiting SSI. Evidence-based guidelines, education for healthcare personnel and patients, and monitoring are the three essential elements for SSI prevention.[35] So far, the guidelines have been formed based on accumulated research studies. A systemic examination of education found that diverse teaching methods, including through education program, were implemented in various centers. To accomplish this, entire staff, including surgeons and perioperative personnel, as well as patients, had to be involved.[36] In addition, for a suitable infrastructure, hospitals must adapt their systems and culture.[37] A committed leadership, good compliance with various elements of SSI bundle, a high degree of staff participation, and the centralization of crucial surgical activities are all important factors to successfully reduce SSIs.

Conclusion

Patients with EOFPC who undergo cytoreductive surgery are more likely to develop SSI, which is linked to increased postoperative morbidity, mortality, and worse survival rates. Therefore, controllable factors, such as wound closure material selection provide chances to prevent SSIs and limit the disrupted aspects of survival in these women.

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

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근거 중심의 수술부위감염 예방 진료권고안

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The Evidence-Based Practice Guideline for the Prevention of Surgical Site Infection

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The Korean Surgical Infections Society (KSIS) aims to manage the surgical infection specialized in Korea. The surgical site infection (SSI) is defined as infection occurring in the incision and organ or surrounding of the patient undergoing surgery. Surgical Site Infection is one of the most common medical-related infections, causing an extension of hospitalization period and an increase in medical costs, and causing medical disputes. About 55% of SSI are reported to be preventable by carrying out an evidence-based strategy, and all medical staff and medical periods should identify the cause of SSI and perform effective practice to prevent it. Although the World Health Organization (WHO) also announced medical guidelines through systematic paper review and meta-analysis in 2016 and announced standard prevention guidelines for medical-related infections in Korea in 2017, however, additional surgical guidelines are needed for SSI. The KSIS recognizes the need to prevent SSI in Korea. The Evidence-based Practice Guideline for the Prevention of SSI by the Practice Guideline Committee in the KSIS was developed as an "Adaptation and GRADE-ADOLOPENT" methods and was applied to reinforce and update for WHO Guideline 2016. Among the WHO 2016 and other existing SSI guidelines were reviewed, the application target was selected as a key question according to the Korean domestic surgical environment, and the literature was searched by expanding to January 2021, and systematic review and analysis of the literature was performed, and the Evidence-based Practice Guideline for the Prevention of SSI was reported herein.

Key Words: Surgical site infection, Practice guideline, Perioperative care, Operative surgical procedure, Prevention and control

서론 및 배경

대한수술감염학회는 2011년 대한외과감염연구회라는 이름으로 발족하였고, 수술 감염 예방 및 치료에 관한 연구 및 교육을 위해 다양한 활동을 해왔으며, 2013년 학회로 승인되었다. 수술 감염에 대한 정확한 실태조사와 연구를 통하여 우리나라에 특화된 수술부위감염 지침을 만들고 더 나아가 수술 부위 감염률을 줄이기 위한 다양한 노력과 교육을 실시하는 것이 우리 학회의 목표이다.

대한수술감염학회 진료지침위원회는 우리 학회의 목표를 실현하는 과정의 일부로 수술감염을 줄이기 위한 모든 진료권고안을 제정하기 위해 구성되었으며, 근거기반 중심의 수술감염예방 진료권고안은 수술을 받는 환자 및 수술을 시행하는 의료진, 그리고 수술과 연관된 정책전문가 등의 모든 환자와 의료진, 그리고 의료 관계자 모두를 위한 내용입니다.

수술부위감염은 수술을 받는 환자의 절개부위 및 장기 혹은 그 주위에서 발생되는 감염으로 정의할 수 있으며, 미국질병관리본부(Center for Disease Control and Prevention, CDC)의 정의가 가장 일반적으로 사용되고 있다.[1] 수술부위감염은 가장 발생하는 의료관련 감염의 하나이며, 입원기간의 연장 및 의료비용의 증가를 야기하고, 의료분쟁의 원인이 되기도 한다.[2] 세계보건기구(World Health Organization, WHO)에 따르면 수술부위감염은 중, 후진국에서 가장 흔한 의료관련감염으로 수술한 환자의 약 1/3이 영향을 받고, 선진국에서도 두번째 흔한 의료관련감염으로 조사되었다고 보고하였다.[3] 하지만, 수술부위감염의 약 55%는 근거 기반의 전략을 수행함으로써 예방 가능하다는 보고[4]가 있어 모든 의료진 및 의료기간은 수술부위감염의 원인을 파악하고 이를 예방하기 위한 효과적인 실무를 수행해야 한다. 이를 위해 세계 각국에서는 수술부위감염을 감소시키기 위한 노력의 일환으로 진료권고안을 개발하고 배포하고 있다.[5-7] 세계보건기구에서도 체계적인 논문 검토 및 메타분석을 통한 진료권고안을 2016년에 발표하였고,[3] 2018년에는 중, 후진국의 의료환경을 고려하여 진료권고안을 일부 개정하여 발표하였다.[8]

하지만, 수술 환경 및 상황이 다른 국내에서 외국의 진료권고안을 일률적으로 적용하는 것은 무리가 있다. 국내에서도 2017년 의료관련감염 표준예방지침[9]을 발표하기는 했지만, 수술부위감염에 대해서는 추가적인 진료권고안이 필요한 상황이다. 국내 수술실 환경을 고려하더라도, 1차 의료기관과 상급병원의 차이가 커서 공통으로 적용될 수 있는 수술부위감염 진료권고안을 제정하는데 어려움이 있다. 우리 대한수술감염학회에서는 국내 수술환경에 적합한 근거

기반 중심의 수술부위감염 예방 권고안의 필요성을 인식하고 진료권고안 개발을 시작하였다.

이해 당사자의 참여

진료권고안 위원회는 Table 1과 같다.

진료권고안의 개발 목적과 대상

1. 진료권고안의 개발 목적

진료권고안은 국내외 보고를 기반으로 국내의 현 실정에 맞는 근거 중심의 지침을 개발하고 보급하여 수술부위감염의 발생을 감소시키는 것을 목적으로 한다. 또한 수술에 참여하는 의료진에게 안전한 치료 방법 결정과 효과적인 의사결정을 돕고, 수술을 시행 받는 환자 그리고 의료 정책전문가들의 이해를 돕기 위해 개발되었다.

2. 진료권고안 사용자

수술과 관련된 1차, 2차, 3차 의료진, 환자, 그리고 의료정책전문가 등 관련자.

3. 진료권고안이 다루는 인구 집단

수술을 받는 모든 소아, 성인 환자.

4. 진료권고안의 범위

수술부위감염을 예방하는 목적으로 수술 전, 수술 중, 수술 후 행해질 수 있는 모든 진료행위 및 권고사항을 대상으로 한다.

진료권고안 개발 방법

진료권고안은 수용개작 방식(adaptation)으로 개발되었으며, 기존 권고안을 기준으로 최신성을 보강하여 업데이트

Table 1. 진료권고안 위원회

구분	성명	소속	전문분야	병원규모
위원장	엄준원	고려대학교 안산병원	대장항문외과	3차
간사	홍영기	국민건강보험공단 일산병원	대장항문외과	2차
위원	이형순	국민건강보험공단 일산병원	이식외과	2차
위원	장지영	국민건강보험공단 일산병원	중환자외상외과	2차
위원	정윤빈	연세의대 세브란스병원	외과입원전담의	3차
위원	노경태	이화의대 서울병원	대장항문외과	2차
위원	오보영	한림대학교 평촌성심병원	대장항문외과	3차
위원	박경식	건국의대 건국대병원	내분비외과	3차
위원	김찬영	전북의대 전북대학교병원	위장관외과	3차
위원	백용해	동국대학교병원	위장관외과	2차
위원	장종범	서울의대 분당서울대병원	정형외과	3치
위원	김영석	연세의대 강남세브란스병원	성형외과	3차
위원	정재흥	연세의대 원주세브란스기독병원	비뇨기과	3차
위원	최종림	계명대학교 간호대학	감염관리학과	3차
위원	김성헌	연세의대 세브란스병원	이비인후과	3차
위원	성용원	서울의대 보라매병원	흉부외과	2차
위원	배성욱	계명의대 동산병원	대장항문외과	3차
위원	김혜진	경북의대 칠곡경북대병원	대장항문외과	3차
위원	박윤영	경희의대 강동경희대병원	대장항문외과	2차
위원	박지원	서울의대 서울대학교병원	대장항문외과	3차
위원	김창현	전남의대 화순병원	대장항문외과	3차
위원	이석환	경희의대 강동경희대병원	대장항문외과	2차
방법론 전문위원	김현정	고려의대 예방의학교실	코클란연구소(한국지부)	3차

하는 GRADE-ADOLOPMENT 방법[10]을 적용하였다. 기존 가이드라인을 검토하고 내부회의를 거쳐, 문헌의 체계적 검토 및 분석을 발표했던 2016년 WHO 가이드라인[3]을 기준 진료권고안으로 선정하였다. WHO 가이드라인의 권고안 중 내부 회의를 거쳐 국내 수술환경에 맞게, 그 적용 대상으로 핵심질문으로 우선 선정하였고, 2021년 1월까지의 기간으로 확대하여 문헌 검색하였으며, 그리고 국내 연구를 추가 검색하였다.

1. 핵심질문의 도출

핵심질문의 도출 과정은 대한수술감염학회 지침개발위원회에서 WHO 가이드라인의 각 권고사항의 포함 여부에 대해 설문조사를 실시하였다. 설문조사에 따라 우선 순위를 정하고 내부 회의를 통해 항목을 선정하였고, 최종 결정된 핵심질문은 Table 2와 같다.

2. 최신성 보강을 위한 문헌 검색

문헌 검색은 내부 논의를 거쳐 2016년 WHO 가이드라인[3]의 검색식을 적용하기로 하였다. 기존 WHO 가이드라인에서 각 핵심질문별로 적용된 검색 기간을 확인하고, 같은 검색식과 조건을 이용하여 최근까지 보고된 문헌을 추가 검색하였다. 추가 검색된 문헌들을 기존 WHO 가이드라인에서 사용된 문헌들과 통합하여 분석에 사용하였다. 검색이 완료된 문헌들은 EndNote를 이용하여 합산되었으며, 제목, 저자명, 출판연도, 저널명을 통해 중복을 배제하였다. 그러나 데이터베이스에서 제공하는 상기 용어가 상이한 경우 중복이 배제되지 않는 경우가 있으며, 이 경우에는 수기로 중복을 배제하였다. 국내 논문 검색은 수술부위감염, 수술 부위 감염, SSI, 또는 surgical site infection의 검색어를 이용하였다. 해외 논문 검색에 사용된 데이터베이스는 MEDLINE, EMBASE, CINAHL, Cochrane이었으며, 국내 논문 검색은 KMBASE, KoreaMed를 이용하였고, 검색은 2021년 1월 12일에 수행되었다. 검색식은 최종 완료된 수술부위감염 진료권고안 책자에서 추가할 예정이다.

3. 문헌 선택

근거 선택의 과정은 각 핵심질문별로 1-3명의 위원을 할당하여 PRISMA Flow Diagram[11]에 따라 보고하였다.

문헌 선택을 위한 개별 핵심질문별 포함과 배제기준은 각 핵심질문별로 PICOS (Patient [환자집단, 대상환자, 관심대상], Intervention [중재: 치료법, 진단법, 예후요인, 노출 등], Comparator/Comparison/Control [비교군, 비교 타당한 현존하는 대안 중재], Outcomes [결과, 중재를 통해 기대하는 결과변수], Setting [임상 연구 설계])의 형식으로 도출하여 적용하였다. 도출된 문헌 중 무작위 대조군 연구가 충분한 경우에는 관찰 연구는 배제하였고, 무작위 대조군 연구가 충분치 않아 분석이 어렵다고 판단되는 경우에는 선택된 모든 비무작위 관찰 연구를 포함하였다. 핵심 질문 중 하위 질문이 있는 경우에는 각 하위 질문에 해당하는 문헌을 각각 선택하였다.

Table 2. 핵심질문 요약

핵심질문 1	수술부위 체모 제거가 수술부위감염에 미치는 영향은 무엇이고, 체모 제거 시 적절한 시기 및 방법은 무엇인가?
핵심질문 2	수술 환자의 수술 직전 수술 부위 소독에 알코올 포함 소독제를 사용해야 하는가?
핵심질문 3	수술부위감염 예방을 위한 효과적인 외과적 손 위생 방법은 무엇인가?
핵심질문 4	수술부위감염을 감소시키기 위해 집중적 영양 관리가 필요한가?
핵심질문 5	수술부위감염을 감소시키기 위해 체온 유지(warming)가 중요한가?
핵심질문 6	수술부위감염 예방을 위해 수술 전후 기간에 집중적 혈당 조절이 필요한가?
핵심질문 7	수술 중 적절한 순환 혈액량 유지를 위한 Goal Direct Fluid Therapy (GDFT, 목표 지향 수액 치료)가 수술부위감염에 영향을 미치는가?
핵심질문 8	수술부위감염을 감소시키기 위한 수술포의 종류 및 사용방법은?
핵심질문 9	이중 수술 장갑 사용, 또는 수술 중 수술 장갑을 교체하거나 특정 유형의 수술 장갑을 사용하는 것이 수술부위감염 예방에 효과적인가?
핵심질문 10	수술 후 항생제를 계속 사용하는 것이 수술 전 예방적 항생제만을 사용하는 것보다 수술부위감염 예방에 효과적인가?
핵심질문 11	배액관이 있을 때 수술 후 항생제를 계속 사용해야 하는가? 수술부위감염을 감소시키기 위한 적절한 배액관 제거 시기는?

4. 질 평가 및 근거 수준 평가

근거 수준의 평가는 두 단계에 걸쳐 시행하였다. 첫 번째 단계는 일차 문헌의 개별 질 평가이며, 두 번째 단계는 이를 통합하여 하나의 근거 수준을 평가하는 단계이다.

첫 번째 단계인 일차 연구의 질 평가는 개별 연구설계에 따라 구분하여 사용하였다. 문헌의 질 평가는 각 핵심질문별 위원에 의해 독립적으로 수행되었으며, 평가 결과의 불일치는 위원내 합의를 통해 결정하였다. 개별 근거 수준 평가는 무작위 대조연구는 Cochrane ROB 2.0[12], 비무작위 관찰연구는 Newcastle-Ottawa Quality Assessment Scale[13]을 이용하였다.

두 번째 단계인 근거 수준 평가는 GRADE 그룹에서 제시하는 근거 수준 평가기준에 따랐다(Table 3). 근거 수준 평가의 복잡성을 고려하여 근거 수준 평가는 방법론 전문가와 개별 핵심질문위원의 토론과정을 통해 결정하여 근거 수준 평가의 객관성과 진료권고안내 동일한 평가기준을 적용하였다. 평가 결과는 SoF Table로써 본문에 제시하였다. 모든 근거 수준은 결과지표에 따라 각각 부여하였으며, 진료권고안 도출 시 제시된 근거 수준은 개별 진료권고안의 가장 중요한 일차 결과의 근거 수준에 따랐다. 평가된 근거 수준의 개별 핵심질문 내 포함된 연구의 근거의 질을 기술하여 해당 근거의 제한점과 강점에 대한 기술을 하였다.

5. 추정치의 합산(메타분석)

메타분석은 포함된 연구에서 충분히 설명 가능하지 않은 이질성이 존재하지 않는 경우, 2개 이상의 결과를 포함한 경우 수행하였다. 단 메타분석을 수행하기 위한 방법으로 연구설계가 서로 다른 경우 합산하지 않고 각각을 분리해서 제시하였으며, 서로 다른 결과인 경우는 각각의 결과를 모두 사용하였다. 원칙적으로 모든 메타분석은 random effect model을 적용하였으며, 통계적 이질성인 I^2의 결과를 확인하였으나, 통계적 이질성은 연구대상의 수와 사건수에 많은 영향을 받는 특성을 고려하여, 통계적 이질성이 없는 경우에도 임상적 이질성이 있는지 여부에 대한 판단을 하였다. 무작위 대조연구는 crude data를 우선 이용하였고, 연구 설계상 대조가 가능한 odds ratio (OR)가 있는 경우에는 OR을 메타분석에 사용하였다. 메타분석은 대상 중재로 기인되는 이득과 위해의 모든 결과를 대상으로 하였다.

Table 3. 근거 수준 평가기준

근거 수준	정 의
높음(high)	효과의 추정치가 실제 효과에 가깝다는 것을 매우 확신할 수 있다.
중등도 (moderate)	효과의 추정치에 대한 확신을 중등도로 할 수 있다. 효과의 추정치는 실제 효과에 근접할 것으로 보이지만 상당히 다를 수도 있다.
낮음(low)	효과의 추정치에 대한 확신이 제한적이다. 실제 효과는 효과 추정치와 상당히 다를 수 있다.
매우 낮음 (very low)	효과의 추정치에 대한 확신이 거의 없다. 실제 효과는 효과의 추정치와 상당히 다를 것이다.

6. 진료권고안 도출 및 권고 등급 결정의 원칙과 의미

진료권고안 도출은 내부 위원회의 검토 과정과 외부 검토의 과정을 통해 최종 진료권고안으로 결정되었다.

- 권고 등급 결정의 원칙: 모든 권고는 근거와 연계된다(근거를 기반하여 권고를 도출한다).
- 권고 등급의 의미: 권고의 등급은 강도를 의미하는 것이 아닌 권고 적용의 일반성에 대한 의미를 포함한다.
- 권고 수준: 근거를 기반하여 각 중재를 통한 이득과 위해의 정도를 평가하여 위원회의 맹검 적용 투표 방식을 통한 4단계 권고 등급 결정(일반적 사용[Do, Strong], 선택적 사용[Do, Conditional], 제한적 사용[Do not, Conditional], 사용제한[Do not, Strong])으로 정의된다. 권고 강도 강함(strong)은 개입에 따른 바람직한 효과가 바람직하지 못한 효과보다 명백하게 클 때로 충분한 정보를 제공받은 대부분의 환자가 그 중재 방법을 선택한다는 것을 의미하며 권고 강도 선택적(conditional)인 개입에 따른 바람직한 효과가 바람직하지 못한 효과보다 큰지 여부가 불확실한 때로 충분한 정보를 제공받은 환자가 다른 개입 방법을 선택할 수 있음을 의미한다.

A. 일반적 권고: 해당 권고 대상의 대부분의 환자에게 사용하는 것을 권고한다.

B. 선택적 권고: 해당 권고 대상의 환자 중 이득/위해/비용/환자의 선호도를 고려하여 선택적으로 사용하는 것을 권고한다.

C. 제한적 권고: 해당 권고 대상의 환자 중 이득/위해/비용/환자의 선호도를 고려하여 제한적으로 사용하는 것을

Table 4. 권고 등급의 정의

권고 등급	방향	강도	정의
일반적 권고	Do	Strong	치료나 검사의 편익이 그로 인한 위험, 부담, 비용을 명백히 상회하는 경우
선택적 권고		Conditional	치료나 검사의 편익이 그로 인한 위험, 부담, 비용을 상회하나 불확실한 경우
제한적 권고	Do not	Conditional	치료나 검사의 위험, 부담, 비용이 그로 인한 편익을 상회하나 불확실한 경우
사용 제한 권고		Strong	치료나 검사의 위험, 부담, 비용이 그로 인한 편익을 명백히 상회하는 경우

권고한다(제한적으로 사용은 가능하나 사용에 대한 주의가 필요하다).

D. 사용 제한 권고: 해당 권고 대상의 대부분의 환자에게 사용하지 않는 것을 권고 한다(Table 4).

■ 진료권고안 초안 도출 방법

내부 위원회 진료권고안 도출 및 권고 등급 결정 과정은 각 핵심질문 담당위원이 근거의 요약과 근거 수준을 통해 해당 진료권고안이 가지는 여러 근거의 강점과 한계, 이득과 위해의 크기와 균형, 환자의 가치와 선호, 의사의 장애요인, 재정적 혹은 해당 의료기관에서의 적용 가능성 등을 고려하여 일차적으로 진료권고안과 권고 등급의 가안을 개발하였으며, 이를 전체 개발위원의 회의에서 개별 담당위원의 발표와 이에 대한 이견 조정을 위한 충분한 의사결정 시간을 가진 후 참석자 전체의 맹검이 적용된 투표를 시행하였다.

■ 내부 위원회 권고 등급 결정 과정 및 결과: 내부 위원회 권고 등급 결정 과정에 대한 원칙

• 70% 이상 참여가 이루어진 경우에만 시행한다. 또한 참석하지 않은 위원 전체에 대해 사전에 위원회의 결정에 동의하는 것에 대한 위임장을 받는다.

• 모든 투표 과정은 맹검을 적용하여 실시한다.

• 모든 위원 중 참여자가 70% 이상인 경우에 투표를 실시한다(사전 공지에 의해 참여하지 않은 모든 위원은 위원회의 결정에 따름에 의의가 없음으로 간주하며, 사전 참석 여부에 대한 회신과 참석이 불확실한 경우 결정사항에 의의가 없음에 대한 서면 의견서를 제출 받는다).

• 개별 사항에 70% 이상 투표에 70% 이상 찬성이 있는 경우 위원회의 결정이 합의에 이르렀다고 평가한다. 만약 70% 이상의 찬성이 없는 경우 투표 결과에 대해 진행자는 투표 결과를 위원회에 공개하지 않는다.

• 만약 70% 이상의 찬성이 없는 경우 개발자에 의해 수정을 검토하고, 수정 여부와 관계없이 재발표의 기회를 제공한다.

• 2차 투표 결과에도 70% 이상의 일치가 일어나지 않는 경우, 위원회는 해당 핵심질문에 대한 토론 과정을 갖고 3차 투표 여부에 대한 판단을 결정한다(Table 5).

수술부위감염 예방 진료권고안

핵심질문 1. 1-1. 수술을 시행 받는 환자에서 체모를 제거하지 않거나 꼭 필요한 경우 전기면도기(클리퍼)로만 제거한다.

(제한적 권고[Do not, Conditional recommendation], 중간 수준의 근거[Moderate quality of evidence])

1-2. 면도날을 사용한 제모는 수술 전 또는 수술실에서도 권장하지 않는다.

(사용 제한 권고[Do not, Strong recommendation], 중간 수준의 근거[Moderate quality of evidence])

핵심질문 2. 수술부위 피부 소독 시 기존 소독제(클로로헥시딘 또는 포비돈-요오드)에 알코올을 추가하는 것을 권고한다.

(선택적 권고[Do, Conditional recommendation], 중간 수준의 근거[Moderate quality of evidence]).

핵심질문 3. 수술 전 외과적 손위생의 효과적인 방법으로 적절한 항균비누와 물을 이용한 핸드스크럽 혹은, 적절한 알코올 기반 소독제를 이용한 핸드러빙을 선택할 수 있다.

(선택적 권고[Do, Conditional recommendation], 낮은 수준의 근거[Low quality of evidence]).

핵심질문 4. 대수술을 받는 환자의 수술 부위 감염을 예방하기 위해 경구 또는 장관을 통한 다중 영양소 강화 영양 지원을 고려할 수 있다.

(선택적 권고[Do, Conditional recommendation], 낮은 수준의 근거[Low quality of evidence])

Table 5. 진료지침위원회의 권고 등급 결정 과정 및 결과

핵심질문			1차 초안	1차 투표 결과	수정안	2차 투표 결과	최종결과
KQ 1	KQ 1-1	권고방향	Do not	14/17 (82.4%)			Do not
		권고등급	Conditional	14/17 (82.4%)			Conditional
	KQ 1-2	권고방향	Do not	12/17 (70.6%)			Do
		권고등급	Strong	13/17 (76.5%)			Strong
KQ 2		권고방향	Do	14/17 (82.4%)			Do
		권고등급	Strong	8/17 (47.1%)	Conditional	13/17 (76.5%)	Conditional
KQ 3		권고방향	Do	13/17 (76.5%)			Do
		권고등급	Conditional	12/17 (70.6%)			Conditional
KQ 4		권고방향	Do	13/17 (76.5%)			Do
		권고등급	Conditional	13/17 (76.5%)			Conditional
KQ 5		권고방향	Do	13/17 (76.5%)			Do
		권고등급	Conditional	7/17 (41.2%)	Strong	14/17 (82.4%)	Strong
KQ 6		권고방향	Do	12/17 (70.6%)			Do
		권고등급	Conditional	12/17 (70.6%)			Conditional
KQ 7	KQ 7-1	권고방향	Do	13/17 (76.5%)			Do
		권고등급	Strong	12/17 (70.6%)			Strong
	KQ 7-2	권고방향	Do	13/17 (76.5%)			Do
		권고등급	Conditional	13/17 (76.5%)			Conditional
KQ 8	KQ 8-1	권고방향	Do	13/17 (76.5%)			Do
		권고등급	Conditional	15/17 (88.2%)			Conditional
	KQ 8-2	권고방향	Do	13/17 (76.5%)			Do
		권고등급	Conditional	13/17 (76.5%)			Conditional
KQ 9		권고방향	Do	13/17 (76.5%)			Do
		권고등급	Strong	3/17 (17.6%)	Conditional	16/17 (94.1%)	Conditional
KQ 10		권고방향	Do not	12/17 (70.6%)			Do not
		권고등급	Conditional	13/17 (76.5%)			Conditional
KQ 11	KQ 11-1	권고방향	Do not	13/17 (76.5%)			Do not
		권고등급	Conditional	15/17 (88.2%)			Conditional
	KQ 11-2	권고방향	Do	13/17 (76.5%)			Do
		권고등급	Conditional	14/17 (82.4%)			Conditional

핵심질문 5. 수술 부위 감염을 감소시키기 위해 수술 중 체온유지장치 사용을 권고한다.

(일반적 권고[Do, Strong recommendation], 중간 수준의 근거[Moderate quality of evidence]).

핵심질문 6. 수술을 받는 당뇨병 및 비당뇨병 성인 환자에서 수술 부위 감염의 위험을 감소시키기 위해 수술 전후에 집중적 혈당 조절을 할 것을 권고한다.

(선택적 권고[Do, Conditional recommendation], 낮은 수준의 근거[Low quality of evidence])

핵심질문 7. 7-1. 수술 중에는 적절한 순환 혈액량 유지를 위한 목표 지향 수액 치료(GDFT, Goal Direct Fluid Therapy)를 시행할 것을 권고한다.

(일반적 권고[Do, Strong recommendation], 중간 수준의 근거[Moderate quality of evidence])

7-2. 수술 후에는 적절한 순환 혈액량 유지를 위한 목표 지향 수액 치료(GDFT, Goal Direct Fluid Therapy)를 시행할 것을 권고한다.

(선택적 권고[Do, Conditional recommendation], 낮은

수준의 근거[Low quality of evidence])

핵심질문 8. 8-1. 수술 부위 감염 예방을 위해 수술 중 소독된 일회용 수술 포 또는 소독된 재활용 수술 포를 사용할 수 있다.

(선택적 권고[Do, Conditional recommendation], 낮은 수준의 근거 근거[Low quality of evidence])

8-2. 수술 부위 감염을 예방하기 위해 소독과 관계없이 접착성 수술포를 사용할 수 있다.

(선택적 권고[Do, Conditional recommendation], 매우 낮은 수준의 근거[Very low quality of evidence])

핵심질문 9. 수술 중 장갑을 이중으로 착용하거나, 또는 교체하거나 특정 유형의 장갑을 사용하는 것이 수술부위 감염의 위험을 감소시키는 지를 평가할 근거가 충분하지 않기 때문에 수술자의 판단에 따라 사용할 것을 권고한다. 다만, 청결 창상에서는 이중장갑을 사용하는 것을 고려할 수 있다.

(선택적 권고[Do, Conditional recommendation], 매우 낮은 수준의 근거[Very low quality of evidence])

핵심질문 10. 수술 후 예방적 항생제의 추가적인 사용은 권고하지 않는다.

(제한적 권고(Do not, Conditional recommendation], 중등도 수준의 근거[Moderate quality of evidence])

핵심질문 11. 11-1. 수술 후 상처 배액관이 있다고 해서 항생제를 계속 사용하는 것을 권고하지 않는다.

(제한적 권고[Do not, Conditional recommendation], 낮은 수준의 근거[low quality of evidence])

11-2. 임상적으로 적응증에 해당할 경우, 상처 배액관을 조기에 제거할 것을 권고한다.

(선택적 권고[Do, Conditional recommendation], 낮은 수준의 근거[low quality of evidence])

진료권고안의 갱신과 방법

1. 진료권고안의 개정 기준

이번 진료권고안은 새로운 진단 방법 및 약제, 치료법 등에 대한 양질의 근거가 보고되는 경우 새로운 진료권고안의 추가나 기존 진료권고안의 수정, 보완하는 방법으로 3년 주기로 개정을 계획하고 있다. 그러나 해당 진료권고안의 대부분의 권고를 뒷받침하는 근거 수준이 낮음을 고려하여 즉시 개정을 위한 기준은 다음과 같다.

- 현재 권고의 방향과 상반되는 양질의 근거가 보고되는 경우: 즉시 해당 근거를 평가하여 위원회 소집을 통한 권고 내용의 수정에 대한 평가를 수행한다.
- 현재 진료권고안과 유사한 효과를 기대하는 다른 치료/진단에 대한 양질의 근거가 보고되는 경우: 해당 권고와의 비교를 통해 대안적 치료/진단인지 혹은 선택적 치료/진단인지에 대한 평가를 수행한다.
- 현재 진료권고안에 대한 동일한 결과의 양질의 근거가 보고되는 경우: 해당 진료권고안의 근거 수준의 상향을 고려한다.

2. 진료권고안 갱신 및 개정을 위한 핵심질문 선정

진료권고안의 갱신을 위한 핵심질문은 사용자 그룹에 대한 의견 조사를 통해 추가가 필요한 핵심질문을 조사하고, 새롭게 제시된 치료/진단에 대한 전문가 그룹의 의견조사를 통해 우선 순위에 따라 선정한다. 단 기존에 개발된 진료권고안의 경우 해당 근거가 높음이 아닌 경우 모든 진료권고안을 개정을 위한 핵심질문으로 선정한다.

- 신규 추가된 핵심질문: 연도를 제한하지 않고 모든 근거에 대한 검색을 수행하여 신규개발의 일련의 과정에 따른다.
- 기존 핵심질문: 2021년 1월 12일 해당 진료권고안에 대한 근거를 검색하였으므로 근거의 검색은 이후 일자만을 추가 검색한다. 추가된 근거가 없는 경우 기존 진료권고안의 근거 수준과 권고의 방향과 등급을 유지하며, 추가된 근거가 있는 경우 기존 진료권고안의 근거와 새로 추가된 근거를 재통합하여 새롭게 근거 수준과 권고의 방향과 등급을 재부여한다.

진료권고안 개발의 재정 지원과 개발의 독립성

1. 연구비

진료권고안은 대한수술감염학회의 진료지침위원회(위원장 엄준원)에서 주관하여 개발되었으며, 질병관리청 정책연구 용역사업인 “수술부위감염 예방 프로토콜 다기관 중재 및 효과 분석(20210708848-01), 연구 책임자, 이석환, 외

과교수 강동경희대학교병원)"의 일환으로 포함되었으며, 재정 지원이 진료권고안의 내용이나 진료권고안 개발 과정에 직접적인 혹은 잠재적인 영향을 주지 않았다.

2. 개발자의 이해상충관계 확인

진료권고안 개발에 참여한 전 모든 구성원들의 잠재적인 이해상충관계 유무를 확인하기 위하여 최근 2년 동안 진료권고안 개발 내용과 관련된 주제로 1,000만 원 이상의 후원 혹은 사례금을 받고 자문을 한 경우, 특정 기관 혹은 제약회사의 자금지원을 받아 연구를 수행한 경력이 있거나 경제적 이익에 대한 권리를 제공받는 경우가 있는지의 여부를 조사한 결과 상충되는 혹은 잠재적인 이해관계가 없었다.

진료권고안 보급 계획

진료권고안은 이용 편의성을 높이기 위해 주요 내용을 담은 요약본을 제작하여 진료에서 쉽게 사용할 수 있도록 하였으며, 대한의학회 인준을 거쳐, 전체 진료권고안과 함께 대한수술감염학회의 저널과 홈페이지내 진료권고안에 게시하여 수술을 시행하는 의료진이라면 누구나 쉽게 다운로드 받아 사용할 수 있도록 할 예정이다. 또한, 인터넷 사용이 불편한 이용자를 위한 책자도 함께 제작하여 배포할 예정이다.

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

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근거 중심의 수술부위감염 예방 진료권고안: 체모 제거

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The Evidence-Based Practice Guidelines for Prevention of Surgical Site Infection: Hair Removal

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Hair removal of surgical site have been widely performed to prevent surgical site infection. Various studies have been reported on whether hair removal at the surgical site affects the occurrence of surgical site infection and which method should be used for hair removal. Therefore, the practice guideline committee collected literature on this topic and conducted a systematic review, and then decided on the following recommendations. First, it is recommended not to remove hair for patients undergoing surgery, or to remove with clipper if absolutely necessary. Second, razor is not recommended either before surgery or in the operating room.

Key Words: Hair removal, Surgical site infection, Practice guideline

서론

수술부위의 체모 제거는 수술부위감염을 감소시키기 위하여 넓게 사용되어 왔다. 최근까지 체모 제거 여부와 체모 제거 방법이 수술부위감염의 발생에 영향을 미치는가에 대한 여러 연구들이 출판되었다. 이러한 연구들에서 체모를 제거하지 않거나 또는 제거하는 경우 면도날, 전기면도기(클리퍼), 제모 크림을 사용하는 것들이 서로 비교되었다. 이에 본 진료권고위원회에서는 가용한 근거를 수집하고 체계적인 검토 및 분석을 통해 수술부위 체모 제거가 수술부위감염에 미치는 영향은 무엇이고, 체모 제거 시 적절한 시기 및 방법은 무엇인지에 대한 진료지침을 마련하고자 하였다.

대상 및 연구 방법

진료권고안 개발 방법은 수용개작 방식(adaptation)으로 개발되었으며, 2016년 발표된 세계보건기구(World Health Organization, WHO) 가이드라인[1]을 기준 진료권고안으로 최신성을 보강하는 GRADE-ADOLOPMENT 방법[2]을 적용하였다. WHO 가이드라인의 권고안에서 국내 수술환경에 적용할 대상을 핵심질문으로 선정하였고, 최신성 보강을 위해 문헌 검색을 시행하여 추가하였다(Table 1). 국외 논문은 MEDLINE, EMBASE, CINAHL, Cochrane으로 WHO 가이드라인에서 적용한 기간(1990년 1월 1일부터 2014년 1월 17일)을 최신까지 연장하여 검색하였고, 국내 논문 검색은 KMBASE, KoreaMed를 검색하였으며, 논문 검색은 2021년 1월 12일에 수행되었다(Fig. 1).

Table 1. 포함 및 배제기준

대상환자(P)	모든 종류의 수술을 시행 받은 성인 환자
중재(I)	체모 제거를 하지 않는 것
비교군(C)	체모의 제거(다른 방법의 체모 제거 방법들과 시기)
결과(O)	수술부위감염, 수술부위감염으로 인한 사망률
연구설계(S)	연구 설계를 제한하지 않음.
대상 사용자	수술을 시행하는 1-3차 의료기관의 의사 및 의료종사자

P: patient, I: intervention, C: comparator/comparison/control, O: outcomes, S: setting.

핵심질문 1. 수술부위 체모 제거가 수술부위감염에 미치는 영향은 무엇이고, 체모 제거 시 적절한 시기 및 방법은 무엇인가?

근거수준: 근거수준평가와 근거의 강도와 한계

근거 검토의 목적은 제모의 방법과 시기(전기면도기, 탈모크림, 또는 면도날 면도)가 수술부위감염 발생에 영향을 미치는지 여부를 조사하는 것이었다. 일차 결과는 수술부위감염 및 수술부위감염에 따른 사망의 발생률이었다. 총 16개의 무작위 배정 연구 또는 준무작위 배정 연구[3-18]들이 검토되었으며(Table 2), 메타분석을 수행하였다. 이 중 10건의 연구[3-12]가 2000년도 이전에 수행되었으며 6건의 연구[13-18]가 2016년까지 보고되었다. 분석은 크게 1) 체모 제거를 하는 것과 하지 않는 것의 비교, 2) 각각의 체모 제거 방법 간의 비교, 3) 체모 제거의 시점에 대한 비교로 구성 되어있다. 체모 제거를 하지 않는 것과 비교하여, 면도날(risk ratio [RR]: 1.80, 95% confidence interval [CI]: 0.98-

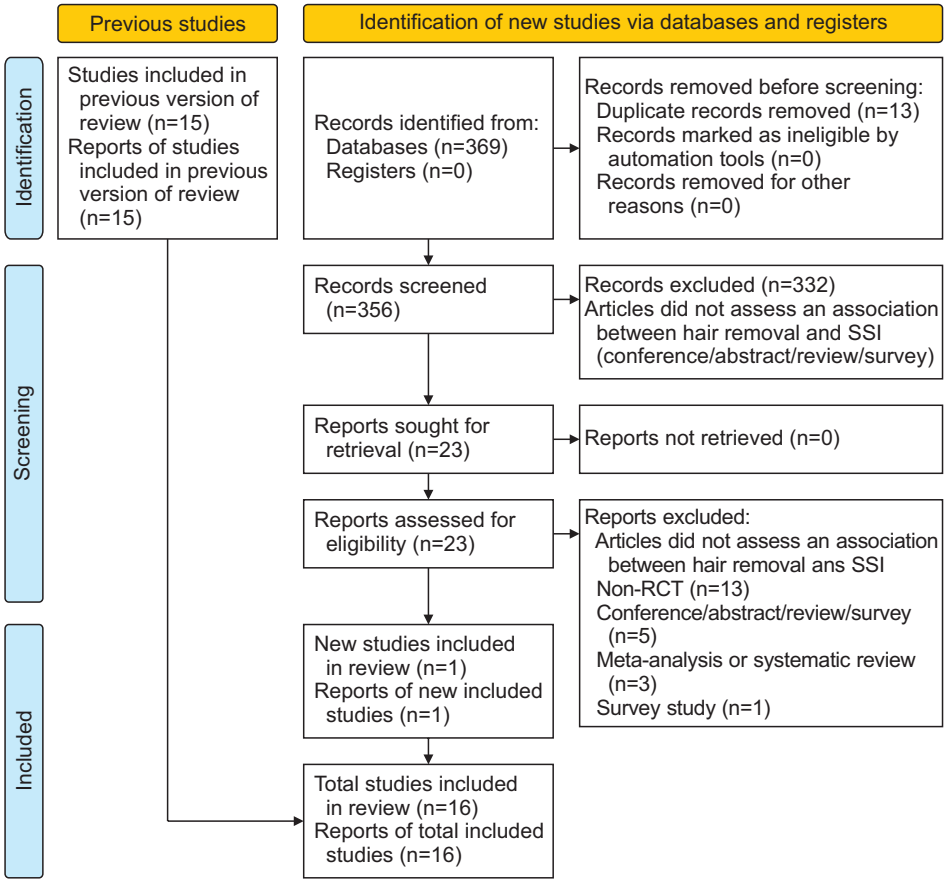

Fig. 1. Study selection. PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases and registers only. PRISMA: preferred reporting items for systematic reviews and meta-analyses, SSI: surgical site infection, RCT: radomized control study.

3.31), 탈모크림(RR: 1.02, 95% CI: 0.45-2.31) 그리고 전기면도기(RR: 0.97, 95% CI: 0.76-1.23)를 이용한 제모 방법들이 수술부위감염을 유의하게 감소시키지는 못하였으며 이는 각각 낮은 수준의 근거, 낮은 수준의 근거 그리고 중간 수준의 근거로 평가되었다. 수술 전 제모를 시행하는 경우 각각의 제모 방법 간의 비교에서는 전기면도기의 사용이 면도날을 사용하는 경우에 비해 수술부위감염을 유의하게 감소시키는 것으로 확인되었으며 이것은 중간 수준의 근거로 평가되었다(RR: 0.52, 95% CI: 0.3-0.91). 또한, 전기면도기로 제모 하거나 제모 하지 않는 것이 면도날을 이용한 제모에 비해 수술부위감염을 유의하게 감소시켰으며 중간 수준의 근거로 확인되었다(RR: 0.54, 95% CI: 0.36-0.80). 수술 전날의 면도날 제모가 수술 당일의 면도날 제모와 비교하여 수술부위감염의 비율의 차이가 없는 것을 확인하였으며(RR: 0.81, 95% CI: 0.41-1.61), 전기면도기 사용 시에도 수술 전날 시행과 당일 시행의 차이가 없었다(RR: 2.26, 95% CI: 0.72-7.11). 이것은 모두 낮은 수준의 근거로 평가되었다(Table 3).

수집된 연구들은 성인 환자들을 대상으로 하였고 소아 집단을 대상으로 하는 연구는 없었다. 그러나 본 지침에서는 이 권장 사항이 소아 환자에게도 유효한 것으로 간주하였다.

결론

1. 수술을 시행 받는 환자에서 체모를 제거하지 않거나 꼭 필요한 경우 전기면도기(클리퍼)로만 제거한다.

(제한적 권고[Do not, Conditional recommendation], 중간 수준의 근거[Moderate quality of evidence])

2. 면도날을 사용한 제모는 수술 전 또는 수술실에서도 권장하지 않는다.

(사용 제한 권고[Do not, Strong recommendation], 중간 수준의 근거[Moderate quality of evidence])

Table 2. Evidence Table

Study	Design, setting, population	Type of surgery	SSI definition	Randomization and blinding	Intervention	Results
Abouzari et al.[14] (2009)	RCT, single centre, mixed population	Elective cranial surgery (exclusion of ventriculo-peritoneal shunt surgery)	Follow-up until complete wound healing. Presence of infection, including pus at the operative site, a positive culture from a swab of the incision, development of postoperative bacterial meningitis and/or inflammation at the area of the wound	Unknown randomization and blinding	A) Shaving (unknown timing and location) B) Clipping (unknown timing and location) C) No hair removal	A) n=65 SSI: 3/65 (4.6%) B) n=65 SSI: 1/65 (1.5%) C) n=65 SSI: 1/65 (1.5%) No p-value or OR reported
Adisa et al.[15] (2011)	RCT, single centre, adults	Clean operations with access through hair-bearing areas of the body	Modified Southampton wound infection scoring system (presence of undue wound redness and swelling, discharge of serous or haemoserous fluids, discharge of pus or wound dehiscence)	Envelope randomization, blinding of assessor	A) Shaving (immediately before surgery in the OR) B) Depilatory cream (potassium thioglycolate) (morning of surgery, unknown location)	A) n=86 SSI: 11/86 (12.8%) B) n=79 SSI: 2/79 (2.5%) p=0.015
Alexander et al.[7] (1983)	RCT, single centre, mixed population	Elective surgery (exclusion of dirty wounds, proctologic procedures, skin grafts, operations on the genitalia, head or hand, amputations of the toe or foot or operations for decubitus ulcers)	Infection defined as discharge of pus, classified as either stitch abscess, superficial abscess (requiring minor drainage) or deep abscess (requiring major drainage in the OR or extending into a major body cavity) checked at time of discharge	Envelope randomization, unknown blinding	A) Shaving (night before surgery) B) Shaving (morning of surgery) C) Clipping (night before surgery) D) Clipping (morning of surgery) Unknown type of razor and clipper	A) n=271 SSI: 14/271 (5.2%) B) n= 266 SSI: 17/266 (6.4%) C) n=250 SSI: 10/250 (4.0%) D) n=226 SSI: 4/226 (1.8%) p<0.027, No OR reported
Balthazar et al.[6] (1982)	RCT, single centre, male patients	Elective inguinal herniorrhaphy	Infection defined as discharge of purulent exudate at postoperative day 5	Randomization table, unknown blinding	A) Shaving (wet shaving with standard safety razor immediately before surgery) B) Clipping (non-sterilized, ordinary barber's electric clippers immediately before surgery)	A) n=100 SSI: 2/100 (2%) B) n=100 SSI: 1/100 (1%) No p-value or OR reported
Celik and Kara[13] (2007)	RCT, single centre, mixed population	Spinal surgery	Purulent discharge from the surgical wound; increasing pain, tenderness, or redness around the incision line, in addition to haematologic test results showing a high polymorphonuclear lymphocyte count or an increasing	Unknown randomization and blinding	A) Shaving (immediately before surgery in the OR) B) No hair removal	A) n=371 SSI: 4/371 (1.1%) B) n=418 SSI: 1/418 (0.2%)

Table 2. Continued

Study	Design, setting, population	Type of surgery	SSI definition	Randomization and blinding	Intervention	Results
Court-Brown[5] (1981)	RCT, single centre, mixed population	Abdominal surgery (without any other incision or construction of a colostomy)	Infection defined as discharge of material from which bacteria were cultured; assessed daily and 28 days' postoperatively	Unknown randomization and blinding	A) Shaving (disposable safety razor, 18-24 hours before elective surgery, within 6 hours before emergency surgery) B) Depilatory cream (potassium thioglycolate and calcium hydroxide, identical timing to group A) C) No hair removal	A) n= 137 SSI: 17/137 (12.4%) B) n= 126 SSI: 10/126 (7.9%) C) n= 141 SSI: 11/141 (7.8%) p=NS
Goëau-Brissonnière et al.[9] (1987)	RCT, single centre, mixed population	Elective surgery requiring hair removal (clean, clean-contaminated or contaminated)	Examined on postoperative days 2 and 5 after surgery by a blinded assessor and defined as purulent discharge or partial or complete dehiscence	Randomization table, blinding of assessor	A) Razor (night before surgery) B) Depilatory cream (thioglycolic acid in the form of sodium and calcium, night before surgery)	A) n=51 SSI: 0/51 (0%) B) n=49 SSI: 0/49 (0%) No p-value or OR reported
Grober et al.[16] (2013)	RCT, single centre, male adults	Surgery involving male genitalia and requiring preoperative hair removal	Evidence of increasing cellulitis and/or pus from the surgical incision within 3 months of surgery	Unknown randomization, unknown blinding of SSI (blinding of photographs to assess skin trauma)	A) Clipping (3M surgical clipper, immediately before surgery in the OR) B) Shaving (Gillette® 2 blade disposable plastic blue razor, immediately before surgery in the OR)	A) n=107 SSI: 2/107 (1.9%) B) n=108 SSI: 2/108 (1.9%) No p-value or OR reported
Horgan et al.[12] (1999)	Quasi-RCT, single centre, unknown population	Elective cranial surgery for tumour or vascular anomaly	Unknown	Alternately shave/ unshaven, unknown blinding	A) Shaving (unknown timing and location) B) No hair removal	A) n=10 SSI: 0/10 (0.0%) B) n=10 SSI: 0/10 (0.0%) No p-value or OR reported
Ilankovan and Starr[10] (1992)	RCT, single centre, mixed population	Maxillofacial surgery	Presence of purulent material, local erythema associated with fever or tenderness and wound breakdown (7 days)	Random number sequence, unknown blinding	A) Shaving (immediately before surgery in the OR) B) No hair removal	A) n=25 SSI: 0/25 (0.0%) B) n=25 SSI: 0/25 (0.0%) No p-value or OR reported

Table 2. Continued

Study	Design, setting, population	Type of surgery	SSI definition	Randomization and blinding	Intervention	Results
Kattipattanapong et al.[17] (2013)	RCT, single centre, adults	Ear and/or mastoid surgery	CDC National Nosocomial Infections Surveillance system.	Block computer randomization, unknown blinding	A) Shaving (mean time between shaving and surgery 16.7±6.7 hours, unknown location) B) No hair removal	A) n=66 SSI: 3/66 (4.5%) B) n=70 SSI: 2/70 (2.8%) p=0.674
Powis et al.[4] (1976)	RCT, two centres, age of patients not reported	Surgery requiring removal of hair at the operative site	Examined on postoperative days 2 and 5 by an independent observer; grade 3 or higher considered as infection (purulent discharge or dehiscence)	Randomization based on hospital registration number	A) Shaving (disposable razor or a safety razor with disposable blades; 20 patients on night before surgery, 26 patients on day of surgery; mean duration between shaving and surgery, 3.3 hours) B) Depilatory cream (calcium thioglycolate trihydrate, calcium hydroxide and strontium hydroxide) (26 patients on night before surgery, 20 patients on day of surgery; mean duration between cream and surgery, 4.1 hours)	A) n=46 SSI: 1/46 (2.2%) B) n=46 SSI: 1/46 (2.2%) p=NS
Rojanapirom and Danchaivijitr[11] (1992)	RCT, single centre, mixed population	Open appendectomy for acute appendicitis	Unknown definition, follow-up until stitches were removed (7-10 days)	Unknown randomization and blinding	A) Razor (day of surgery, unknown location) B) No hair removal	A) n=40 SSI: 3/40 (7.5%) B) n=40 SSI: 3/40 (7.5%) No p-value or OR reported
Seropian and Reynolds[3] (1971)	RCT, single centre, mixed population	Appendectomy	Unknown definition, assessed by infection control unit	Randomization based on hospital registration number	A) Shaving (standard razor, unknown timing and location) B) Depilatory cream (calcium thioglycolate trihydrate, calcium hydroxide and strontium hydroxide)	A) n=249 SSI: 14/249 (5.6%) B) n=157 SSI: 1/157 (0.6%) p=0.02

Table 2. Continued

Study	Design, setting, population	Type of surgery	SSI definition	Randomization and blinding	Intervention	Results
Thur de Koos and McComas[8] (1983)	RCT, single centre, male patients	Elective surgery	Unknown	Randomized by bed number (even=cream; uneven=razor), unknown blinding	A) Depilatory cream (cetyl alcohol and thioglycolic acid, night before surgery in the ward) B) Shaving (wet, unknown type of razor, immediately before surgery in the OR)	A) n=116 SSI: 9/116 (7.6%) B) n=137 SSI: 10/137 (7.3%) p=NS
Kowalski et al.[18] (2016)	RCT, single centre, adults	Elective surgery (vascular, ano-rectal, orthopaedic, obstetric, or gynecologic surgery)	CDC SSI definition (superficial, deep, and organspace)	Envelope randomization, unknown blinding.	A) Clipping (unknown timing and location) B) No hair removal	A) n=834 SSI: 113/834 (13.55%) B) n=844 SSI: 118/844 (13.98%) Risk difference, –0.43%; 95%CI, –3.73-2.86), p =0.074 (noninferiory test)

SSI: surgical site infection, RCT: radomized control study, OR: operating room, CDC: Centers for Disease Control and Prevention, NS: no significance.

Table 3. Summary of Finding Table

Shaving compared to no hair removal for
Patient or population: patients with
Settings:
Intervention: Shaving
Comparison: no hair removal

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	No hair removal	Shaving				
SSI (shaving vs. no hair removal)	23 per 1,000	41 per 1,000 (23 to 74)	RR 1.80 (0.98 to 3.31)	1,483 (7 studies)	⊕⊕⊖⊖ Low	
SSI (depilatory cream)	78 per 1,000	80 per 1,000 (35 to 180)	RR 1.02 (0.45 to 2.31)	267 (1 study)	⊕⊕⊖⊖ Low	
SSI (clipping)	131 per 1,000	127 per 1,000 (99 to 161)	RR 0.97 (0.76 to 1.23)	1,808 (2 studies)	⊕⊕⊕⊖ Moderate	

Comparisons of methods of hair removal for
Patient or population: patients with
Settings:
Intervention: Comparisons of methods of hair removal

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Comparisons of methods of hair removal				
SSI (clipping vs. shaving)	47 per 1,000	24 per 1,000 (14 to 43)	RR 0.52 (0.3 to 0.91)	1,558 (4 studies)	⊕⊕⊕⊖ Moderate	
SSI (shaving vs. depilatory cream)	40 per 1,000	103 per 1,000 (34 to 313)	RR 2.56 (0.84 to 7.79)	1,279 (6 studies)	⊕⊕⊖⊖ Low	
SSI (clipping or no hair removal vs. shaving)	50 per 1,000	27 per 1,000 (18 to 40)	RR 0.54 (0.36 to 0.80)	3,413 (10 studies)	⊕⊕⊕⊖ Moderate	

SSI: surgical site infection, CI: confidence interval, RR: risk ratio.

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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REVIEW ARTICLE

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근거 중심의 수술부위감염 예방 진료권고안: 피부 소독

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The Evidence-Based Practice Guidelines for Prevention of Surgical Site Infection: Surgical Site Preparation

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Many studies have demonstrated the several antiseptic agents to be effective for surgical site preparation to prevent surgical site infection, but the optimal agent is still in debate. On behalf of the Korean Surgical Infection Society, the practice guidelines committee collected data regarding effective agents for surgical site preparation. Following the intensive review and analysis, the practice guidelines committee decided to recommend that alcohol-based solution with chlorhexidine gluconate or povidone iodine to be used as antiseptic agents for surgical site preparation (Do, Conditional recommendation, moderate quality of evidence).

Key Words: Surgical site preparation, Surgical site infection, Povidone iodine, Chlorhexidine gluconate

서론

수술부위 소독은 수술을 위한 피부 절개 전 환자의 피부에 소독제를 도포하여 피부에 상재하는 균주를 최소한으로 줄여 수술부위감염을 예방하는 처치를 말한다. 수술부위 소독에 사용되는 제제는 클로로헥시딘, 포비돈-요오드 용액 및 여기에 알코올을 첨가한 소독제 등 다양하나 어떤 소독제가 가장 효과적인지는 아직 불분명하다. 따라서 본 진료권고위원회에서는 가용한 근거를 수집하고 체계적인 검토 및 분석을 통해 수술 부위 소독에 가장 효과적인 소독제 사용에 대한 진료지침을 마련하고자 하였다.

대상 및 연구 방법

진료권고안 개발 방법은 수용개작 방식(adaptation)으로 개발되었으며, 2016년 발표된 세계보건기구(World Health Organization, WHO) 가이드라인[1]을 기준 진료권고안으로 최신성을 보강하는 GRADE-ADOLOPMENT 방법[2]을 적용하였다. WHO 가이드라인의 권고안에서 국내 수술환경에 적용할 대상을 핵심질문으로 선정하였고, 최신성 보강을 위해 문헌 검색을 시행하여 추가하였다(Table 1). 국외 논문은 MEDLINE, EMBASE, CINAHL, Cochrane으로 WHO 가이드라인에서 적용한 기간(1960년 1월 1일부터 2014년 8월 15일)을 최신까지 연장하여 검색하였고, 국내 논문 검색은 KMBASE, KoreaMed를 기간 제한없이 검색하였으며, 논문 검색은 2021년 1월 12일에 수행되었다(Fig. 1).

핵심질문 2. 수술 환자의 수술 직전 수술 부위 소독에 알코올 포함 소독제를 사용해야 하는가?

Table 1. 포함 및 배제기준

대상환자(P)	수술을 시행 받은 환자
중재(I)	알코올 포함 소독제 사용
비교군(C)	알코올을 포함하지 않는 소독제 사용
결과(O)	수술부위 감염률 및 수술부위감염으로 인한 사망률
연구설계(S)	무작위 대조연구
대상 사용자	수술을 시행하는 1-3차 의료기관의 의료진

P: patient, I: intervention, C: comparator/comparison/control, O: outcomes, S: setting.

근거수준: 근거수준평가와 근거의 강도와 한계

분석에 포함된 연구는 기존 WHO guideline에 사용된 17개의 무작위 대조연구 중 문헌고찰이 가능한 16개의 연구[3-18]와 추가된 11개의 무작위 대조연구[19-29]이다(Fig. 1). 이 지침 내 권고사항은 수술 후 감염률을 낮출 수 있는 효과적인 수술부위 피부 소독제의 추천을 위해 개발되었으며, 27개의 무작위 대조연구를 찾을 수 있었다(Table 2). 관절, 척추, 탈장, 제왕절개, 유방, 대장, 혈관, 담낭 수술과 부인과 종양 및 성형외과 수술에 대한 계획적 수술을 시행 받은 성인 환자가 연구에 포함되었으며, 소아 환자에 대한 연구는 없었다. 일차 분석목적은 수술부위감염의 발생과 수술부위감염으로 인한 사망률 분석이었으나 수술부위감염으로 인한 사망률을 보고한 연구는 없어 수술부위 감염률에 대한 분석만 시행하였다. 연구에 포함된 27개의 무작위 대조연구를 통한 메타분석의 결과 알코올이 포함된 소독제와 알코올을 포함하지 않은 기존 소독제(클로로헥시딘 또는 포비돈-요오드)를 사용하였을 때의 수술부위 감염률을 비교했을 때 알코올이 포함된 소독제를 사용한 환자들의 수술부위

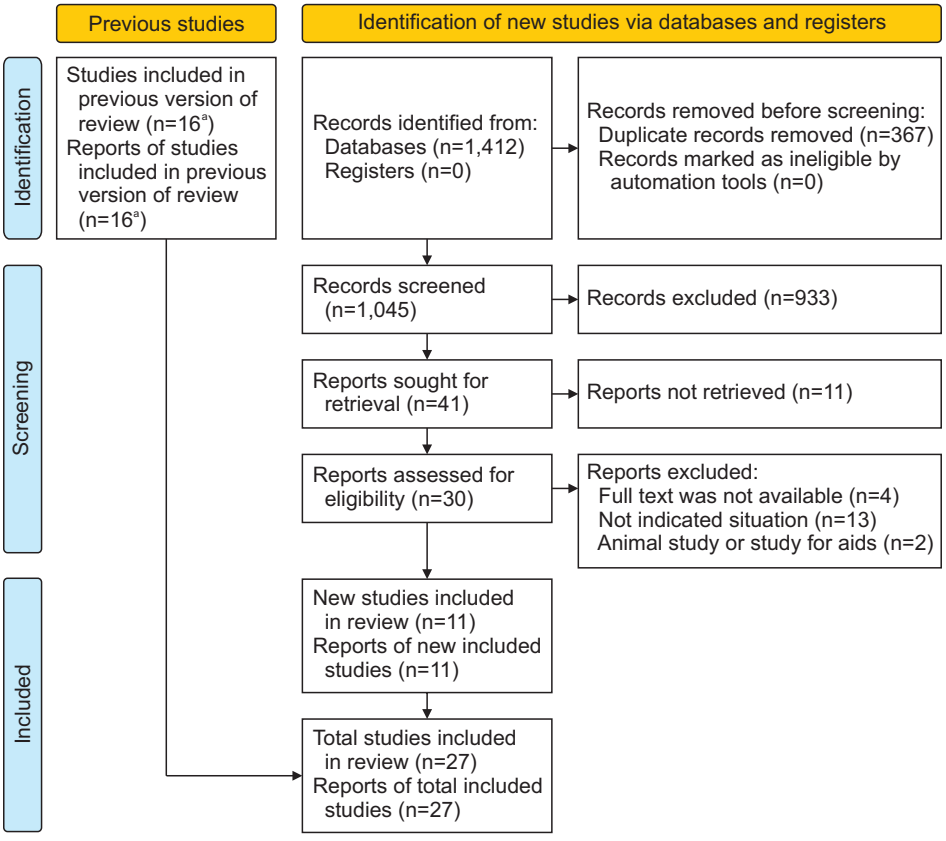

Fig. 1. Study selection. PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases and registers only. PRISMA: preferred reporting items for systematic reviews and meta-analyses. [a]One article is excluded because the full-text is not available.

감염률이 낮은 것으로 나타났다.[4,6-12,14-16,19,21-25,29] 이때 사용된 기존 소독제들의 차이에 따른 수술부위 감염률은 차이를 보이지 않았다.[21] 포함된 연구가 모두 무작위 대조 연구였으나 개별연구의 대상자 수와 연구에 포함된 수술의 종류 및 수술부위 감염 발생 관찰 기간의 이질성 등으로 인해 효과를 과장할 가능성을 배제할 수 없어 중등도 수준의 근거 수준으로 평가(Table 3)되었으며, 세부 분석에서 기존 소독제의 종류에 따른 알코올 포함 여부에 대한 수술부위 감염 감소의 근거가 불충분하여 조건부 권고를 채택하였다.

결론

수술부위 피부 소독 시 기존 소독제(클로로헥시딘 또는 포비돈-요오드)에 알코올을 추가하는 것을 권고한다.

(선택적 권고[Do, Conditional recommendation], 중간 수준의 근거[Moderate quality of evidence])

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

Conceptualization: Gyoung Tae Noh. Data acquisition: Sung Huhn Kim, Youngki Hong. Formal analysis: Sung Huhn Kim, Youngki Hong, Sung Uk Bae. Supervision

Table 2. Evidence Table

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Berry et al.[3] (1982)	Two-arm RCT May 1978-February 1980 Scotland, UK 542 patients Exclusion: sensitivity to solutions	To compare the effect of alcohol-based PVP-I alcohol-based CHG on the incidence of postoperative wound infection in a general surgical unit.	Presence of a wound abnormality: erythematous, serous, discharge or purulent. Follow-up: until discharge.	Elective, mostly clean.	Randomization allocation was done using a table of random numbers and recorded on a card. Each card was then placed in a sealed envelope. Skin shaving was routinely performed on hairy skin. Groups were allocated to bathe with the same scrub as their allocated intervention (7.5% PVP-I or CHG 0.5% in methylated spirit).	Group A: 2 applications of CHG 0.5% in methylated spirit (n=286). Group B: 2 applications of (alcohol) paint 10% (n=256).	Group A: 18/286 Group B: 34/256 p=0.03
Bibbo et al.[4] (2005)	RCT USA 127 patients Exclusion criteria eliminated patients with open wounds, skin ulcers and/or sores and active infection or who were on antibiotic therapy.	To determine the efficacy of CHG compared with PVP-I as a preoperative skin preparation agent in reducing bacterial skin contamination before clean, elective foot and ankle surgery.	NS	Clean, elective foot and ankle surgery.	Enrolled consecutively and randomly assigned into treatment groups. No special bathing instructions; patients followed usual personal hygiene routine on the day of surgery. Culture swabs were processed for aerobic, anaerobic, acid-fast and fungal cultures, as well as a routine qualitative sensitivity screening for antibiotic resistance. Culture results, demographic data, and infectious complications were recorded.	Group 1: patient skin was prepared preoperatively with a 7-minute scrub with PVP-I (7.5%) and painting of the foot and ankle with a PVP-I (10%) solution. Group 2: patient skin was prepared preoperatively with a 7-minute scrub with CHG (4%) and isopropyl alcohol (70%) paint.	SSI Group 1: 0/67 Group 2: 0/60 Microbial culture data also included. OR: NA, 95% CI: NA

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Cheng et al.[5] (2009)	RCT August 2007 to January 2008 UK 50 patients Exclusion criteria: open wounds, skin ulcers and/or sores, a history of onychomycosis, paronychia or nail deformity, poorly controlled diabetes mellitus or recent antibiotic use within 1 week of surgery.	To compare the effect of PVP-I or CHG with and without isopropyl alcohol on lowering the bacterial load. Also assessed whether any additional benefits were to be gained by an additional pre- scrub with a bristled surgical brush with either of these compounds.	NS	Foot surgery.	Patients were randomized via generation of random number tables to be prepared with either alcohol-based PVP-I or alcohol-based CHG. A sterile brush was used to generously apply the solution using the foam part of the brush. The bristled side was then used to scrub for a standardized 3 minutes. Feet were allowed to dry prior to draping. The same agent was used on the patient's other foot and then painted with solution (CFU data only) Specimens for bacterial cultures were obtained by one of the authors from 3 sites on the foot before and after skin preparation and transported for culture and quantitative analysis.	Group 1: alcohol-based betadine (10% PVP-I weight/weight). Group 2: CHG (0.5%) with 70% isopropyl alcohol.	SSI Group 1: 0/25 Group 2: 0/25 Microbial data also reported. OR: NA, 95% CI: NA
Darouiche et al.[6] (2010)	RCT April 2004-May 2008 USA 409 patients 6 university-affiliated hospitals	To compare the efficacy of CHG-alcohol with PVP-I for the prevention of SSI.	CDC criteria	Clean 70%-73% abdominal. All procedures were similarly distributed between groups.	Randomization stratified by hospital using computer-generated randomization numbers without blocking. Preoperative shower with CHG, PVP-I or triclocarban soap was recorded in less than 30% of patients and was similar between groups. Patients and investigators who diagnosed SSI were unaware of group assignments. Outcome: SSI within 30 days after surgery; individual types of SSI.	Preoperatively scrubbed with an applicator containing CHG 2% and 70% isopropyl alcohol (ChloraPrep®; Care Fusion, San Diego, CA, USA) or preoperatively scrubbed and then painted with an aqueous solution of PVP-I 10%. More than one CHG-alcohol applicator was used if the coverage area exceeded 33×33 cm.	Total SSI CHG/alcohol: 39/409 PVP-I: 71/440 RR: 0.59 95% CI:0.41-0.85 p=0.004 Superficial CHG/alcohol: 17/409 PVP-I: 38/440 Deep CHG/alcohol: 4/409 PVP-I: 13/440 Organ/space CHG/alcohol: 18/409 PVP-I: 20/440

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Gilliam and Nelson[7] (1990)	Two-arm RCT USA 60 patients	Not given	NS	Clean total joint surgery.	Hair removal was conducted just prior to skin preparation with a dry shave. Both groups bathed preoperatively with a CHG soap. Non-microbial drapes were also used.	Group A: 5-minute aqueous iodophor scrub followed by the application of iodophor paint (n=30). Group B: water insoluble iodophor-in-alcohol solution (iodophor 0.7% and isopropyl alcohol 74% (DuraPrep™; 3M, St. Paul, MN, USA) (n=30).	Group A: 0/30 Group B: 0/30 OR: NA, 95% CI: NA
Hort and DeOrio[8] (2002)	Two-arm RCT USA 49 consecutive patients	To investigate the usefulness of a standard surgical preparation for the prevention of surgical site contamination.	NS	Foot and ankle surgery.	Patients were randomly assigned to an allocation group. The standard group was given 2 CHG scrub brushes with instructions to perform 2 separate self-scrubs several hours apart before bed. In the operating room, 10-minute scrub with PVP-I cleansing solution followed by PVP-I topical paint. The experimental group was supplemented with the addition of a 3-minute preoperative preparation of the area with alcohol 70%. All patients were draped by a blinded surgeon. Swabs were collected for CFU data.	Group A: PVP-I scrub+aqueous PVP-I paint. Group B: PVP-I scrub+PVP-I paint+alcohol.	Group A: 0/26 Group B: 0/23 OR: NA, 95% CI: NA

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Howard[9] (1991)	Two-arm RCT USA 159 patients over 18 years of age undergoing surgery with no known iodide allergy.	To compare the effectiveness of DuraPrep™ to standard iodophor scrub and paint.	Wounds were considered to be infected if: • they drained pus; • they developed significant erythema at the margins of the wound (erythema around a suture "stitch abscess" was not considered to be a wound infection); • the wound drained serous fluid and was opened by the surgeon; or • the wound was considered to be infected by the operating surgeon.	Clean and clean-contaminated operations	Patients randomized using a 1-to-1 basis. Cultures were taken and incubated for aerobic colonization; wounds were followed daily until discharge and then at clinic visits. Some patients who lived far from the medical centre were followed by their local physician and by telephone communication.	Group 1 (n=140) received a 10- minute scrub with an iodophor detergent followed by an aqueous iodophor paint. Group 2 (n=140) were prepared with a water-insoluble iodophor in isopropyl alcohol 70%.	Group 1: 2/75 Group 2: 2/84
Paocharoen et al.[10] (2009)	RCT June 2006 to November 2008 Thailand 500 adult patients	To study the efficacy of the reduction of bacterial colonization and surgical wound infection among antiseptics.	Incisional SSI: if wound drained purulent material or if the surgeon judged it to be infected and opened it.	Clean, clean-contaminated and contaminated wounds and ASA class 1 and 2.	Randomization by "random assignment". Surgical wounds were examined twice a week in week 1 and every week thereafter up to 1 month. Outcomes were bacterial colonization following skin preparation and postoperative wound infection.	1) 5-minute scrub with PVP-1 scrub followed by PVP-1 paint. 2) 5-minute scrub with Hibitane® scrub solution followed by Hibitane® paint (CHG 4% in 70% isopropyl alcohol 70%).	SSI Group 1: 8/250 Group 2: 5/250 Allergic reaction Group 1: 2/250 Group 2: 0/250 Microbial data also reported.

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Rodrigues and Simões Mde[11] (2013)	Randomized, longitudinal study Brazil 205 adult patients	To analyze the incidence of SSI when the pre-operative skin preparation was performed with PVP-I 10% and CHG-alcohol 0.5%.	NS	Clean and potentially contaminated operations.	Patients were divided into 2 groups according to the order of arrival to the operating room. Postoperative infection of the surgical site was inspected at postoperative days 3, 7, and 30.	Group 1: PVP-I 10% (n=102). Group 2: CHG 0.5% (n=103).	Group 1: 7/95 Group 2: 11/92 p=0.460
Saltzman et al.[12] (2009)	RCT September 2007 to February 2008 USA 150 patients (age, 17-79 years) Patients were excluded if they had an open wound or current infection or were chronically immuno-suppressed.	To examine the native bacteria around the shoulder and to determine the efficacy of 3 different surgical skin preparation solutions on the eradication of bacteria from the shoulder.	NS	Shoulder surgery.	Randomized using randomly assigned sealed envelopes. All patients received preoperative antibiotics. Manufacturer's instructions were used for each preparation agent by the attending surgeon. Culture specimens were obtained for the first 20 patients from 3 different sites before and after the surgical preparation. The remaining 130 patients were cultured from two locations after skin preparation (aerobic and anaerobic microbiology). Assessment of infectious outcomes are not specified.	Each shoulder was prepared with one of 3 surgical skin preparation agents: 1) ChloraPrep® (CHG 2% with isopropyl alcohol 70%; n=50). 2) DuraPrep™ (iodophor 0.7% and isopropyl alcohol 74%; n=50). 3) PVP-I scrub and paint (iodine scrub 0.75% and iodine paint 1%; n=50).	Group 1: 0/50 Group 2: 0/50 Group 3: 0/50 OR: NA, 95% CI: NA
Savage et al.[13] (2012)	Two-arm RCT USA 100 patients	To identify the common bacterial flora on the skin overlying the lumbar spine and to evaluate the efficacy of 2 readily available skin preparation solutions for the elimination of bacterial pathogens from the surgical site following skin preparation.	NS	Elective lumbar spine surgery.	All patients were randomized using a randomly-assigned envelope method. Perioperative use of antibiotics in all patients. The site was prepared according to the manufacturer's instructions by the attending surgeon. Each solution was allowed to adequately dry for 3-5 minutes in order to minimize the recognized risk of fire associated with alcohol-based solutions. Assessment of rate of positive bacterial culture, wound infection.	Skin preparation with: Group 1: ChloraPrep® (n=50; CHG 2% and isopropyl alcohol 70%). Group 2: DuraPrep™ (n=50; available iodine 0.7% and isopropyl alcohol 74%).	SSI Group 1: 1/50 Group 2: 0/50

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Segal and Anderson[14] (2002)	Four-arm RCT USA 209 patients	To investigate whether one method of skin preparation is better than another for reducing postoperative sternal SSIs in patients undergoing coronary artery bypass graft who are at high risk for developing SSIs.	CDC criteria	Coronary artery bypass graft (clean)	All patients were instructed to take an antimicrobial shower the evening before and the morning of surgery. All patients received prophylactic preoperative antibiotics.	Group A: 5-minute scrub with aqueous PVP-I paint (scrub 7.5% and paint 10% both aqueous) (n=52). Group B: aqueous PVP-I paint (10%) (n=56). Group C: iodophor in alcohol, film-forming antiseptic (n=50). Group D: iodophor in alcohol film-forming antiseptic with iodine-impregnated incise drape (not used).	Group A: 7/52 Group B: 7/56 Group C: 1/50 (Group D: 3/51) X^2 between 4 groups=5.889 p=0.117 NS between aqueous and alcohol-based solutions.
Sistla et al.[15] (2010)	RCT India 400 adult patients	To test if CHG ethanol has a superior antimicrobial efficacy compared with PVP-I.	CDC criteria used to report SSI during the postoperative period; CFU counts from patients with SSI compared to those without SSI.	Elective inguinal hernia repair.	All patients fulfilling the inclusion criteria were prospectively randomized using a sealed envelope method. Antiseptics were applied in concentric circles beginning from the site of incision to the periphery and allowed to dry before the surgical site was draped. Incidence of SSI within 20 days following surgery, skin CFU counts pre/post-antisepsis. Patients undergoing prosthetic repair received a single dose of cefazolin 1 g intravenously 1 hour before surgery.	Group 1: PVP-I 10% group (n=285). Group 2: CHG 2.5% -ethanol 70% (n=271).	SSI Group 1:19/200 Group 2: 14/200 Grade 1 infection Group 1: 7/200 Group 2: 5/200 Grade 2 infection Group 1: 10/200 Group 2: 8/200 Grade 3 infection Group 1: 2/200 Group 2: 1/200 (all) p=0.364

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Srinivas et al.[16] (2015)	RCT January 2011 to June 2012 India 342 adult patients	To compare the efficacy of CHG vs. PVI-I in preoperative skin pre- paration for the prevention of SSI in clean-contaminated upper abdominal surgeries	CDC criteria	Clean-contaminated upper abdominal surgeries.	Group A patients were painted 3 times around the site using an applicator containing CHG-alcohol (0.5% CHG in isopropyl 70% alcohol). Group B included those who were preoperatively painted with a PVP-I 5% solution 3 times. All patients received antibiotics preoperatively. SSI was assessed as the primary outcome with a 30-day follow-up period.	Group A: CHG-alcohol (n=163; 0.5% CHG in isopropyl alcohol 70%). Group B: PVP-I (n=188; 5%).	All SSI Group A: 17/158 Group B: 33/184 p=0.061 Superficial SSI Group A: 17/158 Group B: 31/184 Deep SSI Group A: 0/158 Group B: 2/184 Organ/space SSI Group A: 0/158 Group B: 0/184
Tuuli et al.[17] (2016)	RCT September 2011 to June 2015 USA 1,147 pregnant women undergoing caesarean delivery	Patients were randomly assigned to preoperative skin antisepsis with CHG–alcohol or PVP-I–alcohol in a pragmatic trial to determine the com- parative effectiveness of the 2 preoperative skin pre- parations for the prevention of SSI after caesarean delivery.	CDC	Caesarean delivery.	Skin preparation was performed by the circulating nurse according to the manufacturer's instructions, which were similar for the two antiseptic agents. In brief, the prepackaged antiseptic applicator was opened and used to scrub the operative site. A wait time of 3 minutes was allowed between the application of the antiseptic agent and skin incision except in emergency cases in which this step was skipped. Patients also received standard infection prevention measures, including body weight–based preoperative antibiotic prophylaxis.	Group A: CHG 2% with isopropyl alcohol 70%. Group B: PVP-I 8.3% with isopropyl alcohol 72.5%.	All SSI Group A: 23/572 Group B: 42/575 RR: 0.55 (0.34-0.90) p=0.02 Superficial SSI Group A: 17/572 Group B: 28/575 p=0.10 Deep SSI Group A: 0/572 Group B: 2/575 p=0.07

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Veiga et al.[18] (2008)	RCT Brazil 250 patients over 18 years undergoing elective plastic surgery	To compare PVP-I and chlorhexidine-ethanol-based solutions for skin antisepsis before plastic surgery procedures.	CDC criteria	Elective and clean plastic surgery procedures.	Antisepsis protocol was standardized to a vigorous scrub with antiseptic soap followed by sterile towel absorption and painting with an alcohol solution of PVP-I (10%) or chlorhexidine (0.5%). The solution was allowed to dry for 2 minutes after painting. Swabs were obtained from the operative field before the scrub, after painting and at the end of surgery for CFU data.	Group A: PVP-I 10% with alcohol. Group B: chlorhexidine 0.5% with alcohol.	Group A: 4/125 (all classified as superficial SSI) Group B: 0 /125 p=0.6
Charehbili et al.[20] (2019)	RCT Netherlands 3,665 patients who underwent breast, vascular, colorectal, gallbladder or orthopedic surgery between July 2013 and June 2015	To compare chlorhexidine-alcohol and iodine-alcohol for preventing SSI	CDC	Breast, colorectal, vascular, orthopedic and gallbladder surgery	Each participating hospital (cluster) was assigned randomly to apply preoperative skin disinfection using either chlorhexidine-alcohol (0.5 per cent/70 percent) or iodine-alcohol (1 per cent/70 percent). No specifications were given for the manufacturer of the antiseptics. Every 3 months thereafter, participating hospitals switched to using the other antiseptic agent (crossover). This process was repeated until the end of the 2-year study period, with a total of seven crossover events and eight 3-month treatment periods	Group A: chlorhexidine-alcohol Group B: iodine-alcohol	Group A: 70/1,835 (3.8%) Group B: 74/1,830 (4.0%) OR 0.96, 95% CI 0.69 to 1.35

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Charles et al.[21] (2017)	RCT Australia 916 patients underwent "minor skin excision" (i.e., excision of benign or malignant skin lesions under local anesthetic, performed in general practice) from October 2015 to August 2016.	To compare 0.5% chlorhexidine in 70% ethanol and 0.5% clorhexidine aqueous solution for preventing SSI	CDC	"Minor skin excision" (i.e., excision of benign or malignant skin lesions under local anesthetic, performed in general practice)	Consecutive adult patients presenting for minor skin excisions were randomly assigned to undergo preoperative skin antisepsis with 0.5% chlorhexidine in 70% ethanol (intervention) or 0.5% chlorhexidine aqueous solution (control). Our primary outcome was surgical site infection within 30 days of excision.	Group A: 0.5% chlorhexidine in 70% ethanol Group B: 0.5% chlorhexidine aqueous solution	Group A: 5.8% (26/451), 95% CI 3.6% to 7.9% Group B: 6.8% (31/458), 95% CI 4.5% to 9.1%. No significant difference
Dior et al.[22] (2020)	RCT Australia 661 patients 18 years or older who underwent an elective operative laparoscopy for treatment of nonmalignant gynecological disorders between February 28, 2017, and November 26, 2018	To compare alcohol-based chlorhexidine, alcohol-based povidone-iodine, or water-based povidone-iodine for preventing SSI	CDC	Elective operative laparoscopy for treatment of nonmalignant gynecological disorders	661 patients 18 years or older who underwent an elective operative laparoscopy for treatment of nonmalignant gynecological disorders were randomly assigned in a 1:1:1 ratio to have their skin cleaned before surgery with alcohol-based chlorhexidine, alcohol-based povidone-iodine, or water-based povidone-iodine.	Group A: alcohol-based chlorhexidine Group B: alcohol-based povidone-iodine Group C: water-based povidone-iodine	Group A: 38/210 (18.1%) Group B: 32/216 (15.9%) Group C: 34/214 (14.8%) A vs. C: odd ratio 1.13 (95% CI, 0.61-2.08) A vs. B: odd ratio 1.34 (95% CI, 0.71-2.52) C vs. B: odd ratio 1.19 (95% CI, 0.62-2.27) No significant difference

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Bibi et al.[19] (2015)	RCT Pakistan 338 patients During May 2012 and April 2013	To compare povidone-iodine (10%) and 2% chlorhexidine-gluconate in 70% isopropyl alcohol for preventing SSI	CDC	Clean and clean-contaminated surgery	RCT on 338 patients during May 2012 and April 2013. All patients aged 18-60 years undergoing elective clean or clean contaminated surgery in selected wards of above mentioned hospitals were included in the study. Patients having diabetes, infection adjacent to the site of surgery or those undergoing emergency surgery and unwilling to participate were excluded.	Group A: povidone-iodine (10%) Group B: 2% chlorhexidine-gluconate in 70% isopropyl alcohol	Group A: 22/220 (10%) Group B: 12/168 (7.1%) p=0.324
Djozic et al.[23] (2016)	RCT Bosnia and Herzegovina 100 patients Between February 2011 and December	To compare povidone iodine (PI) only and Alkosol (96% ethanol, isopropanol-30 g and ortophenilphenol-0.1 g) and povidone iodide for preventing SSI	The presence of infection was determined by the following criteria: pain or tenderness, induration, erythema, local warmth of the wound etc.	Elective Lichtenstein inguinal hernia repair	100 adult patients were divided and randomized into two groups The first group includes patients whose skin preparations were done with PI only. The second group included patients that are treated with two antiseptics; Alkosol (96% ethanol, isopropanol-30 g and ortophenilphenol-0.1 g) and povidone iodide. The presence of bacterial growth in the wound was determined 24 and 48 hours after operation.	Group A: PI only Group B: Alkosol and povidone iodide.	Group A: 20/50 Group B: 3/50 p<0.01
Gezer et al.[24] (2020)	RCT Turkey 220 patients Between June 2017 and January 2019	To compare povidone-iodine with chlorhexidine alcohol solutions for the prevention of surgical site infection	CDC	Malignant and premalignant gynecologic diseases	This was a randomized controlled trial of a cohort of 220 patients undergoing surgery for malignant or premalignant conditions. Preoperative skin preparations were performed with 10% povidone-iodine at 25°C (PI), 10% povidone-iodine at 37°C (warm PI), 4% chlorhexidine gluconate with alcohol at 25°C (CH) and 4% chlorhexidine gluconate with alcohol at 37°C (warm CH) for each group. The primary outcome was SSI within 30 days of surgery.	Group A: povidone-iodine Group B: chlorhexidine alcohol	Group A: 12/110 (10.9)% Group B: 12/109 (11%) p=1.00 The frequency of SSI was significantly lower in the warm PI group than in the PI group (p=0.032)

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Ngai et al.[26] (2015)	RCT US 1,404 patients From January 2013 to July 2014	To compare chlorhexidine with alcohol, povidone-iodine with alcohol, and both applied sequentially in prevention of surgical site infections	CDC	Cesarean delivery	Women undergoing non-emergent cesarean birth at greater than 37 0/7 weeks of gestation were randomly allocated to one of three antiseptic skin preparations: povidone-iodine with alcohol, chlorhexidine with alcohol, or the sequential combination of both solutions. The primary outcome was surgical site infection reported within the first 30 days postpartum	Group A: povidone-iodine with alcohol Group B: chlorhexidine with alcohol Group C: combination of povidone-iodine with alcohol and chlorhexidine with alcohol used together	Group A: 21/463 (4.6%) Group B: 21/474 (4.5%) Group C: 18/467 (3.9%) p=0.85
Peel et al.[27] (2019)	RCT Australia 780 patients Between August 2014 and January 2016	To assess the efficacy of surgical site skin preparation with 0.5% chlorhexidine gluconate in 70% ethanol to 1% iodine in 70% ethanol	CDC	Elective hip or knee arthroplasty	A cluster randomized, controlled, single-centre, assessor-blinded, superiority trial in patients undergoing elective hip or knee arthroplasty. The primary outcome was superficial wound complication, defined as a composite endpoint of superficial incisional surgical site infection and/or clinically significant wound ooze in the 30 days following arthroplasty.	Group A: chlorhexidine-alcohol Group B: iodine-alcohol	Any SSI Group A: 12/390 (3.1%) Group B: 4/390 (1.0%) p=0.014 - There was an increased odds of surgical site infection in the chlorhexidine-ealcohol group compared to iodine- alcohol: 12 (3.1%) versus four (1.0%) respectively (OR 3.06; 95% CI 1.26, 7.46; p=0.014).

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Shadid et al.[28] (2019)	RCT Netherlands 49 patients March 2013 to April 2014	To compare the effect of chlorhexidine 0.5%/70% alcohol with iodine 1%/70% alcohol on lowering positive cultures before elective foot surgery	CDC	Clean foot surgery (scheduled for a hallux valgus correction or arthrodesis of the first metatarso-phalangeal joint)	Consecutive patients ≥18 years of age scheduled for a hallux valgus correction or arthrodesis of the first metatarsophalangeal joint were included. Swabs were taken from 2 sites before and twice after preparing the skin and were quantitatively and qualitatively analyzed	Group A: chlorhexidine alcohol Group B: iodine alcohol	Wound infection Group A: 0/26 (0%) Group B: 2/23 (8.7%) - No significant differences were observed for positive cultures
Springel et al.[29] (2017)	RCT US 932 patients From February 2013 through May 2016	To determine if chlorhexidine-alcohol would result in fewer surgical site infections than povidone-iodine when used as skin antisepsis preparation	CDC	Cesarean delivery	Single-center pragmatic randomized controlled trial at an urban tertiary care institution to compare chlorhexidine-alcohol 26-mL single-step applicator to povidone-iodine aqueous scrub and paint 236-mL wet skin tray as preoperative skin antiseptic preparation or women undergoing cesarean delivery. Treatment was assigned simple 1:1 randomization immediately before skin preparation.	Group A: chlorhexidine alcohol Group B: povidone-iodine	Overall SSI Group A: 29/461 (6.3%) Group B: 33/471 (7.0%) p=0.38 - Superficial surgical site infection (4.6% vs. 5.5%; p=0.55), deep surgical site infection (0.0% vs. 0.4%; p=0.50), and endometritis (1.7% vs. 1.1%; p=0.42) in chlorhexidine-alcohol vs. povidone-iodine arms, respectively

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results (SSI)
Günday et al.[25] (2020)	Two-arm RCT Center: NA Study period: NA 80 patients	To compare the two different methods for skin disinfection in cardiac surgery.	Superficial tissue infection, deep wound infection including muscle and fascia, and organ or bone tissues infection, also known as mediastinitis. Localized swelling, erythema, discharge and ternal distance were the criteria for infection.	Cardiac surgery including on-pump or off-pump surgery	Each patient was randomly assigned to group 1 (scrub and iodine followed by skin disinfection with alcohol) or group 2 (povidone iodine three times).	Group 1: PVP-I+alcohol (n=48) Group 2: PVP-I (n=32)	Discharge Group 1: 2/48 Group 2: 3/32 p=0.384 Sternal distance Group 1: 0/48 Group 2: 3/32 p=0.060 Mediastinitis Group 1: 0/48 Group 2: 0/32 p=NA Mortality Group 1: 1/48 Group 2: 0/32 p=0.999

SSI: surgical site infection, NA: not applicable, NS: not significant, ASA: American Anesthesiologists Association, CDC: Centers for Disease Control and Prevention, CFU: colony-forming unit, CHG: chlorhexidine gluconate, PVP-I: povidone-iodine, RCT: randomized controlled trial, OR: odds ratio, CI: confidence interval, RR: risk ratio.

Table 3. Summary of Finding Table

Surgical site preparation for Patient or population: patients with Settings: Intervention: surgical site preparation						
Outcomes	Illustrative comparative risks[a] (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Surgical site preparation				
Alcohol-based solutions vs. aqueous solutions						
SSI	100 per 1,000	74 per 1,000 (59 to 93)	RR 0.74 (0.59 to 0.93)	6,249 (18 studies)	⊕⊕⊕⊖ Moderate	
CHG+alcohol vs. aqueous PVP-I						
SSI	104 per 1,000	83 per 1,000 (68 to 103)	RR 0.80 (0.65 to 0.99)	4,475 (11 studies)	⊕⊕⊖⊖ Low	
PVP-I+alcohol vs. aqueous PVP-I						
SSI	125 per 1,000	52 per 1,000 (20 to 139)	RR 0.42 (0.16 to 1.11)	1,136 (8 studies)	⊕⊕⊖⊖ Low	
CHG+alcohol vs. aqueous CHG						
SSI	68 per 1,000	58 per 1,000 (35 to 95)	RR 0.85 (0.51 to 1.41)	909 (1 study)	⊕⊕⊖⊖ Low	
CHG+alcohol vs. PVP-I+alcohol						
SSI	58 per 1,000	51 per 1,000 (37 to 70)	RR 0.88 (0.64 to 1.21)	8,370 (11 studies)	⊕⊕⊖⊖ Low	

SSI: surgical site infection, CI: confidence interval, RR: risk ratio, CHG: chlorhexidine gluconate, PVP-I: povidone-iodine. [a]The basis for the assumed risk (e.g., the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

and validation: Sung Uk Bae, Ji Young Jang, Jongrim Choi, Yong Won Seong, Hye Jin Kim, Yoon Bin Jung, Chong Bum Chang, Bo Young Oh, Kyoung Sik Park, Yonghae Baik, Chan-Young Kim, Ji Won Park, Chang Hyun Kim, Jae Hung Jung, Youn Young Park, Hyung Soon Lee, Young Seok Kim, Hyun Jung Kim. Writing of original draft: Youngki Hong. Review and editing: Hyun Jung Kim, Suk-Hwan Lee, Jun Won Um.

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REVIEW ARTICLE

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근거 중심의 수술부위감염 예방 진료권고안: 외과적 손위생

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The Evidence-Based Practice Guidelines for Prevention of Surgical Site Infection: Surgical Hand Preparation

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Surgical hand preparation has been highlighted to prevent the surgical site infection as a basic principle for surgical procedure. On behalf of the Korean Surgical Infection Society, the practice guidelines committee collected data regarding an effective surgical hand preparation. Following the intensive review and analysis, the practice guidelines committee decided to recommend that the surgical hand preparation could be performed effectively either by scrubbing with an appropriate antimicrobial soap and water or handrubbing with alcohol-based solution (Do, Conditional recommendation, low quality of evidence).

Key Words: Surgical site infection, Practice guideline, Hand

서론

환자 진료와 간호에서 일상적인 손위생의 목적은 먼지, 유기물을 제거하고 일시적인 집락균의 오염을 줄이기 위함이다. 일상적인 손위생 방법과는 달리 외과적 손위생은 일시적인 집락균을 제거하고 피부 상재균을 줄여야 한다. 또한, 장갑 낀 손에서의 미생물 성장을 억제해야 한다. 수술부위감염을 줄이는 데 외과적 손위생의 영향에 대한 과학적 증거가 제한적임에도 불구하고 이 예방 조치의 목표는 수술 중 특히 수술장갑의 눈의 띄지 않는 천공으로 인해 수술팀 손의 상재균이 수술창상으로 유입되는 것을 감소시키기 위함이다. 일반비누로 손을 씻으면 수술용 장갑 아래 피부 미생물이 빠르게 증식하는 반면, 항균비누로 외과적 손위생을 하면 미생물은 더 천천히 증식한다. 따라서 본 진료권고위원회에서는 가용한 근거를 수집하고 체계적인 검토 및 분석을 통해 효과적인 외과적 손위생에 대한 진료지침을 마련하고자 하였다.

대상 및 연구 방법

진료권고안 개발 방법은 수용개작 방식(adaptation)으로 개발되었으며, 2016년 발표된 세계보건기구(World Health Organization, WHO) 가이드라인[1]을 기준 진료권고안으로 최신성을 보강하는 GRADE-ADOLOPMENT 방법[2]을 적용하였다. WHO 가이드라인의 권고안에서 국내 수술환경에 적용할 대상을 핵심질문으로 선정하였고, 최신성 보

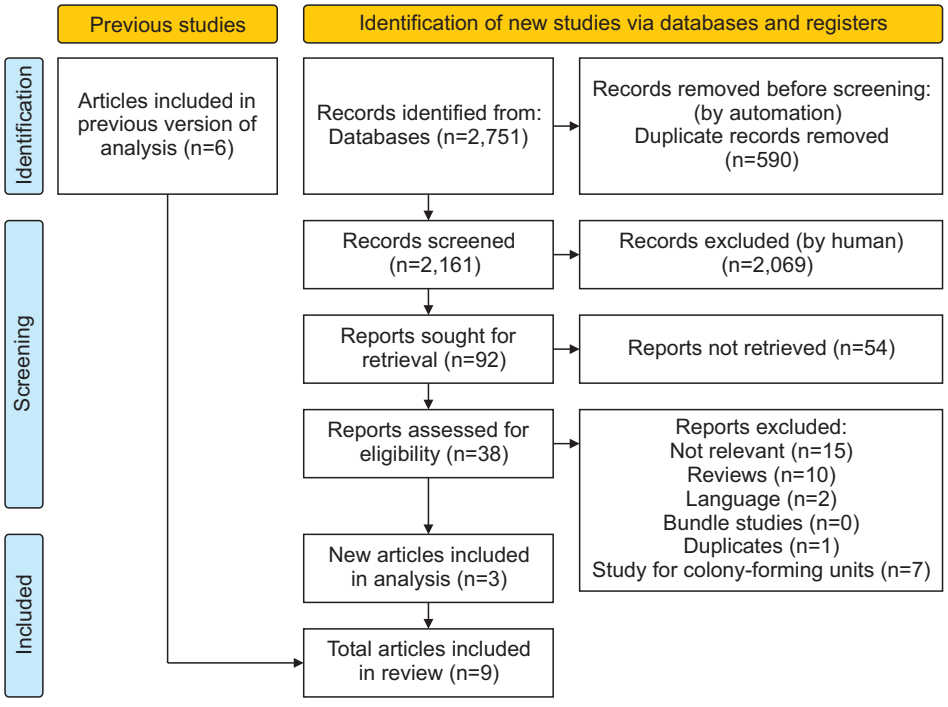

Fig. 1. Study selection. PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases and registers only. PRISMA: preferred reporting items for systematic reviews and meta-analyses.

강을 위해 문헌 검색을 시행하여 추가하였다. 국외 논문은 MEDLINE, EMBASE, CINAHL, Cochrane으로 WHO 가이드라인에서 적용한 기간(1990년 1월 1일부터 2014년 4월 24일)을 최신까지 연장하여 검색하였고, 국내 논문 검색은 KMBASE, KoreaMed를 기간 제한 없이 검색하였으며, 논문 검색은 2021년 1월 12일에 수행되었다(Fig. 1).

핵심질문 3. 수술부위감염 예방을 위한 효과적인 외과적 손 위생 방법은 무엇인가?

근거수준: 근거수준평가와 근거의 강도와 한계

근거 검토의 목적은 외과적 수술 시 멸균 장갑을 착용하기 전에 시행하는 외과적 손위생에서 전통적 방법인 핸드스크럽(handscrubbing)과 알코올 기반 소독제를 이용한 핸드러빙(Hand-rubbing)이 수술부위감염에 미치는 영향을 확인하는 것이었다.

의료 활동 중 일상적인 손위생의 목적은 먼지, 유기물을 제거하고 일시적인 집락균의 오염을 줄이기 위함이다. 일상적인 손위생과는 달리 외과적 손위생은 일시적인 집락균을 제거하고 피부 상재균을 줄여야 한다. 특히 수술 중 수술장갑의 미세천공으로 인해 수술팀의 손에 존재하는 미생물들이 수술 창상으로 유입되는 것을 감소시킬 필요가 있다.

항균 비누와 물을 이용한 핸드스크럽과 알코올 기반 소독제를 이용한 핸드러빙을 비교하고 수술 부위 감염 예방에 대한 결과를 보고한 3개의 무작위배정임상시험[1-3] 및 6개의 관찰연구[4-9]를 포함하여 총 9개의 연구가 확인되었다(Fig. 1). 가용한 국내 연구는 없었다. 그 외 실험실 또는 병원 환경에서 colony-forming units (CFU)를 비교한 다수의 연구를 확인하였으나, 연구들 간의 이질성으로 인해 비교가 어렵고, 수술부위감염에 대한 직접적인 비교가 아닌 간접 증거를 제시하는 연구로 판단되어 본 지침의 분석에 포함하지 않기로 하였다(Table 1). 핸드스크럽은 주로 chlorhexidine gluconate와 povidone-iodine 또는 일반비누가 사용되었고 알코올 포함 소독제는 다양한 농도의 알코올을 포함하는 제품이 사용되었다. 제품이 일정하지 않아 각각 비교할 수는 없기 때문에 핸드스크럽과 핸드러빙으로 분류하여 비교하였다(Table 2).[10,11]

메타분석의 결과는 전체적으로 수술부위감염을 예방하는 데 핸드스크럽과 핸드러빙의 차이는 없음을 보여주었다. 무작위 대조군 연구들에 대한 근거의 질은 비뚤림 위험과 비정밀성으로 인해 낮은 근거 수준으로 평가하였으며, 관찰 연구의 경우 비정밀성으로 인해 매우 낮은 근거 수준으로 평가하였다. 검토된 근거의 낮은 수준으로 인하여 외과적 손위생의 권고 강도는 환자의 상황과 병원의 환경 등을 고려하여 핸드스크럽 또는 핸드러빙을 적절히 선택할 수 있도록 선택적 권고를 채택하였다(Table 3).

Table 1. 포함 및 배제기준

대상환자(P)	수술 참여 의료진
중재(I)	항균비누를 이용한 핸드스크럽 또는 알코올 기반 소독제를 이용한 핸드러빙
비교군(C)	일반 또는 다른 의학적 비누를 이용한 핸드스크럽
결과(O)	수술부위 감염률 및 수술부위감염으로 인한 사망률
연구설계(S)	연구 설계를 제한하지 않음
대상 사용자	수술을 시행하는 1-3차 의료기관의 의료진

P: patient, I: intervention, C: comparator/comparison/control, O: outcomes, S: setting.

결론

수술 전 외과적 손위생의 효과적인 방법으로 적절한 항균비누와 물을 이용한 핸드스크럽 혹은, 적절한 알코올 기반 소독제를 이용한 핸드러빙을 선택할 수 있다.

(선택적 권고[Do, Conditional recommendation], 낮은 수준의 근거[Low quality of evidence])

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Table 2. Evidence Table

Study	Country/ study period	Type of study/ setting	Intervention	Comparator	Primary outcome - SSI rate	Difference between groups	Cost analysis
A. Randomized controlled trial with SSI outcome							
Parienti et al.[3] (2002)	France/ 16 months	Multicentre randomized equivalence trial	Handrubbing protocol with ABHR (Sterilium®) for 5 minutes (n=2,252)	Hand scrubbing with PVI 4% or CHG 4% for 5 minutes (n=2135)	2.44% handrub group 2.48% hand scrub group	OR: 0.04% (95% CI: 0.88-0.96) NS difference	
Nthumba et al.[4] (2010)	Kenya/ 11 months	Longitudinal comparative cluster randomized cross-over trial in a rural hospital	ABHR procedure with WHO formula II for 3 minutes (n=1,537)	Hand scrubbing with plain soap and water for 4-5 minutes (n=1596)	8.3% in ABHR (95% CI: 6.7-9.5) 8.0% plain soap & water group (95% CI: 6.9-9.8)	Crude OR: 1.03 (95% CI: 0.80-1.33; p=0.804) NS difference	The approximate total weekly cost of ABHR was EUR 4.60 compared with EUR 3.30 for plain soap and water (cost ratio: 1:1.4).
Al-Naami et al.[5] (2009)	Saudi Arabia/ 9 months	Randomized equivalence trial in a university hospital	Handrubbing with alcohol-based hand gel (Purell®) (n=272)	Hand scrubbing with PVP-I 4% or CHG 4% 3-5 minutes (n=228)	2.94% in ABHR; 5.26% in traditional hand scrub group	OR: 1.833, (95% CI 0.683-5.007; p=0.275) NS difference	
B. Observational studies with SSI outcome							
Weight et al.[6] (2010)	USA/ study period not stated	Retrospective comparative study in a paediatric urology clinic	Handrubbing protocol with Avagard® for 2 minutes (n=1,800)	Hand scrubbing with antiseptic-impregnated hand brush for 6 minutes (n=1,800)	0.11% handrub group 0.17% hand scrub group	NS difference (p>0.99)	Avagard® costs USD 0.59 per application; antiseptic-impregnated hand brushes cost USD 1.04 per application.
Marchand et al.[7] (2008)	Canada/ 2 years	Retrospective observational before/after study in a heart institute, cardiovascular surgery patients	Handrubbing with ethyl alcohol 70%/ CHG 0.5% hand rub rinse (n=2,174)	Hand scrubbing with antiseptic detergent (n=2,084)	3.59% handrub group 3.33 % hand scrub group	NS difference[a]	Standard hand scrub= CAD 6,000/year for 2,000 surgical procedures Handrub= CAD 2,531/year for an annual saving of approximately CAD 3,500
Adjoussou et al.[8] (2009)	Côte d'Ivoire/ 5 months	Comparative study in a university hospital, gynaecology patients	Handrubbing with Sterilium® (n=113)	Hand scrubbing with PVP-I (n=205)	11.5% handrub group 13.2% traditional hand scrub group	NS difference (p=0.8)	1 dose of PVP-I= EUR 0.2, 1 dose of ABHR=EUR 0.1

Table 2. Evidence Table

Study	Country/ study period	Type of study/ setting	Intervention	Comparator	Primary outcome - SSI rate	Difference between groups	Cost analysis
Oriel et al.[10] (2017)	USA/ 2 years	Retrospective observational before/ after study	Handrubbing with ethyl alcohol 70%/ CHG 4% hand rub (n=2,293)	Hand scrubbing with CHG 4% (n=4,051)	1.5% handrub group 1.8% hand scrub group	NS difference (p=0.031)	
Gaspar et al.[11] (2018)	Brazil/ 7 months	Comparative observational before/after study in a tertiary-care university hospital, cardiac and orthopedic patients	Handrubbing with alcohol (n=99)	Hand scrubbing with either 2% chlorhexidine or 10% PVP-I (n=132)	4.0% handrub group 8.3% hand scrub group	No difference (RR=0.48, 95% CI 0.16-1.48)	
Iwakiri et al.[9] (2017)	Japan/ 2 years	Retrospective observational before/ after study in a university hospital, orthopedic patients	Handrubbing with alcohol based 0.5% CHG (n=688)	Hand scrubbing with CHG 4% (n=712)	1.1% handrub group 1.3% traditional hand scrub group	No difference (p=0.999)	Traditional hand scrub; USD 2 Waterless hand rub; USD 1

SSI: surgical site infection, ABHR: alcohol-based handrub, PVI or PVP-I: povidone-iodine, CHG: chlorhexidine gluconate, RR: relative risk, CI: confidence interval, OR: odds ratio, EUR, euro, USD: US dollar, CAD: Canadian dollar, NS: not significant. Sterilium®: 75% aqueous alcohol solution, propanol-1, propanol-2 and mecetronium, Purell®: 62% ethyl alcohol as an active ingredient; water, aminomethyl propanol, isopropyl myristate, propylene glycol, glycerine, tocopheryl acetate, carbomer and fragrance (perfume) as inactive ingredients, WHO formula II: 75% (v/v) isopropyl alcohol, 1.45% (v/v) glycerol, 0.125% (v/v) hydrogen peroxide), Avagard®: 61% ethanol and 1% CHG. [a]p not provided.

Table 3. Summary of Finding Table

Hand rubbing compared to Hand scrubbing for
Patient or population: patients with
Settings:
Intervention: Hand rubbing
Comparison: Hand scrubbing

Outcomes	Illustrative comparative risks[a] (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Hand scrubbing	Hand rubbing				
SSI (RCT)	47 per 1,000	49 per 1,000 (40 to 59)	RR 1.04 (0.85 to 1.26)	8,070 (3 studies)	⊕⊕⊖⊖ Low	
SSI (NRS)	25 per 1,000	23 per 1,000 (19 to 29)	RR 0.94 (0.77 to 1.15)	16,151 (6 studies)	⊕⊖⊖⊖ Very low	

SSI: surgical site infection, CI: confidence interval, RR: risk ratio, RCT: randomized controlled trial, NRS: non-randomized controlled study.
[a]The basis for the assumed risk (e.g., the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

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REVIEW ARTICLE

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근거 중심의 수술부위감염 예방 진료권고안: 강화 영양 지원

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The Evidence-Based Practice Guidelines for Prevention of Surgical Site Infection: Enhanced Nutritional Support

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Nutritional support in surgical patients alters the immune system, which affects postoperative outcomes such as surgical site infection. Malnourished patients are more susceptible to infection after surgery, which can lead to delayed recovery, prolonged hospital stay, and increased morbidity and mortality. However, there is little evidence about the optimal timing and dosage of enhanced nutritional support in surgical patients. On behalf of the Korean Surgical Infection Society, the practice guidelines committee collected data on enhanced nutritional support in surgical patients. Through a systematic literature review of the evidence, the practice guidelines committee suggests considering the administration of oral or enteral multiple nutrient-enhanced nutritional formulas to prevent SSI in underweight patients who undergo major surgical operations (Conditional recommendation, low quality of evidence).

Key Words: Surgical site infection, Nutritional status, Enteral nutrition, Nutrition therapy, Practice guideline

서론

단백질 및 미세영양소 결핍을 비롯한 영양결핍은 건강에 영향을 미치는 주요한 문제이다. 영양 상태는 면역 체계에 중대한 영향을 미치며, 면역 체계의 변화는 환자를 수술 후 감염에 더욱 취약하게 할 수 있다. 특히 영양의 결핍은 수술 후 회복의 지연, 이환율 및 사망률의 증가, 재원 기간의 연장, 의료 비용의 증가, 높은 조기 재입원율 등 수술 후 나쁜 예후와 연관될 수 있다.

일부 연구에 따르면 조기 영양 지원은 대수술 후 결과를 향상시키고 특정한 영양실조 또는 심한 손상 환자에서 감염성 합병증의 발생률을 감소시켰다. 수술에 대한 신체의 반응에서 영양의 역할을 고려할 때, 영양 중재가 수술 부위 감염 및 이와 관련된 이환율을 감소시킬 것이라고 생각되나, 수술 부위 감염과 영양 결핍의 역학적 연관성을 모든 외과의 각 분야에서 일관되게 입증하는 것이 어려웠다. 따라서

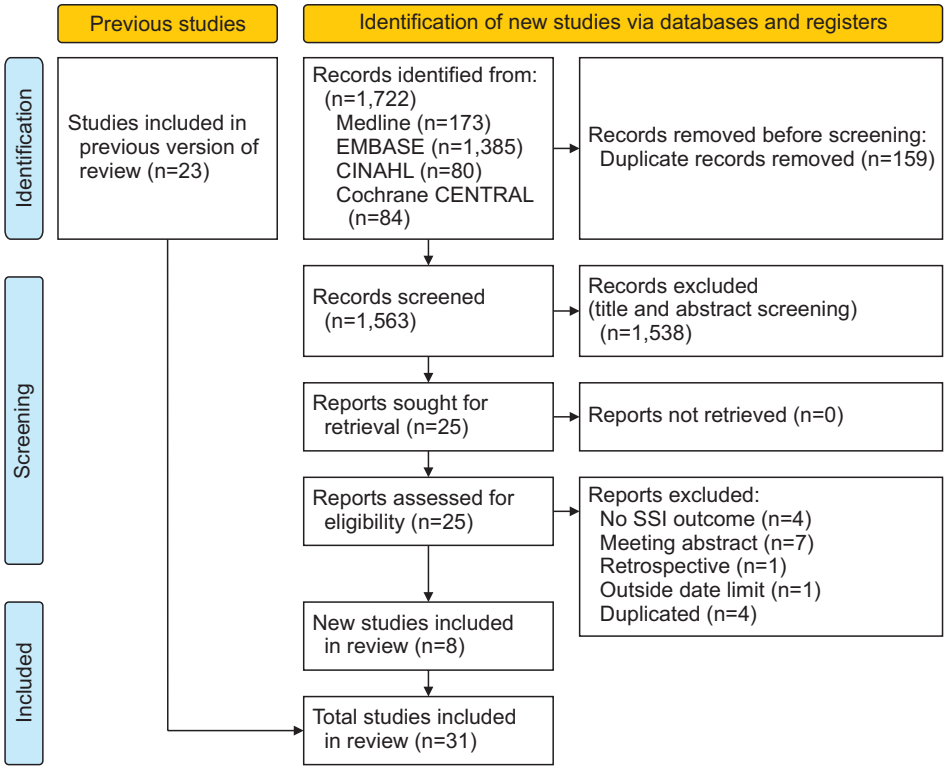

Fig. 1. Study selection. PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases and registers only. PRISMA: preferred reporting items for systematic reviews and meta-analyses, SSI: surgical site infection.

본 진료권고위원회에서는 가용한 근거를 수집하고 체계적인 검토 및 분석을 통해 수술 부위 감염 예방을 위한 영양 지원 효과에 대한 체계적인 검토를 실시하여 이에 대한 진료지침을 마련하고자 하였다.

대상 및 연구 방법

진료권고안 개발 방법은 수용개작 방식(adaptation)으로 개발되었으며, 2016년 발표된 세계보건기구(World Health Organization, WHO) 가이드라인[1]을 기준 진료권고안으로 최신성을 보강하는 GRADE-ADOLOPMENT 방법[2]을 적용하였다. WHO 가이드라인의 권고안에서 국내 수술환경에 적용할 대상을 핵심질문으로 선정하였고, 최신성 보강을 위해 문헌 검색을 시행하여 추가하였다. 국외 논문은 MEDLINE, EMBASE, CINAHL, Cochrane으로 WHO 가이드라인에서 적용한 기간(1990년 1월 1일부터 2015년 6월 24일)을 최신까지 연장하여 검색하였고, 국내 논문 검색은 KMBASE, KoreaMed를 기간 제한 없이 검색하였으며, 논문 검색은 2021년 1월 12일에 수행되었다(Fig. 1).

핵심질문 4. 수술부위감염을 감소시키기 위해 집중적 영양 관리가 필요한가?

근거수준: 근거수준평가와 근거의 강도와 한계

근거 검토의 목적은 수술부위감염 예방을 위한 강화 영양 지원의 평가를 표준 영양과 비교하여 평가하는 것이었다. 대상은 수술을 시행 받은 모든 연령대의 환자였으며, 일차 결과 지표는 수술 부위 감염 및 수술 부위 감염에 따른 사망의 발생이었다(Table 1).

Table 1. 포함 및 배제기준

대상환자(P)	대수술(Major operation)을 시행 받은 환자
중재(I)	강화 영양 지원
비교군(C)	일반 영양 지원 또는 영양 지원 없음
결과(O)	수술부위 감염률 및 수술부위감염으로 인한 사망률
연구설계(S)	연구 설계를 제한하지 않음
대상 사용자	대수술을 시행하는 2, 3차 의료 기관의 의료진

P: patient, I: intervention, C: comparator/comparison/control, O: outcomes, S: setting.

수술부위감염 예방에 대한 결과를 보고한 27개의 무작위배정임상시험[3-29] 및 4개의 관찰연구[30-33]를 포함하여 총 31개의 연구가 확인되었다(Fig. 1, Table 2). 심장 수술, 두경부, 소화기, 대장, 간담췌 또는 부인과 종양에 대한 계획적 수술을 시행 받은 성인 환자가 연구에 포함되었으며, 소아 환자에서는 이용 가능한 연구가 없었다. 투여 경로, 투여된 영양 제제, 수술 부위 감염의 정의는 연구별로 다양하였는데, 영양 투여 경로는 경구, 경장 또는 비경구로 다양하였으며, 연구에 사용된 경장영양액은 각기 포함된 영양소가 동일하지 않고 단일 또는 다중 영양소 강화영양액의 용량 역시 연구에 따라 다양하였다. 몇몇 연구에서는 영양학적 또는 염증성 바이오마커를 1차 결과로 사용하였고, 수술 부위 감염을 2차 결과로 다루었기 때문에 일부 연구에서는 평가 기간이 짧았다.

연구팀과 지침개발위원회는 포함된 연구에 대한 세밀한 평가를 거쳐, 경구 및 경장 영양을 이용한 연구만을 포함하여 메타 분석을 시행하고, 정맥 영양을 이용한 연구를 제외하였다. 주된 이유는 비경구 경로가 경구 및 경장 경로와 매우 다르고 정맥 접근과 관련된 감염 위험을 고려할 때 수술부위 감염을 예방하는 목적으로만 강화 영향 지원을 시행하는 것은 부적절하다고 판단하였기 때문이다. 위의 언급한 이질성에도 불구하고, 두 메타 분석을 통하여 각각 경구 또는 경장 경로를 통하여 공급되는 단일 영양소 강화 영양 지원 대 표준 영양 지원, 다중 영양소 강화 영양 지원 대 표준 영양 지원에 대한 비교를 수행하였다.

단일 영양소 강화 영양 지원 대 표준 영양 지원에 대한 메타 분석에서 무작위 대조군 연구들에 대한 근거의 질은 비뚤림 위험과 비정밀성으로 인해 낮은 근거 수준으로 평가하였으며, 관찰 연구의 경우 비정밀성으로 인해 매우 낮은 근거 수준으로 평가하였다. 다중 영양소 강화 영양지원 대 표준 영양 지원에 대한 메타 분석에서 무작위 대조군 연구들에 대한 근거의 질은 비뚤림 위험, 비일관성 및 출판 비뚤림으로 인해 낮은 근거 수준으로 평가하였으며, 관찰 연구의 경우 비정밀성으로 인해 매우 낮은 근거 수준으로 평가하였다. 검토된 근거의 낮은 수준으로 인하여 강화 영양 지원에 대한 권고 강도는 환자의 상황과 강화영양액의 이용 가능 여부 등을 판단하여 중재를 적용할 수 있도록 조건부 권고를 채택하였다(Table 3).

Table 2. Evidence Table

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Beattie et al.[3] (2000)	RCT United Kingdom Population: patients admitted for elective gastrointestinal or vascular surgery who had a body mass index of 20 kg/m^2 or less on admission, postoperatively, and/or weight loss of 5% or more during operative	To investigate changes in nutritional status and the influence of oral supplements on nutritional status, morbidity, and quality of life in postoperative surgical patients.	Not specified	Gastrointestinal or vascular	Randomization: computer-generated table Exclusion criteria: patients who required parenteral nutrition, those who were pregnant or lactating, those with terminal diseases, those with decompensated liver or renal disease. Follow-up: 10 weeks Amounts/timing: patients were encouraged to aim to consume 400 mL of the supplements in small frequent amounts between meals to increase nutrient intake.	C: routine nutritional management I: oral dietary supplement (Ensure Plus®; Ross Laboratories, Lake Bluff, IL, USA)	Wound infection C: 7/49 I: 4/52 RR=0.53 95% CI: 0.17-1.73 Chest infection C: 6/49 I: 2/52 RR=0.31 95% CI: 0.07-1.48
Burden et al.[4] (2011)	RCT unblinded Spain Population: adult patients undergoing elective curative surgery for colorectal cancer with a minimum of 10 days preoperatively.	To determine whether preoperative oral supplementation using a standard formulation reduces the number of postoperative complications.	CDC criteria and Buzby (CDC data used)	Colorectal cancer surgery	Randomization: block randomization with numerical blocks used to ensure that similar numbers were represented by each group. Weight loss was considered to be a prognostic variable at baseline; patients were weighed and divided into two strata for randomization –0%-9% weight loss and >10% weight loss. Opaque envelopes were used for allocation and a volunteer set up the procedure. Exclusion criteria: pregnancy, enrolment in another study, unable to give consent or inoperable tumour. Timing: time of enrolment (10+ days preoperatively) until surgery; not continued postoperatively. Follow-up: 3 months	C: instructed to increase energy and protein from foods based on an information leaflet. Dietary intake diary recorded for compliance. I: 400 mL of an oral supplementary drink daily and dietary advice (see control). Milk-based supplements were given initially (630 kcal; 6 g protein), but replaced with fruit juice if not tolerated (630 kcal; 4 g protein). Unblinded due to the nature of the study. Ward staff unaware of randomization.	Wound infection: C: 17/62 I: 9/54 p=0.145

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Casas-Rodera et al.[5] (2008)	RCT Spain Population: patients undergoing surgery for oral and laryngeal cancer.	Comparison of 2 immuno-enhanced enteral nutritional formulas with a control diet and evaluation of the effect on postoperative infections, length of stay and inflammatory markers.	Not specified	Head and neck cancer	Randomization: not specified. Exclusion criteria: severely impaired hepatic function, ongoing infection, autoimmune disorder, steroid treatment, nutritional oral supplementation in the previous 6 months. Amount/timing: protein requirements were 1.5 g/kg/day. Enteral feeding was started within 12 hours of surgery. Infusion rate was progressively increased every 24 hours until the daily nutritional goal was reached on postoperative day 3. End point was a minimum oral intake of 1,500 calories/day and 1 g/kg/day of protein without supplementation with a minimum of 7 days of enteral support.	Group 1: enteral diet supplemented with arginine. Group 2: standard polymeric enteral formula (control). Group 3: enteral diet supplemented with arginine, RNA, and omega-3 fatty acids.	Wound infection Group 1: 1/15 Group 2: 2/15 Group 3: 1/14 Wound fistula Group 1: 3/15 Group 2: 2/15 Group 3: 1/14 General infection Group 1: 0/15 Group 2: 1/15 Group 3: 0/14 p=NS for all
Celik et al.[6] (2009)	RCT Turkey Population: patients with a diagnosis of gynaecological malignancy.	To assess the effect of immunonutrition on biochemical and haematological parameters, incidence of infection, postoperative complications, mortality rate and length of hospital stay.	Not specified	Elective gynaecological oncologic surgery.	Randomization: blinded envelopes. Exclusion criteria: neoplasms treated with radio- or chemotherapy, chronic inflammatory bowel disease, renal insufficiency, cardiac insufficiency, hepatic insufficiency, severe respiratory insufficiency, current infection, diabetes mellitus and congenital or acquired immunodeficiency. Amount/timing: intervention group received 30 kcal/day of enhanced formula for 2 days before surgery and 7 days postoperatively.	C: standard enteral nutrition formula orally (Ensure Standard®) I: multiple nutrient enteral nutrition (Impact®; Nestlé Health Science SA, Vevey, Switzerland).	Wound infection C: 5/25 I: 1/25 p<0.05 Wound dehiscence C: 2/25 I: 0/25 p<0.05

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
de Luis et al.[7] (2002)	RCT Spain Population: patients with oral and laryngeal cancer.	The aim of our study was to investigate whether postoperative nutrition of head and neck cancer patients using an arginine- enriched diet, could improve nutritional variables as well as clinical outcomes.	Respiratory tract infection: chest radiographic examination showed new or progressive infiltration, temperature >38.5°C and isolation of pathogens from the sputum or blood culture. Urinary infection: urine culture showed at least 10^5 colonies of a pathogen. - All complications were assessed with standard methods by the same investigator.	Head and neck cancer	Randomization: not specified. Exclusion criteria: Severely impaired hepatic and renal function, ongoing infections, autoimmune disorders, steroid treatment, nutritional oral supplementation in the previous 6 months, and severely malnourished. Amount/timing: Postoperative: enteral feeding was started within 12 hours of surgery at a rate of 20 mL/hour. The infusion rate was progressively increased every 24 hours until the daily nutritional goal (32 kcal/kg; 1.7 g protein/kg) was reached on day 4. Follow-up: 14 days	C: isocaloric, isonitrogenous enteral formula. I: enteral diet supplemented with arginine and dietary fibre.	Infectious complications C: 9/24 I: 9/23 p=NS Wound infection C: 3/24 I: 1/23 p=NS

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
de Luis et al.[8] (2004)	RCT Spain Population: patients undergoing surgery for oral and laryngeal cancer	The aim of our study was to investigate whether postoperative nutrition of head and neck cancer patients using an arginine enhanced formula could improve nutritional variables as well as clinical outcomes.	Respiratory tract infection: chest radiographic examination showed new or progressive infiltration, temperature >38.5°C and isolation of pathogens from the sputum or blood culture. Urinary infection: urine culture showed at least 10^5 colonies of a pathogen. - All complications were assessed with standard methods by the same investigator.	Head and neck cancer	Randomization: not specified. Amount/timing: Postoperative: enteral feeding was started within 12 hours of surgery at a rate of 20 mL/hour. The infusion rate was progressively increased every 24 hours until the daily nutritional goal (32 kcal/kg; 1.7 g protein/kg) was reached on day 4.	C: isocaloric, isonitrogenous enteral formula with dietary fibre. I: enteral diet supplement with arginine and dietary fibre.	Wound infection C: 0/45 I: 0/45 p=NS Wound fistula C: 5/45 I: 2/45 p<0.05 General infection C: 4/45 I: 2/45 p=NS
de Luis et al.[9] (2009)	RCT Tertiary care, Spain Population: patients with oral and laryngeal cancer.	To investigate whether postoperative nutrition of head and neck cancer patients using a higher dose of arginine-enhanced diet (17 g/day) than previous studies could improve nutritional variables, as well as clinical outcomes, when compared with a control enteral diet.	General infections: respiratory tract infection was diagnosed when the chest radiographic examination showed new or progressive infiltration, temperature >38.5°C and isolation of pathogens from the sputum or blood culture. Urinary infection was diagnosed if the urine culture showed at least 10^5 colonies. Follow-up: 12 days	Head and neck cancer surgery	Randomization: not specified. Exclusion criteria: severely impaired hepatic and renal function, ongoing infection, autoimmune disorders, steroid treatment, nutritional oral supplementation in the previous 6 months and severely malnourished. Amount/timing: Postoperative: enteral feeding was started within 8-12 hours of surgery at a rate of 20 mL/hour. The infusion rate was increased every 24 hours until postoperative day 4 with 17 g/day of arginine.	C: isocaloric, isonitrogenous enteral formula. I: enteral diet supplements with arginine.	Wound infection C: 0/37 I: 0/35 General infection C: 2/35 I: 2/35 Wound fistula C: 7/37 I: 1/35

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Falewee et al.[10] (2014)	RCT, double-blind, placebo controlled, multicentre phase III 8 centres; France Population: patients aged 18-75 years with squamous cell carcinoma of the oral cavity, oropharynx, larynx, or hypopharynx with anticipated surgery and postoperative enteral feeding for a minimum of 7 days.	To investigate whether preoperative or perioperative immunonutritio n could reduce postoperative infectious complications and surgical site infections in this population.	CDC	Head and neck cancer	Randomization: centralized and carried out by the CS Randomization module from Clinsight software (Clinsight, Poitiers, France). The stratification consisted of searching with an algorithm for the less often allocated treatment code among patients whose randomization criteria matched the ongoing patient. Blinding: The allocation of patients to trial groups was carried out independently by the pharmacy clinical trials units using randomization lists. Double-blinding with adequate labels was used to minimize bias with bedside physicians and nurses. Follow-up: 90 days Amount/timing: Preoperative: for 7 days before surgery, patients received 3 bags/day Postoperative: for 7-15 days, all patients received an increasing number of bottles of enteral nutrition (1 bottle day 1, 2 bottles day 2, etc.)	Group A (control): perioperative formula without immune nutrients (Impact®). Group B: preoperative formula with immune nutrients (multiple nutrient, Impact®) and postoperative standard diet. Group C: perioperative formula with immune nutrients (multiple nutrient, Impact®).	Infection (systemic, surgical site infection, or nosocomial pneumopathy). C: 35/64 Group B: 37/68 Group C: 33/73 p=0.44

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Fujitani et al.[11] (2012)	Design: RCT Japan Population: patients with resectable primary gastric adenocarcinoma, aged no more than 80 years.	To investigate the impact of preoperative enteral immuno- nutrition on the incidence of postoperative complications and C-reactive protein values (as a marker of inflammatory response) in patients undergoing elective total gastrectomy for gastric cancer.	CDC	Gastrectomy	Randomization: carried out by data centre staff using the minimization method, with an algorithm that balanced the institution. Preoperative: immunonutrition group received 1,000 mL/day of immunonutrient-enriched enteral feed (Impact®) added to a normal diet for 5 days before surgery. Control group had regular diet without supplementation.	C: regular diet I: 1,000 mL/day immunonutrient-enriched enteral feed (Impact®) for 5 days plus regular diet	SSI C: 23/120 Superficial: 7 Deep: 1 Organ/space: 15 I: 27/120 Superficial: 8 Deep: 5 Organ/space: 17 RR: 1.09 (0.66, 1.78) Wound infection or dehiscence C: 8/111 I: 13/120 p=0.369
Gianotti et al.[12] (2002)	RCT Italy Population: patients with histologically documented neoplasm of the gastrointestinal tract and planned major elective surgery.	To understand prospectively whether preoperative supplementation could be as efficacious as the perioperative approach and superior to conventional treatment (without artificial nutrition) in reducing postoperative infections and the length of hospital stay.	Not specified	Gastroin-testin al tract cancer surgery	Randomization: computer programme generated list. Exclusion criteria: weight loss >10% in past 6 months, age <18 years, hepatic dysfunction, respiratory dysfunction, renal dysfunction, Karnofsky score <60, pregnancy, ongoing infections and immune disorder. Amount/timing: Group 1: 1 L/day for 5 days before surgery Group 2: 1 L/day for 5 days before surgery AND starting 12 hours after surgery.	C: no artificial nutritional supplement before surgery, intravenous solution of glucose 5% and electrolytes after surgery. Group 1: preoperative supplemented liquid diet (per os) (oral Impact®). Group 2: preoperative supplemented liquid diet (per os) and postoperative supplemented liquid diet (enteral).	Wound infection C: 11/102 Group 1: 7/102 Group 2: 7/101

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Klek et al.[13] (2008)	RCT Poland Population: well-nourished patients undergoing gastrointestinal surgery.	To assess the clinical effect of immuno-stimulatory enteral and parenteral nutrition in patients undergoing resection for gastrointestinal cancer in well- nourished patients.	Wound infection: purulent exudate in the wound with positive bacterial culture	Major upper gastroin-testina l surgery	Randomization: not specified; patients were randomly assigned in a 2×2 factorial design to 4 groups receiving immunostimulating vs. normal diets, and enteral vs. intravenous nutritional support. Exclusion criteria: patients requiring nutritional support, with disseminated tumours, serious comorbidities and renal or liver failure. Amount/timing: parenteral nutrition was commenced 20-24 hours postoperatively and continued for at least 7 days. Protein requirements were 0.15 g N/kg and covered by 10%-15% amino acid solutions. Energy requirements were 150 kcal/g and covered by glucose and lipid emulsions.	Standard enteral nutrition (SEN). Immunostimulating enteral nutrition (IMEN). Standard parenteral nutrition (SPN). Immunostimulating parenteral nutrition (IMPN).	Wound infection SEN: 2/53 IMEN: 4/52 SPN: 2/49 IMPN: 1/51

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Klek et al.[14] (2011)	RCT Poland Population: malnourished patients aged 18-85 years undergoing resection for pancreatic or gastric cancer.	To assess the impact of enteral immunonutrition in the postoperative period.	Wound infection: purulent exudate in the wound with positive bacterial culture. Collection of pus confirmed by percutaneous drainage or at reoperation. Sepsis: fever >38°C, hypotension, or oliguria together with positive blood culture.	Subtotal and total gastric resection with lympha-denectomy and pancreato-duodenec-tomy.	Randomization: computer generated randomization list managed by an external person not involved in the study Exclusion criteria: well-nourished patients or with metastatic disease, pregnant, poor general health status with recent history of severe heart, lung, kidney or liver failure, with history of allergies or drug intolerance. Postoperative: enteral feeding was commenced 6 hours after surgery with glucose 5% solution at 20 mL/hour for the first 12 hours, followed by Peptisorb (Nutricia, Amsterdam, the Netherlands) or Reconvan (Fresenius-Kabi, Bad Homburg, Germany) at 20 mL/hour on day 1, 50 mL/hour on day 2, 75 mL/hour on day 3 and 100 mL/hour thereafter until the day 7.	C: standard enteral nutrition, oligopeptide, isocaloric diet (Peptisorb). I: immunomodulating enteral nutrition (Reconvan).	Wound infection C: 27/153 I: 12/152 p=0.01077 Sepsis C: 2/153 I: 4/152 p=0.40498 Pneumonia C: 45/153 I: 33/152 p=0.12322
Oguz et al.[15] (2007)	RCT Turkey Population: patients with a diagnosis of colorectal cancer.	To investigate the effect of L-alanine-L-glutamine (Gln) on the postoperative complication rate and duration of hospitalization in patients operated for colorectal cancer.	Wound infection: evidence of redness and tenderness of surgical wound with discharge of pus.	Colorectal	Randomization methods: not specified. Exclusion criteria: patients with metabolic disorders (hyperthyroidism, diabetes mellitus) and patients who had undergone an emergency surgery or abdominoperineal resection. Amounts/preoperative days given: patients received 1,000 mL/day enteral nutrition for 5 days before surgery. Amounts/postoperative days given: 500 mL/day for the first 2 days and 1,000 mL/day enteral nutrition after postoperative day 3. Follow up: NS. Outcomes collected: not specified.	C: enteral nutrition I: parenteral L-alanine-L-glutamine (Gln, Dipeptiven®; Fresenius-Kabi), 1 g/kg/day and enteral nutrition.	Wound infection C: 6/52 I: 1/57 p=0.038 Abdominal abscess C: 4/52 I: 0/57 p=0.044 Pulmonary tract infection C: 2/52 I: 1/57 p=NS Urinary tract infection C: 2/52 I: 3/57 p=NS Wound dehiscence C: 4/52 I: 0/57 p=0.044

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Roth et al.[16] (2013)	Prospective, randomized, single centre study September 2008 to March 2011 Switzerland Population: 169 consecutive bladder cancer patients scheduled.	To evaluate whether recovery can be improved with total parenteral nutrition in patients following extended pelvic lymph node dissection, cystectomy and urinary diversion.	Clavien-Dindo classification	Radical cystectomy	Randomization: prospectively randomly allocated by a computer based programme. Exclusion criteria: previous pelvic lymph node dissection, chronic inflammatory bowel disease, previous radiation therapy, prior bowel surgery, severe hepatic or cardiac dysfunction, inability to give fully informed consent. Timing: total parenteral nutrition commenced on postoperative day 1, continued for 5 consecutive days. Oral intake was started with clear fluids on the day of surgery with fluids started on postoperative day 1. Solid diet was resumed on the return of active bowel sounds and when fluids were well tolerated. Follow-up: 30 days	C: oral alimentation was introduced on postoperative day 1 in both groups with a gastrostomy tube in place, which was initially left on drainage. Oral intake was started with clear fluids on the day of surgery with fluids started on postoperative day 1. Solid diet was resumed on the return of active bowel sounds and when fluids were well tolerated. The gastrostomy tube was removed after the patient passed stool and tolerated closure of the gastrostomy tube without nausea and vomiting for >24 hours. I: total parenteral nutrition (1,500 mL/day; total 1,860 kcal/day; 10^5 g polyamino acids/day; 360 g glucose/d; 0 g lipids/d) was administered continuously for 5 days starting on postoperative day 1. No intravenous supplementation of vitamins and trace elements was given. An additional 30 IU Actrapid HM (Novo Nordisk, Copenhagen, Denmark) and 1,875 IU heparin (Liquemin; Drossapharm, Basel-Stadt, Switzerland) per 24 hours were added to the total parenteral nutrition solution.	Wound infection C: 2/83 I: 4/74

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Snyderman et al.[17] (1999)	RCT USA Population: patients with stages II-IV squamous cell carcinoma of the oral cavity, pharynx or larynx undergoing oncologic surgery with curative intent and requiring postoperative nutritional supplementation.	To determine if perioperative nutritional supplementation with a multiple nutrient-enhanced formula is superior to a standard formula for the prevention of postoperative infectious complications.	Not specified	Head and neck cancer	Randomization: not specified. Follow-up: 1 month	Enhanced formula Group I: pre- and postoperatively Group II: postoperatively. Control formula Group III: pre- and postoperatively Group IV: postoperatively. Combined oral and enteral nutrition based on patient condition; patients assessed daily for intake/amount infused.	Postoperative infection C: 19/47 I: 10/82 p=0.02 SSI data is for enhanced (all) vs. standard (all) nutrition
Suzuki et al.[18] (2010)	Prospective RCT May 2006 to January 2008 Japan Population: 30 consecutive patients undergoing pancreatico-duodenectomy.	To determine whether the use of multiple nutrient-enhanced formulas influences the following factors: cell-mediated immunity and differentiation, and the infectious complication rate after pancreatico-duodenectomy.	Not specified	Pancreatico-duodenec-tomy	Exclusion criteria: under 18 or over 75 years of age, preoperative chemotherapy and/or radiation therapy, active preoperative infection, administration of corticosteroids or immunosuppressive agents, gastrointestinal obstruction, respiratory, cardiac or hepatic dysfunction, renal failure, history of recent immunosuppressive or immunologic disease and preoperative evidence of widespread metastatic disease.	Group A: oral supplementation for 5 days (1,000 kcal/day) before operative resection with a formula enriched with arginine, omega-3 fatty acids, and RNA (oral Impact®; Ajinomoto Pharma Co., Ltd., Tokyo, Japan) in addition to a half-amount of ordinary diet after surgery. Group B: postoperative group that underwent postoperative enteral infusion of the same enriched formula with no artificial nutrition before operative resection. Group C (control): total parenteral nutrition with no artificial nutrition before operative resection. Patients in groups B and C were allowed to consume an ordinary diet during the 5 days before operative resection. Enteral feeding started at 12-18 hours after surgery at a 10 mL/hour rate. The velocity was increased progressively by 20 mL/day until 25 kcal/kg/day was reached. Oral food intake was allowed on postoperative day 7. The 3 regimens were approximately isocaloric before and after.	Wound infection Group A: 0/10 Group B: 4/10 Group C: 2/10

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Tepaske et al.[19] (2007)	RCT, double-blind, placebo-controlled, 3 arms The Netherlands Population: patients were included if they were aged 70 years or older, had a compromised left ventricular function or were planned for mitral valve surgery.	To determine whether addition of glycine to a standard preoperative oral multiple nutrient-enhanced formula improves outcome.	Infections were strictly scored according to CDC criteria.	Cardiac surgery	Randomization: opaque, sealed envelopes containing the assignments, performed by a person not involved in the study and patient care. Exclusion criteria: less than 21 years, pregnant, insulin-dependent diabetes mellitus, severe renal or liver failure, known malignancy, and use of immunosuppressive medication or nonsteroidal anti-inflammatory drugs.	C: isocaloric, isocolaemic formula (placebo, Novartis Nutrition). I1: standard oral multiple nutrient-enhanced formulas. I2: glycine-enriched oral immune-enhancing nutrition Supplement.	Wound infection C: 0/24 I1: 0/24 I2: 1/22 p=0.02 Pneumonia C: 10/24 I1: 4/24 I2: 4/22 p=0.09 Urinary infection C: 4/24 I1: 0/24 I2: 2/22 p=0.12
Tepaske et al.[20] (2001)	RCT, double-blind, placebo-controlled The Netherlands Population: patients scheduled to undergo cardiac surgery who met one or more of the following criteria: age 70 years or older, ejection fraction less than 0.40, or replacement of mitral valve.	To ascertain whether an oral multiple nutrient-enhanced formula could improve preoperative host defence and subsequently lower postoperative infections and organ dysfunction in patients undergoing elective cardiac surgery who are at high risk of infection.	CDC	Cardiac	Randomization: blocks of 10 by closed envelope, done by a person not involved in the study. Exclusion criteria: less than 21 years, pregnant, insulin-dependent diabetes mellitus, severe renal and/or liver failure, known malignancy, use of immunosuppressive medication or non-steroidal anti-inflammatory drugs (except aspirin) on a long- term basis. Amount/timing: all patients took a minimum of 5 L and a maximum of 10 L of the oral supplement in addition to their normal food intake during the 5-10 days before the operation. After surgery, patients who were on a ventilator and required tube feeding received either the intervention or control until extubation.	C: isocaloric, isocolaemic formula (placebo; Novartis Nutrition, Basel, Switzerland). I: pre-operative oral immune enhancing nutritional supplement (oral Impact®; Novartis Nutrition).	Wound infection C: 2/22 I: 0/23 p=0.233 Pneumonia C: 12/22 I: 3/23 p=0.047 Urinary infection C: 1/22 I: 2/23 p=1.000

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Wei et al.[21] (2014)	Prospective RCT May 2007 to March 2008 People's Republic of China Population: adult patients undergoing a surgical operation for a gastric tumour	To investigate the effect of omega-3 fish oil fat emulsion-based parenteral nutrition on nutritional state, immune function, inflammatory reaction, expression of tumour factors and the incidence of complications in patients after surgical resection for gastric cancer.	Not specified	Gastric resection	Randomization: not specified ("randomly allocated"). Exclusion criteria: age <18 years or >75 years, body mass index <16 or >30, hepatic insufficiency, abnormal renal function, ongoing infection and fever in the preceding month, major gastrointestinal disease (that is, Crohn's) autoimmune disorders, steroid treatment and medication that could modulate the metabolism or body weight, pregnancy or breast feeding, received total parenteral nutrition 2 months before the operation, severely malnourished. Timing: all patients received total parenteral nutrition for at least 6 consecutive postoperative days through a central venous catheter. Both groups were given parenteral nutrition consisting of 104-125 kcal/kg/day of calories for energy with glucose and fat emulsion as the main sources of energy (35%-50% fat emulsion and 0.15-0.20 g/kg.day of nitrogen). Glucose and exogenous insulin were provided at a ratio of 6:1, together with vitamins, water, electrolytes and trace elements (10-12 hours). Follow-up: followed by same investigator surgeon, recorded (range NS)	C: fat emulsion consisted of omega-6 lipid content. I: fat emulsion was partially replaced with omega-3 polyunsaturated fatty acids.	Incisional wound infection C: 3/20 I: 1/26 p=0.303 Abdominal infection C: 1/20 I: 0/26 p=0.435

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Asida et al.[22] (2019)	RCT, double blinded Japan Sep 2012 to Sep 2013 Population: 24 patients (20-80 years) undergoing pancreaticoduo-denectomy for a periampullary cancer	To investigate whether preoperative enteral diets enriched in eicosapentaenoic acid (EPA) supplements could reduce the incidence of hypercytokinemia and infectious morbidity after pancreatoduo-denectomy (PD)	CDC criteria	Pancreatico-duodenec-tomy (Whipple procedure)	Randomization: Not specified ("randomly allocated"). Exclusion: Age younger than 20 years or older than 80 years, inadequate oral intake, receiving other immunonutrition therapies, immunologic disorder, poorly controlled diabetes, inflammatory bowel disease, or active preoperative infection. Follow-up: In all patients, blood samples were obtained 7 days before surgery at the start of preoperative immunonutrition (postoperative day [POD] 7), just before surgery (POD 0), and on PODs 1, 4, 7, and 14.	C: Isocaloric isonitrogenous standard nutrition (600 kcal/day) without EPA (Procure Z; Nisshin Oillio Group, Ltd., Tokyo, Japan) for 7 days before surgery, in addition to 1,200 kcal of regular food. I: Oral supplementation (600 kcal/day) containing EPA (Prosure; Abbot Japan Co., Ltd., Tokyo, Japan) for 7 days before surgery, in addition to 1,200 kcal of regular food.	Infectious complication I: 6/11 C: 7/9 p=0.37 Superfical SSI I: 1/11 C: 3/9 p=0.28 Deep incisional SSI I: 0/11 C: 0/9 p=0.99 Organ/Space SSI I: 0/11 C: 0/9 p=0.99

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Kitagawa et al.[23] (2017)	RCT, non-blinded, controlled Japan May 2013 to March 2015 Population: 30 patients who were diagnosed with resectable esophageal cancer	To investigate the effects of a preoperative immune-modulating diet (IMD) before thoracoscopic esophagectomy for patients with esophageal cancer.	Pneumonia: (1) fever >38.0°C, (2) new infiltrate on a chest X-ray image with and increased volume of purulent sputum, and (3) leukocytosis (white blood cell count $>12.0\times10^9$/L) with antibiotic treatment Anastomosis leak and SSI: Presence of an abscess or discharge associated with the anastomosis	Esophagectomy	Randomization: Envelope method Exclusion: A history of allergy to milk or soy, severe renal dysfunction, liver dysfunction, or acute pancreatitis. Amount/timing: In the 5 days before surgery, an oral nutrition supplement (600 kcal/day) was supplied in addition to the daily solid food given to patients. After the surgery, the patients were moved to the surgical intensive care unit, and we administered total parenteral nutrition (840 kcal/24 h) with tight glycemic control using an artificial pancreas (STG-55) to avoid severe hypoglycemia. Twelve hours after surgery, enteral nutrition (30 kcal/h) was initiated using an oligomeric formula (Twinline®). Oral nutrition was initiated about 7 days after surgery if there was no evidence of an anastomotic leak.	C: The supplement comprised a standard liquid diet (MEIBARANCE®; Meiji Dairies Co., Tokyo, Japan) The MEIBARANCE, used as the SLD, contains dextrin as a carbohydrate source, total milk protein, amino acids (0.18 g/100 mL of arginine and 1.12 g/100 mL of glutamine acid), O3FA (5% alpha linolenic acid), O6FA (16% linoleic acid), and vitamins C and E. The O6FA to O3FA ratio was 3:2. The energy content of the MEIBARANCE was 100 kcal/100 mL. I: The oral nutrition supplement was MHN-02. MHN-02 contains palatinose as a carbohydrate source, RNA, whey-hydrolyzed protein (WHP), amino acids (essential amino acids: 0.13 g/100 mL of arginine and 1.0 g/100 mL of glutamine acid), 21% medium chain triglycerides, enriched omega-3 fatty acids (O3FA: 4% alpha linolenic acid, 1.2% eicosapentaenoic acid, and 0.8% docosahexaenoic acid), omega-6 fatty acids (O6FA: 12% linoleic acid), and vitamins C and E. The O6FA to O3FA ratio was 2. The energy content of MHN-02 was 100 kcal/100 mL.	Infectious complication I: 4/14 C: 5/15 p=0.900 Pneumonia I: 1/14 C: 4/15 p=0.330 Anastomosis leak I: 2/14 C: 1/15 p=0.600 SSI I: 3/14 C: 1/15 p=0.330

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Moya et al.[24] (2016)	RCT Spain Population: 128 patients (at least 18 years of age, to be scheduled for surgery for colorectal cancer with a laparoscopic approach, to be normo-nourished)	To determine whether the joint implementation of immunonutrition and a laparoscopic approach improves morbidity, mortality, and length of stay (LOS) compared with dietary advice.	Wound infection: Spontaneous drainage of purulent material from the wound or from the surgeon's deliberate revision and a positive culture of drained serous fluid.	Colorectal surgery (Laparo-scopic)	Randomization: Using the web site Exclusion: The need for emergency surgery, an American Society of Anesthesiologists (ASA) physical status of IV, renal failure defined via hemodialysis, patients on nutritional supplements, the inability to consume food orally (dysphagia, sophageal stricture, and pyloric stenosis), psychiatric disorders, human immunodeficiency virus (HIV), pregnancy, bowel obstruction, undergoing colostomy or ileostomy, and uncontrolled infection. Timing: An immune-enhancing dietary supplement for 7 days before colorectal resection and 5 days postoperatively or dietary advice. Follow up: The 30-day postoperative complications were recorded.	C: Received no supplements (only dietary advice) I: An immune-enhancing dietary supplement (IEF)-ATEMPERO® produced by Vegenat® for 7 days prior to colorectal resection and for 5 days postoperatively. The patients in the IEF group were asked to consume two cartons (400 mL) of their assigned supplement per day for 7 days prior to surgery and to keep daily records of the volume consumed in a dedicated "compliance diary." This dietary supplement was consumed in addition to normal food intake. No patient received total parenteral nutrition during the preoperative period of the trial. Postoperatively, the patients were asked to consume two cartons (400 mL) of supplement each day for 5 days.	Infectious complications I: 6.60% C: 14.80% RR: 2.466 (0.716-8.491) p=0.142 Wound infection I: 0.00% C: 11.50% RR: 0.470 (0.387-0.570) p=0.006 Pneumonia I: 3.30% C: 3.30% RR: 1.000 (0.136-7.337) p=1.000 Venous catheter infection I: 3.30 C: 1.60 RR: 0.492 (0.043-5.569) p=0.559

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Moya et al.[25] (2016)	RCT, single-blind, multicenter Spain Jan 2014 to March 2015 Population: 264 patients who were required to be at least 18 years of age, to be scheduled for surgery for colorectal cancer, to be normonourished	To compare immunonutrition versus standard high calorie nutrition in patients undergoing elective colorectal resection within an Enhanced Recovery After Surgery (ERAS) program.	CDC criteria	Colorectal surgery	Randomization: Using the web site Exclusion: Need for emergency surgery, an American Society of Anesthesiologists (ASA) physical status IV, renal failure defined via hemodialysis, patients on immunomodulatory or nutritional supplements, hypersensitivity to arginine,omega-3 fatty acids, or nucleotides, the inability to consume oral nutrition (dysphagia, esophageal stricture, and pyloric stenosis), psychiatric disorders, HIV, pregnancy, bowel obstruction, and uncontrolled infection. Amounts/timing: The patients were asked to consume 2 cartons (400 mL) of their assigned feed per day for 7 days prior to surgery and to daily record the volume consumed in a dedicated "compliance diary." This dietary supplement was consumed in addition to normal food intake. No patient received total parenteral nutrition during the preoperative period of the trial. Postoperatively, the patients were asked to consume 2 cartons (400 mL) of either feed each day for 5 days. Follow up: The 30-day postoperative complications were recorded.	C: Hypercaloric, high-protein supplement (HHS)-SUPRESSI of Vegenat) for 7 days prior to colorectal resection and for 5 days postoperatively I: An immune-enhancing feed (IEF)-ATEMPERO produced by Vegenat for 7 days prior to colorectal resection and for 5 days postoperatively	SSI I: 5.70% C: 17.2% RR: 0.293 (0.119-0.717) p=0.005 Superfical/Deep incisional SSI I: 5.70% C: 16.4% RR: 0.310 (0.126-0.764) p=0.008 Organ/space SSI I: 0.80% C: 2.40% RR: 0.328 (0.034-3.196) p=0.313 Pneumonia I: 1.60% C: 3.30% RR: 0.492 (0.088-2.736) p=0.408 UTI I: 0.80% C: 0.80% RR: 1.000 (0.062-16.171) p=1 Venous catheter infection I: 3.30% C: 7.40% RR: 0.426 (0.127-1.421) p=0.154

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Yildiz et al.[26] (2016)	RCT Turkey Jan 2012 to Feb 2013 Population: 41 patients with malignancies of the upper gastrointestinal tract were included (distal esophagus, stomach, and head of the pancreas).	To evaluate the effect of perioperative enteral immunonutrition on morbidity (overall and specific incidence of complications), mortality, and length of hospital stay (LHS) after elective radical gastrointestinal surgery.	Not specified	Distal esophagectomy, total or subtotal gastrectomy, or pancreaticoduodenectomy Gastric cancer: D2 LND	Randomization: Not specified ("randomly assigned"). Exclusion: Stage 4 malignancies; coexistent severe lung, kidney, heart, or liver diseases; age less than 18 or greater than 75 years; and nutritional therapy intolerance. Timing: Nutritional support was provided for 7 days before and 7 days after the intervention. Route: Although oral route was the initial choice of nutrition preoperatively, tube feeding was also used in patients with insufficient oral intake.	C: Enteral nutrition was accomplished with Ensure Plus (Abbott Nutrition) I: Enteral nutrition was accomplished with Ensure Plus (Abbott Nutrition) + Abound (Abbott Nutrition) was administered 2 times a day in 250 mL of watery solution. Adequate amounts of two main immunonutrients, glutamine (>14 g/day) and arginine (>12 g/day), were provided	SSI I: 2/21 C: 5/20 p=0.021 UTI I: 1/21 C: 3/20 p=0.020 Sepsis I: 0/21 C: 1/20 p=1
Uno et al.[27] (2016)	RCT Japan July 2010 to Sep 2013 Population: 64 consecutive patients undergoing major hepatobiliary resection who were candidates for an elective operation	To examine the participation of resolvin E1 on antiinflammatory effects of immunonutrition in severely stressed patients. A secondary aim was to investigate the effects of immunonutrition on surgical complications in patients undergoing hepatobiliary resection.	SSI: CDC Intra-abdominal abscess: purulent discharge with positive cultures from abdominal drains and as a collection requiring either surgical or radiologic drainage. Pneumonia: CDC's definitions for nosocomial pneumonia.	Hepatobiliary resection	Randomization: The use of sealed envelopes containing computer-generated distribution numbers. Exclusion: Age <18 years or >80 years, ongoing infection, gastrointestinal obstruction, respiratory dysfunction, cardiac dysfunction, hepatic dysfunction, renal failure, history of recent immunosuppressive or immunologic disease (including preoperative chemotherapy and/or radiation therapy), and preoperative evidence of widespread metastatic disease. Follow-up: Infectious complications were recorded for up to 30 days after the operation.	C: No artificial nutrition and were allowed to consume regular food before the operation (2,000 kcal/d). I: Oral supplementation (1,000 kcal/d) containing EPA, arginine, and nucleotides (oral IMPACT; Nestle Health Science Co., Ltd., Kobe, Japan) for 5 consecutive days before the operation in addition to 50% reduction in amount of regular food (1,000 kcal/d).	Infectious complication I: 8/20 C: 15/20 p=0.025 Wound infection I: 6/20 C: 10/20 p=0.197 Intra-abdominal abscess I: 6/20 C: 12/20 p=0.057 Pneumonia I: 1/20 C: 3/20 p=0.292

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Vijey Aanandhi and John[28] (2017)	RCT India Population: 30 participants following abdominal surgery belonging to the age group of 20-55 years were recruited from the surgery ward of ESIC hospital.	To understand the effect of glutamine supplementation in patients following abdominal surgery on plasma glutamine levels, length of hospitalization (LOH), and rate of infection.	Not specified	Abdominal surgery	Randomization: Not specified ("randomly assigned"). Exclusion: Patients with comorbidities such as Type I diabetes and Type II diabetes on insulin management, renal diseases (creatinine concentration >2.5 mg/dL), cardiac disorders (Class III or IV), hepatic disease (total bilirubin concentration >3 mg/dL), autoimmune diseases, chronic use of steroids (30 mg or more for more than a month), chronic obstructive pulmonary disease (partial pressure of carbon dioxide>375 kPa or 50 mmHg) and pregnant women. Withdrawal criteria: Non-compliance with the blood test. Route: Gastrostomy and jejunostomy tubes were placed during the surgery for post-operative nutrition support. However, 10% of the participants were given oral feeds directly in post-surgery as they showed tolerance for the same. Timing/amount: Feeding for either group began at strength of 1,200 kcal/day further advancing it on a daily basis toward the goal caloric requirement of 35-40 kcal/kg body weight. Goal nutrition also provided 1.5 g protein/kg body weight/day. The experimental group was given 0.5 g glutamine/day for 5 days.	C: Began at strength of 1,200 kcal/day further advancing it on a daily basis toward the goal caloric requirement of 35-40 kcal/kg body weight. Goal nutrition also provided 1.5 g protein/kg body weight/day. I: Feeding protocol for control group plus 0.5 g glutamine/day for 5 days. 10 g of the glutamine from the supplement (Meta gluta ZS) was mixed in 180 mL of water and given orally and enterally for the patients where oral feed was not possible.	Infection I (n=15): 26.60% C (n=15): 53.30% χ^2-value: 2.36

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Yeğen et al.[29] (2020)	RCT Turkey Population: 97 patients who were scheduled for a major elective abdominal (Gastric, colon, rectal) cancer surgery in our clinic. All patients with performance score 0, 1, and 2 according to Eastern Cooperative Oncology Group (ECOG), and have the capacity of in taking minimal 750 mL or more fluids orally or enterally were included in our study.	To compare the effects of perioperative standard and immunomodulating enteral nutrition on clinical outcomes of the patients received major abdominal cancer surgery.	Superficial wound infection: infection involves the skin and subcutaneous tissue associated with the incision site. Deep wound infection: infection is related to fascia, muscle or deep soft tissue associated with surgical incision	Major elective abdominal (Gastric, colon, rectal) cancer surgery	Randomization: Not specified ("randomly assigned"). Exclusion: Inability to control metabolic state, psychiatric, cases, ECOG performance score ≥3, pregnancy, renal and liver failure, acute mechanical or paralytic intestinal obstruction, gastrointestinal hemorrhage, hemoglobin (Hb) level less than 8 g/dL and emergent procedures Timing: Enteral nutrition days prior to surgery and 30 days after surgery	C: 200 mL (3 times/day) Resource® 2.0 fiber 7 days prior to surgery and 30 days after surgery I: 74 g powder plus 250 mL water (3 times/day) Oral Impact® RTD 7 days prior to surgery and 30 days after surgery	SSI I: 6/39 C: 28/39 p=0.00 UTI I: 2/39 C: 13/39 p=0.03 Pneumonia I: 0/39 C: 10/39 p=0.01
Horie et al.[30] (2006)	Prospective clinical study Japan Population: colorectal cancer patients undergoing elective surgery without malnutrition.	To ascertain the effects of preoperative enteral immunonutritio n on SSI in patients with colorectal cancer without malnutrition.	CDC criteria	Elective colorectal (cancer)	Non-randomized: patients enrolled sequentially into either immunonutrition group or control group. Follow-up: 30 days after discharge Exclusion criteria: malnutrition, bowel obstruction, severe cardiopulmonary complication, diabetes, collagen disease or renal failure.	I: supplement to normal preoperative diet with 3 packs of Impact® enteral immunonutrition/day (750 mL containing 9.6 g arginine, 2.49 g omega fatty acids, and 0.96 g RNA with a kcal:mL ratio of 1:1). C: unclear if placebo or no packets to supplement oral intake.	C: 5/34 I: 0/33 p<0.05

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Okabayashi et al.[31] (2008)	Prospective trial January 2000 to March 2007 Japan Population: 112 patients undergoing surgical management for hepatocellular carcinoma (84 men, 28 women).	To evaluate the clinical benefit of perioperative supplementation of a branched- chain amino acid-enriched nutrient mixture for patients undergoing liver resection for hepatocelllar carcinoma.	Not specified	Liver resection for hepato-cellular carcinoma.	Randomization: not randomized. Exclusion criteria: not specified. Follow-up: 3-84 months (mean, 21 months).	C: no added dietary supplementation. I: patient diet was supplemented with branch-amino acids-rich soft-powder mixture (Aminoleban; Otsuka Pharmaceutical Company, Tokyo, Japan): 13 g free amino acids, 13 g, gelatin hydrolysate, 1 g casein, 62.1 g carbohydrate, 7 g lipid, glscyrrhizin, others with 420 kcal) at 100 g/day commencing at 2 weeks preoperatively.	SSI C: 11/72 I: 2/40 p=0.19
Takeuchi et al.[32] (2007)	Prospective case-control study Japan Population: consecutive patients diagnosed with primary thoracic esophageal squamous cell carcinoma.	To test the hypothesis that preoperative, postoperative, or both, enteral multiple nutrient-enhanced formulas supplemented with arginine, omega-3 fatty acids and RNA may reduce postoperative complications in patients undergoing esophagectomy for thoracic esophageal squamous cell carcinoma.	Incisional wound infection: evidence of purulent exudate in the wound and isolation of pathogenic organisms in the culture.	Esophagecto my for thoracic esophageal squamous cell carcinoma.	Randomization: not specified. Amount/timing: control group received enteral diet during the first 14 postoperative days. Intervention 1 received enhanced diet through the first 14 postoperative days. Intervention 2 received enhanced diet both 5 days pre- and 14 days postoperatively. Daily intake began at 250 kcal/day and increased by 250 kcal/day until 1,500 kcal/day was reached for all groups.	C: Enteral diet postoperatively I1: enteral diet supplemented with multiple nutrient-enhanced formulas containing arginine, omega-3 fatty acids, and RNA postoperatively. I2: enteral diet supplemented with multiple nutrient enhanced formulas containing arginine, omega-3 fatty acids, and RNA pre- and postoperatively.	Incisional wound infection C: 6/20 I1: 2/6 I2: 0/14 p=0.067 Sepsis/bacteraemia C: 2/20 I1: 1/6 I2: 0/14 p=0.36

Table 2. Continued

Study	Design, setting, population	Study objective	SSI definition	Type of surgery	Methods	Intervention	Results
Yeh et al.[33] (2008)	Prospective case-control study 2006 Taiwan (People's Republic of China) Population: 70 patients (20-85 years) undergoing gastrointestinal surgery by a single surgeon.	To evaluate the impact of a supplement of alanyl-glutamine dipeptide in parenteral nutrition on perioperative immune and nutritional changes and clinical outcomes for patients undergoing gastrointestinal operations.	Not specified	Gastroin-testin al surgery	Non-randomized. Exclusion criteria: immunosuppressive condition, including acquired immunodeficiency syndrome, autoimmune disorders, organ transplantation, radiation therapy or chemotherapy within the previous 6 months and insulin- dependent diabetes. Timing: solution infused via a peripheral venous line started 1 day before operation and continued until postoperative day 6. Follow-up: discharge 6 days postoperative; mortality 1 month.	I: 500 cc amino acid 5% supplemented with 100 cc glutamine 20%. C: 500 cc amino acid 8% per day as nitrogen source.	Wound infection I: 2/35 C: 0/35 p=1.0

SSI: surgical site infection, RCT: randomized controlled trial, I: intervention, C: control, RR: risk ratio, CI: confidence interval, CDC: Center for Disease Control and Prevention, RNA: ribonucleic acid, NS: not significant, SLD: standard liquid diet, UTI: urinary tract infection.

Table 3. Summary of Finding Table

Single nutrient-enhanced nutrition compared to standard nutrition support for the prevention of SSI Patient or population: Patients with undergoing surgical operation (any type of procedure) Intervention: Single nutrient-enhanced nutrition support						
Outcomes	Illustrative comparative risks[a] (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Single nutrient-enhanced				
SSI (RCT)	95 per 1,000	46 per 1,000 (22 to 98)	RR 0.49 (0.23 to 1.04)	335 (7 studies)	⊕⊕⊖⊖ Low	
SSI (NRS)	153 per 1,000	50 per 1,000 (12 to 214)	RR 0.33 (0.08 to 1.40)	112 (1 study)	⊕⊖⊖⊖ Very low	
Multiple nutrient-enhanced formula compared to control for the prevention of SSI Patient or population: Patients with undergoing surgical operation (any type of procedure) Intervention: Multiple nutrient-enhanced nutrition support						
Outcomes	Illustrative comparative risks[a] (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Multiple nutrient-enhanced				
SSI (RCT)	233 per 1,000	116 per 1,000 (77 to 174)	RR 0.50 (0.33 to 0.75)	1,881 (14 studies)	⊕⊕⊖⊖ Low	
SSI (NRS)	204 per 1,000	16 per 1,000 (2 to 128)	RR 0.08 (0.01 to 0.63)	107 (2 studies)	⊕⊖⊖⊖ Very low	

SSI: surgical site infection, CI: confidence interval, RR: risk ratio, RCT: randomized controlled trial, NRS: non-randomized controlled study.
[a]The basis for the assumed risk (e.g., the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

결론

대수술을 받는 환자의 수술 부위 감염을 예방하기 위해 경구 또는 장관을 통한 다중 영양소 강화 영양 지원을 고려할 수 있다.

(선택적 권고[Do, Conditional recommendation], 낮은 수준의 근거[Low quality of evidence])

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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REVIEW ARTICLE

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근거 중심의 수술부위감염 예방 진료권고안: 체온 유지 관리

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The Evidence-Based Practice Guidelines for Prevention of Surgical Site Infection: Normothermia

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Hypothermia (or low body temperature) is common during and after major surgical procedures, which is considered to be an adverse effect of surgical site infection. On behalf of the Korean Surgical Infection Society, the practice guidelines committee collected data whether normothermia is an important factor for prevention of surgical site infection. Following the intensive review and analysis, the practice guidelines committee decided to recommend maintenance of normothermia using warming devices in the operation room to reduce surgical site infection (Do, strong recommendation, moderate quality of evidence).

Key Words: Hypothermia, Surgical site infection, Practice guideline

서론

심부체온이 정상으로 유지되는 것이 수술부위감염의 발생을 낮추는 기전은 확실하지 않다. 수술 중 저온 환경에 노출되는 것과 마취로 인한 온도 조절능력의 장애가 수술 중 저체온증을 유발하는 것으로 알려져 있으며, 이러한 저체온증이 수술부위감염을 증가시키는 요인이 될 수 있는지는 명확지 않다. 따라서 본 진료권고위원회에서는 가용한 근거를 수집하고 체계적인 검토 및 분석을 통해 체온 유지가 수술부위감염에 미치는 영향을 연구하고 이에 대한 진료지침을 마련하고자 하였다.

대상 및 연구 방법

진료권고안 개발 방법은 수용개작 방식(adaptation)으로 개발되었으며, 2016년 발표된 세계보건기구(World Health

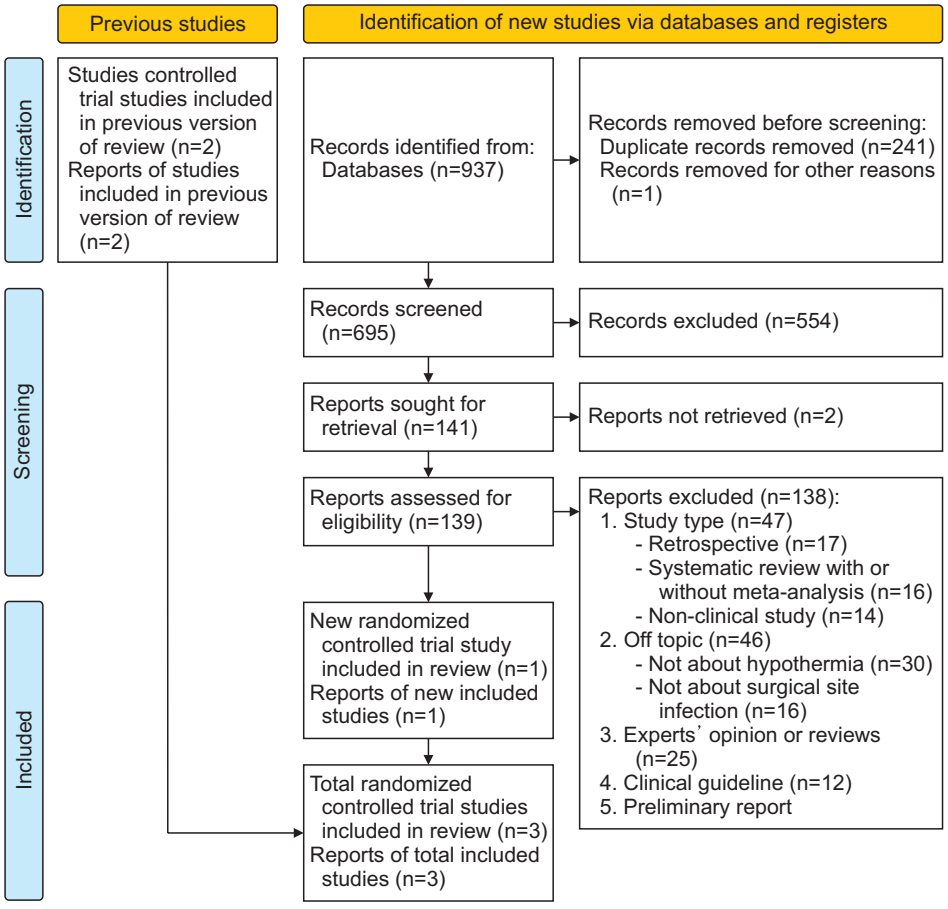

Fig. 1. Study selection. PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases and registers only. PRISMA: preferred reporting items for systematic reviews and meta-analyses.

Organization, WHO) 가이드라인[1]을 기준 진료권고안으로 최신성을 보강하는 GRADE-ADOLOPMENT 방법[2]을 적용하였다. WHO 가이드라인의 권고안에서 국내 수술환경에 적용할 대상을 핵심질문으로 선정하였고, 최신성 보강을 위해 문헌 검색을 시행하여 추가하였다. 국외 논문은 MEDLINE, EMBASE, CINAHL, Cochrane으로 WHO 가이드라인에서 적용한 기간(1990년 1월 1일부터 2015년 8월 17일)을 최신까지 연장하여 검색하였고, 국내 논문 검색은 KMBASE, KoreaMed를 기간 제한 없이 검색하였으며, 논문 검색은 2021년 1월 12일에 수행되었다(Fig. 1).

핵심질문 5. 수술부위감염을 감소시키기 위해 체온 유지(warming)가 중요한가? (Table 1)

근거수준: 근거수준평가와 근거의 강도와 한계

분석에 포함된 연구는 기존 WHO 가이드라인에 사용된 2개의 무작위 대조연구[3,4]와 추가된 1개의 무작위 대조연구[5]이다(Table 2). 근거 검토의 목적은 수술 중 정상 체온 유지를 위한 적극적인 관리를 수행하는 것이 수술부위 감염률을 감소와 연관이 있는지를 평가하는 것이었다. 대장 및 직장 절제술, 탈장 봉합술, 정맥류 수술, 유방 수술, 고관절 전치환술, 폐엽 절제술 혹은 식도 절제술을 포함한 개흉술 등 계획된 주요 수술을 시행 받은 성인 환자가 연구에 포함되었으며, 18세 미만의 환자에 대한 연구는 없었다. 세 연구 모두 수술부위 감염률에 대한 분석을 시행하였으며, 출혈량, 입원기간 등의 차이도 분석하였으나 수술부위감염으로 인한 사망률을 보고한 연구는 없어 수술부위 감염률에 대한 분석만 시행하였다. 연구에 포함된 3개의 무작위 대조연구를 통하여 총 540명의 대상자에 대한 메타분석의 결과, 중간수준의 근거로 수술 중 체온 유지를 위한 적극적인 관리(수액 가온기 사용, 가온 공기 주입 담요의 수술 전, 수술 중 사용 등)를 시행한 군이 대조군에 비해 수술 부위 감염이 유의하게 적은 것으로 나타났다. 포함된 연구가 모두 무작위 대조 연구였으나 개별연구의 대상자 수와 연구에 포함된 수술의 종류 및 수술부위 감염 발생 관찰 기간의 이질성 등으로 인해 효과를 과장할 가능성을 배제할 수 없어 중등도 수준의 근거수준으로 평가되었으며, 내부 회의에서 위원들은 수술 중 체온 유지가 수술부위감염 예방에 반드시 필요하다는데 동의하여 일반적 권고를 채택하였다(Table 3).

Table 1. 포함 및 배제기준

대상환자(P)	수술 대상 환자
중재(I)	수술 중 체온 유지 관리 시행(warming)
비교군(C)	수술 중 체온 유지 관리 안함(non-warming)
결과(O)	수술부위 감염률 및 수술부위감염으로 인한 사망률
연구설계(S)	무작위 대조연구
대상 사용자	수술에 참여하는 1-3차 의료기관의 의료진

P: patient, I: intervention, C: comparator/comparison/control, O: outcomes, S: setting.

결론

수술 부위 감염을 감소시키기 위해 수술 중 체온 유지 장치 사용을 권고한다.

(일반적 권고[Do, Strong recommendation], 중간 수준의 근거[Moderate quality of evidence]).

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

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Table 2. Evidence Table

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results
Kurz et al.[3] (1996)	RCT 3 hospitals (1 university, n=155; 1 university, n=30; 1 other hospital, n=15) July 1993 to March 1995 Austria Population: 200 patients undergoing elective colorectal resection Age: 18-80 years Sex (male/female): 108/92 Operating time: I: 170±9 minutes C: 169±9 minutes p=0.43 minutes Exclusion criteria: minor colon surgery (for example, polypectomy or colostomy performed as the only procedure), use of corticosteroids or other immuno-suppressants.	To test the hypothesis that mild core hypothermia increases both the incidence of surgical wound infection and length of hospitalization in patients undergoing colorectal surgery.	Wound infection (suspected): if pus could be expressed from the surgical incision or aspirated from a lobulated mass inside the wound. Wound infection (confirmed): if pus culture was positive for pathogenic bacteria. ASEPSIS score >20.	Elective colorectal surgery for cancer or inflammatory bowel disease. Cancer 182/200 (91%). Inflammatory bowel disease 18/200 (9%). Inclusion criteria: abdominal intra-peritoneal pull-through procedures.	Patients were randomly assigned to either normothermia or hypothermia groups. Apart from temperature management, other perioperative procedures were standardized for the two groups. Standard mechanical bowel preparation with an electrolyte solution. Intravenous cefamandole (2 g every 8 hours) and metronidazole (500 mg every 8 hours) treatment was maintained for approximately 4 days. postoperatively. Fluids were administered as 15 mL of crystalloid per kg per hour throughout surgery and replaced the volume of blood lost with either crystalloid in a 4:1 ratio or colloid in a 2:1 ratio. Fluids were administered intravenously at rates of 3.5 mL per kg per hour for the first 24 hours postoperatively and 2 mL per kg per hour for the subsequent 24 hours.	Normothermia group: patients were actively warmed by using a forced-air cover placed over the upper body and set to deliver air at 40°C. In addition, intravenous fluids were actively warmed through a fluid warmer. Patient core temperatures were maintained close to 36.5°C. Hypothermia group: used the same forced-air cover as the intervention group but set to deliver air at ambient temperature. Intravenous fluids were administered through the fluid warmer, similar to the intervention group, but the warmer was set to off for the control group. Core temperature was allowed to decrease to approximately 34.5°C.	SSI: 2 weeks Overall: 24/200 (12%) I: 6/104 (6%) C: 18/96 (19%) p=0.009 Smokers: 14/62 (23%) Non-smokers: 10/138 (7%) p=0.004

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results
Melling et al.[4] (2001)	RCT District general hospital April 1999 to May 2000 United Kingdom Population: 416 patients undergoing elective hernia repair (n=155), varicose vein surgery (n=86) or breast surgery with incision >3 cm (n=175) Patient characteristics: similar in all groups, including age, body mass index, sex, fasting >8 hours, hair removal (shaving) >6 hours, type of surgery, surgery in last 3 months, cancer diagnosis, initial core temperature, prophylactic antibiotics, length of surgery, seniority of surgeon. Age: ≥18 years (mean) Intervention 1: 49.7 years Intervention 2: 50 years Inclusion criteria: Elective hernia repair, varicose vein surgery or breast surgery that would result in a scar longer than 3 cm in length. Exclusion criteria: Pregnant, taking long-term oral steroids, had received radiotherapy (to the incision site) or chemotherapy in the last 4 weeks, or had an infection at the time of surgery	To assess the use of a local warming device and a warm air blanket before surgery for the reduction of infection after clean, short duration surgery.	Purulent discharge or a painful erythema lasting 5 days and treated with anti-microbials within 6 weeks of surgery. Wounds were swabbed for culture if purulent discharge present at the time of review. Note: only 14 wound swabs were obtained because of post-operative anti-microbials: "Patients seen at 2 and 6 weeks had often been prescribed antimicrobial treatment by their general practitioner without having the wound swabbed."	Elective hernia repair, varicose vein surgery or breast surgery that would result in a scar longer than >3 cm.	Randomization: prepared in blocks of 90, with the treatment allocation concealed in opaque envelopes. Prophylactic antibiotics C: 47 (34%) I: 36 (26%) in systemic warming and 36 (26%) in the incisional warming. Perioperative care Anesthesia: not described Hair removal-shaving No shaving: 110/416 (26.4%). Shaving: <7 hours preoperatively: 116/416 (27.9%). Shaving: >7 hours preoperatively: 183/416 (20%). Data missing: 9/416. A single trained observer unaware of treatment allocation reviewed patients at 2 and 6 weeks postoperatively	I (1) - systemic (n=139): standard preoperative care plus minimum 30 minutes preoperative warming to the whole body using a forced-air warming blanket. I (2) - local (n=138): standard preoperative care plus minimum 30 minutes preoperative warming only at the planned wound area using a non-contact, radiant heat dressing. C: none of the above. Timing of intervention: preoperative. Duration of intervention: a minimum of 30 minutes until just before surgery. Device: (1) systemic: forced-air warming blanket; (2) local: non-contact, radiant heat dressing.	SSI Non-warmed: 19/139 (14%) Local: 5/138 (4%) Systemic: 8/139 (6%) All warmed: 13/277 (5%) C vs. local: p=0.003 Co vs. systemic: p=0.026

Table 2. Continued

Study	Design, scope, setting, population	Objective	SSI definition	Type of surgery	Study methods	Intervention	Results
Yi et al.[5] (2018)	RCT (NCT02214524) Peking Union Medical College Hospital in Beijing, China, 2014 Population: 62 patients undergoing either initial unilateral total hip replacement or open thoracic operations (pulmonary lobectomy or esophagectomy) Inclusion criteria: age 18 to 80 years and American Society of Anesthesiologists Physical Status 1-3. Exclusion criteria: history of excessive bleeding; partial thromboplastin time >35 s; prothrombin time >35 s; fibrinogen <200 mg/dL; platelet count <100,000/L; history of infection and fever within 4 weeks before surgery; use of steroid or immunosuppressant within 4 weeks before surgery; Raynaud's disease; hypothyroidism or hyperthyroidism; Uncontrolled insulin-dependent diabetes mellitus (preoperative glucose >250 mg/dL); preoperative temperature above 37.5°C or less than 36°C	To determine whether active intraoperative warming reduced bleeding and surgical-site infection in patients undergoing major operations: open thoracic surgery and hip replacement surgery	Purulent discharge or a painful erythema lasting 5 days All patients were followed for 30 days after operation, and those who had an implant were followed for 90 days.	Initial unilateral total hip replacement or open thoracic operations (pulmonary lobectomy or esophagectomy) Hip replacement 24/62 (38.7%). Thoracic Surgery 38/62 (61.3%)	Patients were enrolled and randomly allocated to either a passive warming (PW) group or an active warming (AW) group. All patients received general anesthesia according to the following standard protocol Primary endpoint: intraoperative blood loss Secondary endpoint: post-operative surgical-site infection; cardiovascular events; length of stay (LOS) in the PACU, ICU and hospital; and shivering	PW group: patients were covered with unwarmed cotton blanket (thermal insulation) throughout the operation, from the preoperative holding area, operating room, to post-anesthesia care unit (PACU). AW group: covered with forced-air blankets connected to a warming unit, pre-warmed for 15-30 min with an upper-body blanket in the holding area and then moved onto the operating table prior to induction, where a pre-warmed lower-body blanket was already placed. The Bair-Hugger warming unit was set on its highest temperature (43°C).	SSI PW group: n=3/32 (9.4%) AW group: n=0/30 (0%) p-value=0.2384

SSI: surgical site infection, RCT: randomized controlled trial, I: intervention, C: control, ICU: intensive care unit.

Table 3. Summary of Finding Table

Body warming compared to no warming for
Patient or population: patients with
Settings:
Intervention: Body warming
Comparison: no warming

Outcomes	Illustrative comparative risks[a] (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	No warming	Body warming				
SSI	150 per 1,000	52 per 1,000 (30 to 94)	RR 0.35 (0.20 to 0.63)	540 (3 studies)	⊕⊕⊕⊖ Moderate	

SSI: surgical site infection, CI: confidence interval, RR: risk ratio. [a]The basis for the assumed risk (e.g., the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

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REVIEW ARTICLE

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근거 중심의 수술부위감염 예방 진료권고안: 혈당 조절

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The Evidence-Based Practice Guidelines for Prevention of Surgical Site Infection: Glucose Control

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Many studies have demonstrated an effect of intensive perioperative blood glucose control in reducing surgical site infection (SSI) rates compared to a conventional protocol, but the benefit and risk of intensive protocol are still debated. On behalf of the Korean Surgical Infection Society, the practice guidelines committee collected data regarding intensive perioperative blood glucose control for SSI. Following the intensive review and analysis, the practice guidelines committee decided to recommend that intensive perioperative blood glucose control for both diabetic and non-diabetic adult patients undergoing surgical procedures to reduce the risk of SSI (Do, conditional recommendation, low quality of evidence).

Key Words: Surgical site infection, Glycemic control, Diabetes mellitus, Hyperglycemia

서론

수술은 인슐린을 억제하는 스트레스 반응을 유발하며 췌장의 베타세포 기능에도 영향을 줌으로써 체내 인슐린 수치를 낮추게 된다. 또한, 인슐린 저항성 및 과도한 이화작용으로 인해 수술 환자, 심지어 비당뇨병 환자에서도 고혈당증이 유발될 수 있다. 여러 연구들에 따르면 고혈당증은 수술부위감염, 이환율 및 사망률을 증가시킨다고 보고하였으나, 또 다른 연구들에서는 집중적인 혈당조절이 오히려 저혈당증을 유발함으로써 여러 부작용의 발생 위험을 증가시킨다고 보고하기도 하였다. 따라서 본 진료권고위원회에서는 수술 전후의 혈당 수치가 수술부위감염의 위험도에 미치는 영향을 평가하고 수술을 받는 당뇨병 및 비당뇨병 환자 모두에서 수술 전후의 적정한 혈당 수치를 결정하기 위한 진료지침을 마련하고자 하였다.

대상 및 연구 방법

진료권고안 개발 방법은 수용개작 방식(adaptation)으로 개발되었으며, 2016년 발표된 세계보건기구(World Health Organization, WHO) 가이드라인[1]을 기준 진료권고안으로 최신성을 보강하는 GRADE-ADOLOPMENT 방법[2]을 적용

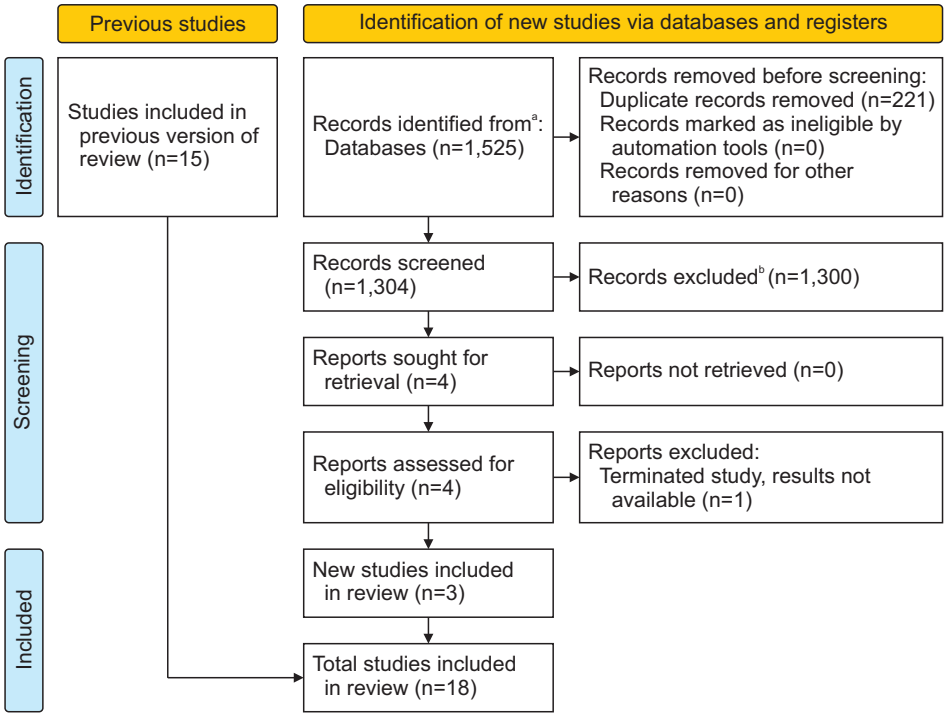

Fig. 1. Study selection. PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases and registers only. PRISMA: preferred reporting items for systematic reviews and meta-analyses. [a]Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers). [b]If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

하였다. WHO 가이드라인의 권고안에서 국내 수술환경에 적용할 대상을 핵심질문으로 선정하였고, 최신성 보강을 위해 문헌 검색을 시행하여 추가하였다. 국외 논문은 MEDLINE, EMBASE, CINAHL, Cochrane으로 WHO 가이드라인에서 적용한 기간(1990년 1월부터 2014년 8월)을 최신까지 연장하여 검색하였고, 국내 논문 검색은 KMBASE, KoreaMed를 기간 제한 없이 검색하였으며, 논문 검색은 2021년 1월 12일에 수행되었다(Fig. 1, Table 1).

핵심질문 6. 수술부위감염 예방을 위해 수술 전후 기간에 집중적 혈당 조절이 필요한가?

근거수준: 근거수준평가와 근거의 강도와 한계

분석에 포함된 연구는 18개의 무작위 대조군 연구[3-20]이다(Table 2). 대부분의 낮은 수준의 근거들에 따르면 수술 전후에 집중적 혈당 조절을 하도록 하는 지침이 기존의 지침과 비교해서 수술 부위 감염의 발생을 유의하게 줄이는 것으로 보고하고 있다. 집중적 혈당 조절 지침에 따르면, 목표 혈당 수준이 ≤110 mg/dL (6.1 mmol/L)인 경우와 상한 목표 수준이 110-150 mg/dL (6.1-8.3 mmol/L)인 경우를 비교한 연구에서 그 효과가 비슷했다. 7개의 연구[3-5,7,8,18,20]에서는 당뇨병 환자들을 대상으로 하였고, 2개의 연구[16,17]에서는 비당뇨병 환자들을 대상으로 하였다. 9개의 연구[6,9-15,19]에서는 당뇨병 환자와 비당뇨병 환자를 모두 포함시켰다. 심장수술이 가장 많이 시행되었고,[3,4,6,8,11-13,17-20] 복부 수술을 포함한 대수술에 초점을 둔 연구[5,7,9,10,14-16]들도 있었다.

하지만 지침개발위원회는 집중적 혈당 조절을 할 경우 저혈당증이 발생할 가능성이 있음을 강조했다. 저혈당증은 심장발작과 같이 생명을 위협하는 합병증을 유발할 수 있다. 이에 대한 기준은 ≤40 mg/dL (2.2 mmol/L)부터 ≤80 mg/dL (4.4 mmol/L)까지 연구에 따라 다양하게 정의하고 있다. 이 외에도 집중적 혈당 조절을 할 경우 뇌졸중이나 사망의 발생 가능성이 있음을 고려하여야 한다.

지침개발위원회는 현재로서 최적의 목표 혈당 수준을 정의할 근거가 없고 집중적 혈당 조절이 수술 부위 감염에 대한 이득이 있음에도 저혈당증이나 뇌졸중, 사망 등과 같은 위해가 있을 수 있다고 판단함으로써 본 권고사항의 강도는 선택적 권고(Do, conditional), 근거수준은 낮음(low)으로 하기로 결정하였다(Table 3).

Table 1. 포함 및 배제기준

대상환자(P)	수술 대상 환자
중재(I)	집중적 혈당 조절을 한 환자
비교군(C)	일반적 혈당 조절을 한 환자
결과(O)	수술부위 감염률, 저혈당증 발생률, 뇌졸중 발생률, 사망률
연구설계(S)	무작위 대조군 연구
대상 사용자	수술을 시행하는 1-3차 의료기관의 전문의

P: patient, I: intervention, C: control, O: outcomes, S: setting.

결론

수술을 받는 당뇨병 및 비당뇨병 성인 환자에서 수술 부위 감염의 위험을 감소시키기 위해 수술 전후에 집중적 혈당 조절을 할 것을 권고한다.

(선택적 권고[Do, Conditional recommendation], 낮은 수준의 근거[Low quality of evidence])

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

Conceptualization: Bo Young Oh. Data acquisition: Youngki Hong, Bo Young Oh. Formal analysis: Youngki Hong, Bo Young Oh. Supervision and validation: Sung Uk Bae, Ji Young Jang, Gyoung Tae Noh, Sung Huhn

Table 2. Evidence Table

Study	Type of surgery	Population	Definition of SSI	Intervention	Control	Timing	Outcome[a]			
							SSI	Hypoglycemia	Mortality	Stroke
Abdelmalak et al.[9] (2013)	Major noncardiac surgery	Patients with and without diabetes	Deep and organ space SSI	Dynamic i.v. insulin infusion; target BG 80–110 (4.4–6.1)	Dynamic i.v. insulin infusion; target BG 180-200 (10.0-11.1)	During surgery and 2 h after surgery	I: 17 of 196 C: 18 of 185 OR 0.88 (0.24, 3.20); (p=0.72)	At least 1 episode of BG <72.7 (4.0) I: 29 of 196 C: 4 of 185 No episodes of severe hypoglycaemia	I: 4 of 196 C: 4 of 185	None
Albacker et al.[6] (2008)	Cardiac surgery (CABG)	Patients with and without diabetes	Superficial wound infection	Fixed high-dose i.v. insulin infusion with dextrose 20% for BG 70-110 (3.9-6.1) ('insulin clamp')	i.v. insulin infusion to maintain BG <180 (10.0) ('sliding scale method')	During surgery	I: 1 of 27 C: 1 of 25 (p=0.99)	None	None	None
Bilotta et al.[10] (2007)	Emergency cerebral aneurysm clipping	Patients with and without diabetes	Wound infections by NNIS definition	Continuous i.v. insulin infusion to maintain BG 80-120 (4.4-6.7)	Continuous i.v. insulin infusion to maintain BG 80-220 (4.4-12.2)	During and after surgery (discharge from ICU or on day 14)	I: 1 of 40 C: 2 of 38	BG <80 (4.4) More frequent in I group RR 3.0 (2.07, 4.35)		
Cao et al.[7] (2011)	Gastrectomy	Patients with type 2 diabetes receiving parenteral nutrition	Wound infection (SSI by CDC definition)	Continuous i.v. insulin infusion; target BG 80-100 (4.4-6.7)	Continuous i.v. insulin infusion; target BG <200 (11.1)	Postoperative until oral intake	I: 4 of 92 C:12 of 87	Severe BG <40 (2.2) I: 6 of 92 C: 1 of 87	I: 4 of 92 C:5 of 87	
Cao et al.[16] (2011)	Gastrectomy	Patients without diabetes receiving parenteral nutrition	Wound infection (SSI by CDC definition)	Continuous i.v. insulin infusion; target BG 80-100 (4.4-6.7)	Continuous i.v. insulin infusion; target BG <200 (11.1)	Postoperative until oral intake	I: 5 of 125 C: 13 of 123	Severe BG <40 (2.2) I: 8 of 125 C: 1 of 123	I: 1 of 125 C: 2 of 123	
Chan et al.[11] (2009)	Cardiac surgery	Patients with and without diabetes	Wound infection	Continuous i.v. insulin infusion initiated at BG >130 (7.2); target BG 80-130 (4.4-7.2)	Continuous i.v. insulin infusion initiated if BG >200 (11.1); target BG 160-200 (8.9-11.1)	During surgery and 36 h after surgery	I: 6 of 54 C: 9 of 55 (p=0.09)	BG <50 (2.8) No difference between groups (p=0.67)	I: 2 of 54 C: 3 of 55	I: 1 of 54 C: 5 of 55
Desai et al.[12] (2012)	Cardiac surgery	Patients with and without diabetes	Deep sternal wound infection	Target BG 90-120 (5.0-6.7)	Target BG 121-180 (6.7-10.0)	Postoperative for minimum of 72 h	I: 1 of 91 C: 0 of 98	BG <60 (3.3) I: 30 of 91 C: 11 of 98	I: 1 of 91 C: 1 of 98	None

Table 2. Continued

Study	Type of surgery	Population	Definition of SSI	Intervention	Control	Timing	Outcome[a]			
							SSI	Hypoglycemia	Mortality	Stroke
Emam et al.[3] (2010)	Cardiac surgery	Patients with type 2 diabetes	Wound infection (superficial, deep)	i.v. insulin infusion (Braithwaite protocol) on evening before surgery or sooner if BG ≥150 (8.3); target BG 100-150 (5.6-8.3)	s.c. insulin per sliding scale; target BG <200 (11.1)	During surgery and 48 h after surgery	I: 0 of 80 C: 5 of 40	None BG <50 (2.8)	None	
Gandhi et al.[13] (2007)	Cardiac surgery	Patients with and without diabetes	Deep sternal infections (as defined by Society of Thoracic Surgeons)	Continuous i.v. insulin infusion to maintain intraoperative BG 80-100 (4.4-5.6)	No insulin during surgery unless BG >200 (11.1), then i.v. insulin infusion	During and after surgery (not specified)	I: 6 of 185 C: 7 of 186 RR 0.9 (0.3, 2.5); (p=0.79) No difference when stratified by diabetic status	BG <60 (3.3) Intraoperative I: 1 of 185 C: 1 of 185 RR 1.01 (0.06, 15.95) During first 24 h in ICU I: 8 of 185 C: 14 of 185	I: 4 of 185 C: 0 of 186	I: 8 of 185 C: 1 of 186
Grey and Perdrizet[14] (2004)	Critical ill surgical patients	All BG ≥140 (7.8) adult surgical ICU patients with and without diabetes	SSI	i.v. insulin infusion to maintain BG 80-120 (4.4-6.7)	i.v. infusion to maintain BG 180-220 (10.0-12.2)	Postoperative throughout ICU stay	I: 2 of 34 C: 10 of 34	BG <60 (3.3) I: 32% C: 7.4% (p<0.001)		
Kirdemir et al.[4] (2008)	Cardiac surgery	Patients with diabetes	Sternal wound infection	Continuous i.v. insulin infusion; target BG 100-150 (5.6-8.3)	s.c. insulin; target BG <200 (11.1) (sliding scale)	During surgery and until day 3 after surgery	I: 1 of 100 C: 12 of 100 (p=0.003)	None	I: 2 of 100 C: 5 of 100	I: 1 of 100 C: 1 of 100
Lazar et al.[8] (2011)	Cardiac surgery	Patients with diabetes	Any sternal infection	Continuous i.v. insulin infusion; target BG 90-120 (5.0-6.7)	Continuous i.v. insulin infusion; target BG 120-180 (6.7-10.0)	During surgery and 18 h after surgery	I: 0 of 40 C: 0 of 42	BG <80 (4.4) I: 30 of 40 C: 4 of 42	None	I: 0 of 40 C: 1 of 42
Okabayashi et al.[15] (2014)	Hepato-biliary-pancreatic surgery	Patients with and without diabetes	SSI	i.v. insulin infusion; target BG 80-110 (4.4-6.1)	i.v. insulin infusion; target BG 140-180 (7.8-10.0)	During and after surgery	I: 9 of 222 C: 22 of 225 (p=0.028)	None BG <80 (4.4)	I: 0 of 222 C: 5 of 225	

Table 2. Continued

Study	Type of surgery	Population	Definition of SSI	Intervention	Control	Timing	Outcome[a]			
							SSI	Hypoglycemia	Mortality	Stroke
Yuan et al.[5] (2015)	Gastrectomy	Patients with type 2 diabetes	SSI	Continuous i.v. insulin infusion; target BG 80-110 (4.4-6.1)	s.c. bolus insulin; target BG <200 (11.1)	Postoperative	I: 5 of 106 C: 14 of 106 (p<0.03)	Severe BG <40 (2.2) I: 8 of 106 C: 1 of 106 (p=0.035)	I: 1 of 106 C: 1 of 106	
Zheng et al.[17] (2010)	Cardiac surgery (valve replace-ment)	Patients without diabetes	Nosocomial infections of deep sternal wounds	Continuous i.v. infusion to maintain BG 70-110 (3.9-6.1) (Portland protocol)	Standard care, no control for BG	During and after surgery	I: 1 of 50 C: 4 of 50	I: 3 of 50 C: 1 of 50		
Javaherforoosh Zadeh and Azemati[18] (2020)	Cardiac surgery (CABG)	Non-insulin dependent diabetic patients	Sternal wound infection	Continuous i.v. insulin infusion; target BG 100-120	Continuous i.v. Infusion; target BG <200 (no control during surgery unless BG ≥200)	During surgery (<200 in ICU in both groups)	I: 1 of 38 C: 7 of 37 (p<0.05)	Hypoglycemia I: 1 of 38 C: 1 of 37	I: 1 of 38 C: 0 of 37	I: 1 of 38 C: 1 of 37
Mohod et al.[19] (2019)	Cardiac surgery (CABG)	Patients with/ without diabetes	Sternal wound infections	Continuous i.v. insulin infusion to maintain BG 80-110 during surgery and until 48 h after surgery in ICU	Conventional insulin therapy (not given insulin unless blood sugar levels were more than 200 mg/dL) i.v. bolus insulin (4 IU) 200-250 and i.v. infusion if >200 after bolus insulin, during surgery and until 48 h after surgery in ICU	Induction, on bypass, 1 h, 2 h, 3 h after bypass, off bypass, ICU admission, 2 h intervals during 1st 24 h, 4 h intervals next 24 h (During and until 48 h after surgery)	I: 2 of 20 C: 4 of 20	Hypoglycemia (blood sugar ≤80 mg/dL I: 5 of 20 C: 0 of 20 (p=0.047)	I: 3 of 20 C: 4 of 20	I: 0 of 20 C: 1 of 20

Table 2. Continued

Study	Type of surgery	Population	Definition of SSI	Intervention	Control	Timing	Outcome[a]			
							SSI	Hypoglycemia	Mortality	Stroke
Duncan et al.[20] (2018)	Cardiac surgical procedure (coronary artery bypass grafting, valve repair/ replace-ment, or combined procedure)	Patients with diabetes	Serious infection morbidity (mediastinitis, sternal wound infection requiring surgical debridement, sepsis, or pneumonia requiring mechanical ventilatory support)	Fixed high-dose i.v. insulin infusion with dextrose 20% for BG 80-110 mg/dL	Conventional low-dose i.v. insulin infusion; target BG <150 mg/dL	During Surgery (standardized postoperative insulin treatment protocol in the ICU in both groups target BG <150 mg/ dL on post-operative day one and <120 mg/dl on day two and later. In 2009 following publication of the NICE-SUGAR trial9, the postoperative glucose target increased to <180 mg/dL)	I: 9 of 709 C: 34 of 730	Hypoglycemia (<60 mg/dL): I: 91 of 709 C: 0 of 730 Severe hypoglycemia (<40 mg/dL): I: 6 of 709 C: 1 of 730 Stroke (neurologic deficit, new postoperative focal [aphasia, decrease in limb function, hemiparesis] or global [diffuse encephalopathy with >24 h of severely altered mental status or failure to awaken postoperatively]): I: 9 of 709 C: 12 of 730 Mortality: I: 9 of 709 C: 13 of 730	I: 9 of 709 C: 13 of 730	I: 9 of 709 C: 12 of 730

SSI: surgical site infection, CABG: coronary artery bypass graft, NNIS: National Nosocomial Infection Surveillance, CDC: Center for Disease Control and Prevention, i.v.: intravenous, BG: blood glucose, ICU: intensive care unit, I: intensive, C: conventional, OR: odds ratio, RR: relative risk, s.c.: subcutaneous. [a]Values in parentheses are 95 percent confidence intervals.

Table 3. Summary of Finding Table

Use of protocols for intensive perioperative blood glucose control
Patient or population: patients with surgery
Settings: intensive protocol vs. conventional protocol for perioperative glucose control
Intervention: upper limit target level <110 mg/dL or 110-150 mg/dL

Outcomes	Illustrative comparative risksa (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Intervention				
SSI (upper limit target level <110 mg/dL)	74 per 1,000	35 per 1,000 (26 to 48)	RR 0.47 (0.35 to 0.64)	3,469 (10 studies)	⊕⊕⊕⊖ Moderate	
SSI (upper limit target level 110-150 mg/dL)	101 per 1,000	28 per 1,000 (12 to 70)	RR 0.28 (0.12 to 0.69)	921 (8 studies)	⊕⊕⊕⊖ Moderate	
Hypoglycemia (upper limit target level <110 mg/dL)	14 per 1,000	88 per 1,000 (21 to 364)	RR 6.34 (1.52 to 26.37)	3469 (10 studies)	⊕⊕⊖⊖ Low	
Hypoglycemia (upper limit target level 110-150 mg/dL)	47 per 1,000	174 per 1,000 (111 to 273)	RR 3.68 (2.34 to 5.78)	921 (8 studies)	⊕⊕⊖⊖ Low	
Stroke (upper limit target level <110 mg/dL)	12 per 1,000	17 per 1,000 (3 to 92)	RR 1.36 (0.24 to 7.57)	2283 (5 studies)	⊕⊕⊖⊖ Low	
stroke (upper limit target level 110-150 mg/dL)	24 per 1,000	11 per 1,000 (3 to 40)	RR 0.45 (0.12 to 1.67)	655 (5 studies)	⊕⊕⊖⊖ Low	
Mortality (upper limit target level <110 mg/dL)	20 per 1,000	15 per 1,000 (9 to 26)	RR 0.76 (0.45 to 1.29)	3369 (9 studies)	⊕⊕⊖⊖ Low	
Mortality (upper limit target level 110-150 mg/dL)	24 per 1,000	16 per 1,000 (6 to 46)	RR 0.68 (0.24 to 1.91)	775 (6 studies)	⊕⊕⊖⊖ Low	

SSI: surgical site infection, CI: confidence interval, RR: risk ratio. aThe basis for the assumed risk (e.g., the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

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REVIEW ARTICLE

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근거 중심의 수술부위감염 예방 진료권고안: 적절한 순환 혈액량 유지

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The Evidence-Based Practice Guidelines for Prevention of Surgical Site Infection: Maintenance of Adequate Circulating Volume Control/Normovolemia

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Sufficient tissue oxygenation is essential for collagen synthesis and wound repair and is improved by adequate arterial oxygenation. Ideally, perioperative fluid therapy prevents tissue hypoxia by maximizing the cardiac output and thus improving arterial oxygenation. However, the optimal perioperative fluid strategy remains a subject of debate. On behalf of the Korean Surgical Infection Society, the practice guidelines committee collected data and assessed the effectiveness of specific fluid management strategies compared with standard fluid regimens and to determine if certain fluid management strategies during surgery might be beneficial to prevent surgical site infection (SSI) in surgical patients. Following the intensive review and analysis, the practice guidelines committee decided to recommend that medium quality evidence shows that intraoperative goal directed fluid therapy (GDFT) has significant benefit in reducing the SSI rate compared to standard fluid management (Do, strong recommendation, medium quality of evidence).

Key Words: Practice guideline, Surgical site infection, Fluid therapy

서론

수술 중 수액 요법이 심장 출력을 극대화하여 동맥 산소를 개선함으로써 조직 저산소증을 예방할 수 있지만 최적의 수액 요법은 여전히 논쟁거리가 있다. 혈량 과부하나 저혈량 상태 모두 수술 사망률과 이환율의 증가와 관련이 있다. 혈량 과부하는 근육 산소 장력을 감소시키며, 수술적 외상으로 인한 염증으로 인한 부종에 의한 조직 내 산소 공급저

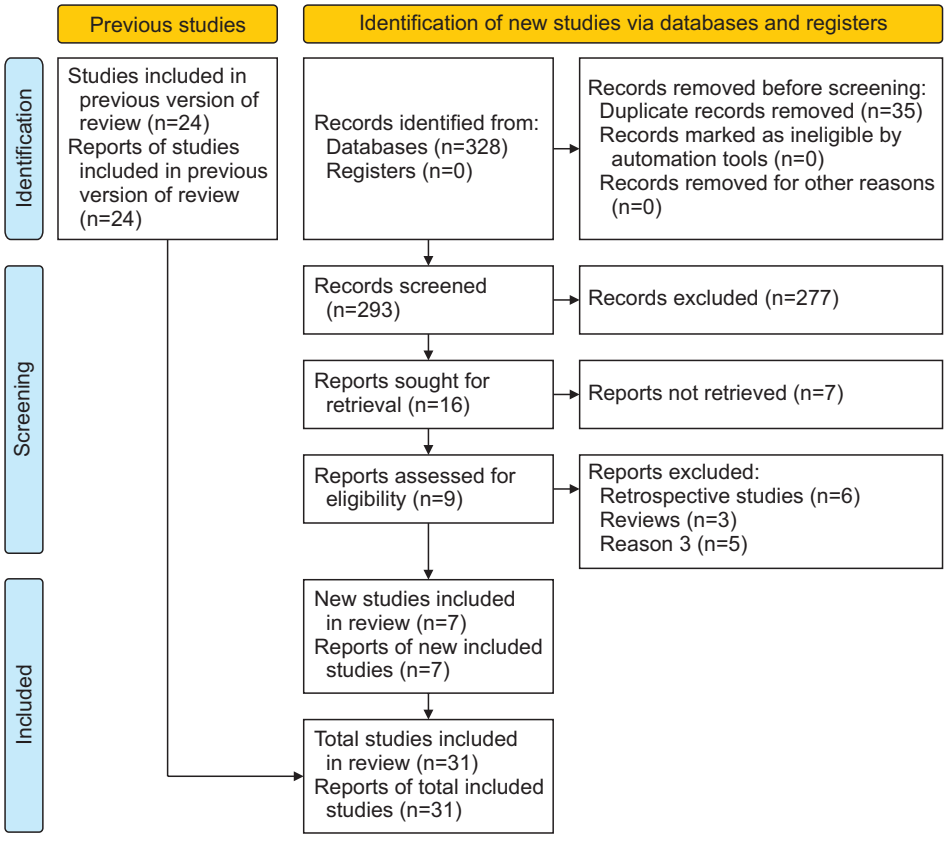

Fig. 1. Study selection. PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases and registers only. PRISMA: preferred reporting items for systematic reviews and meta-analyses.

하와 함께 조직 치유를 방해할 수 있다. 반대로 저혈량 상태는 심박출량 감소로 동맥혈 및 조직 내 저산소증을 유발한다.

최적의 수액(Colloid 또는 Crystalloid) 또는 수액 관리 전략(goal directed fluid therapy [GDFT], 자유로운 또는 제한적)은 논란의 대상으로 남아 있지만, 또한 주어진 용액의 부피에 따른 생리학적 영향은 수술 스트레스 반응의 규모에 따라 달라질 수 있으며 투여되는 용액의 부피에만 의존하지는 않는다. 현재 정상 혈량에 대한 보편적 정의나 그 평가에 대한 표준화된 방법은 없다.

따라서 본 진료권고위원회에서는 현재까지의 근거의 출처와 강도를 심층적으로 분석한 후, 표준수액요법과 비교한 특정 수액 관리전략의 효과를 평가하고 수술 중 특정 수액 관리전략이 수술 후 환자의 수술부위감염 예방에 도움이 될 수 있는지를 판단하기 위해 체계적인 검토를 실시하였다.

대상 및 연구 방법

진료권고안 개발 방법은 수용개작 방식(adaptation)으로 개발되었으며, 2016년 발표된 세계보건기구(World Health Organization, WHO) 가이드라인[1]을 기준 진료권고안으로 최신성을 보강하는 GRADE-ADOLOPMENT 방법[2]을 적용하였다. WHO 가이드라인의 권고안에서 국내 수술환경에 적용할 대상을 핵심질문으로 선정하였고, 최신성 보강을 위해 문헌 검색을 시행하여 추가하였다. 국외 논문은 MEDLINE, EMBASE, CINAHL, Cochrane으로 WHO 가이드라인에서 적용한 기간(1990년 1월 1일부터 2014년 1월 17일)을 최신까지 연장하여 검색하였고, 국내 논문 검색은 KMBASE, KoreaMed를 기간 제한 없이 검색하였으며, 논문 검색은 2021년 1월 12일에 수행되었다(Fig. 1, Table 1).

Table 1. 포함 및 배제기준

대상환자(P)	수술 대상 환자
중재(I)	적절한 순환 혈액량 유지를 위한 목표 지향 수액 치료
비교군(C)	표준 수액 치료
결과(O)	수술부위 감염률 및 수술부위감염으로 인한 사망률
연구설계(S)	연구 설계를 제한하지 않음.
대상 사용자	수술을 시행하는 2, 3차 의료기관의 의사 및 의료종사자

P: patient, I: intervention, C: comparator/comparison/control, O: outcomes, S: setting.

핵심질문 7. 수술 중 적절한 순환 혈액량 유지를 위한 Goal Direct Fluid Therapy (GDFT, 목표 지향 수액 치료)가 수술부위감염에 영향을 미치는가?

근거수준: 근거수준평가와 근거의 강도와 한계

분석에 포함된 연구는 기존 WHO 가이드라인에 사용된 24개의 관찰 연구[3-26]와 추가된 7개의 무작위 연구[27-33]이다(Table 2). 수술 중에는 적절한 순환 혈액량 유지를 위한 GDFT (목표 지향 수액 치료)를 시행하는 것이 표준수액 치료보다 이득이 있는지에 대한 결과 보고는 16개의 randomized controlled trial (RCT) 연구[3-16,32,33]에서 확인할 수 있었다(risk ratio [RR]=0.61, 95% confidence interval [CI]: 0.43-0.86). 수술 후에도 적절한 순환 혈액량 유지를 위한 GDFT (목표 지향 수액 치료)를 시행하는 것이 표준수액 치료보다 이득이 있는지에 대한 2개의 RCT 연구[24,25] 결과 보고가 있었다(RR=0.32, 95% CI: 0.17-0.62).

수술 중에는 적절한 순환 혈액량 유지를 위한 GDFT (목표 지향 수액 치료)를 시행하는 것에 대한 전반적으로 중간 수준의 근거로 인해 강력하게 권고하였다. 그러나 수술 후에 적절한 순환 혈액량 유지를 위한 목표 지향 수액 치료를 시행하는 것에 대해서는 검토된 근거의 낮은 수준으로 인하여 선택적 권고를 채택하였다(Table 3).

결론

1. 수술 중에는 적절한 순환 혈액량 유지를 위한 목표 지향 수액 치료(GDFT, Goal Direct Fluid Therapy)를 시행할 것을 권고한다.

(일반적 권고[Do, Strong recommendation], 중간 수준의 근거[Moderate quality of evidence])

2. 수술 후에는 적절한 순환 혈액량 유지를 위한 목표 지향 수액 치료(GDFT, Goal Direct Fluid Therapy)를 시행할 것을 권고한다.

(선택적 권고[Do, Conditional recommendation], 낮은 수준의 근거[Low quality of evidence])

Table 2. Evidence Table

Study	Type of surgery	End point	Intervention	Control	Timing	Modality of optimi-zation	Outcome
Benes et al.[15] (2010)	Major abdominal surgery (colo-rectal, pancreatic, vascular)	Vigileo™ (Vigileo, Nyon, Switzerland) monitor/flotrack SVV<10% or CI >10% to previous fluid challenge.	Bolus of 3 mL/kg colloids and infusion of dobutamine to maintain CI between 2.5-4 L/min/m^2, ephedrine boluses 5-15 mg or norepinephrine to treat a fall in systolic arterial pressure <90 mmHg or MAP >70 mmHg.	Additional fluids or vasoactive substances to maintain blood pressure, diuresis and CVP in normal ranges (MAP >65 mmHg, heart rate <100 bpm, CVP 8-15 mmHg urine output >0.5 mL/kg/hour).	Intra-operative	Fluids and inotropes	Wound infection/dehiscence I: 2/60 C: 5/60 Intra-abdominal infection (deemed as severe, that is, life disabling or threatening) I: 1/60 C: 4/60 OR/p-values not specified
Boyd et al.[23] (1993)	Emergency/elective major abdominal or vascular surgery or other major operations	PAC: DO2>600 mL/min/m^2	Deliberate increase of oxygen delivery index to greater than 600 mL/min/m^2 by use of dopexamine hydrochloride infusion.	Best standard perioperative care.	Pre- and post-operative	Fluids and inotropes	Wound infection (positive wound swab cultures) I: 3/53 C: 3/54 Abdominal abscess (positive cultures from localized intra-abdominal collection) I: 0/53 C: 1/54 OR/p-values not specifie
Brandstrup et al.[17] (2003)	Elective colorectal resection	Haematocrit 25%-35%.	A) Restricted • No preloading • No replacement of third space loss • 500 mL glucose 5% in water less oral fluid intake during fast • Volume-to-volume with HAES 6% with allowance for maximum 500 mL extra. Blood component therapy started at approximate loss >1,500 mL dependent on hematocrit.	B) Standard • Preload: 500 mL HAES 6% • Third space loss: normal saline • 0.9%: 7 mL/kg/hour, first hour; 5 mL/kg/hour, second and third hours; 3 mL/kg/hour, following hours • Loss during fast: 500 mL of normal saline 0.9% independent of oral intake • Blood loss: loss up to 500 mL: 1,000-1,500 mL of normal saline; loss >500 mL, additional HAES 6%.	Intra-operative	Fluids	Superficial wound infection, haematoma or dehiscence I: 9/69 C: 18/72 Anastomotic leakage (requiring operation) I: 1/69 C: 4/72 Leakage of the rectum (drained deep abscess) I: 2/69 (occurred following re-operation for anastomotic leakage/necrosis of stoma) C: 2/72 Peritonitis without leakage I: 1/69 C: 0/72 Adverse events: not specified LF: specified Overall complications: 21 vs. 40 p=0.003 OR/p-values not specified

Table 2. Continued

Study	Type of surgery	End point	Intervention	Control	Timing	Modality of optimi-zation	Outcome
Forget et al.[3] (2010)	Major abdominal (upper or lower gastrointestinal, hepato-biliary)	Masimo SET® (Masimo, Irvine, CA, USA) pulse oximeter PVI >13% during 5 minutes.	Bolus of 500 mL crystalloids with 2 mL/kg/hour continuous infusion. Bolus of HAES 250 mL every 5 minutes until PVI <13%, norepinephrine to maintain MAP >65 mmHg.	Bolus of 500 mL crystalloids with 4-8 mL/kg/hour continuous infusion. Bolus of colloids if acute blood loss >50 mL or if MAP <65 mmHg or CVP <6 mmHg. If MAP <65 mmHg was unresponsive to fluids, norepinephrine was given.	Intra-operative	Fluids	Infection of surgical site: I: 8/41 C: 8/41 p=1.0 Other infections (pulmonary, line-related, other abdominal) I: 6/41 C: 7/41 Leakage of anastomosis I: 5/41 C: 5/41
Gan et al.[4] (2002)	Elective general, urology, gynaecological	Oesophageal doppler: SV optimization with FTc between 0.35-0.4 seconds.	5 mL/kg lactated Ringer's solution and Ringer's solution at a rate of 5 mL/kg/hour. Protocol group: bolus of fluids administered and guided by Doppler estimations of SV and FTc. • FTc <0.35 seconds 200 mL aliquot of HAES 6% in saline (bolus repeated if FTc <0.35 seconds). When 20 mL/kg HAES 6% was given, lactated Ringer's solution was used for further bolus.	5 mL/kg lactated Ringer's solution and Ringer's solution at a rate of 5 mL/kg/hour. Control group: Bolus of 200 mL fluid given when urinary output <0.5 mL/kg/hour or an increase in heart rate >20% above baseline or >100 beats/minute or a decrease in mean systolic blood pressure less than 20% below baseline or less than 90 mmHg or a CVP <20% baseline.	Intra-operative	Fluids	Wound infection: I: 4/50 C: 5/50 p=not significant
Harten et al.[5] (2008)	Emergency abdominal surgery	LiDCO™ cardiovascular system (Lidco, London, UK): pulse pressure variation less than 10%.	Fluid boluses of 250 mL HAES (Voluven®) were administered over 15 minutes during the operation if the pulse pressure varied by more than 10%.	Standard of care by clinical team in charge.	Intra-operative	Fluids	I: n=14 Fluid balance, 1,910 mL Infection (I): 3/14 Wound infection: 1/14 C: n=15 Fluid balance, 1,515 mL Infection: 4/15 Wound infection: 2/15 p (fluid balance)=0.481 p (intervention)=0.742 p (wound infection)=0.584
Holte and Foss[18] (2007)	Elective colonic surgery	None	Restrictive fluid • 7 mL/kg/hour RL, first hour • 5 mL/kg/hour, subsequent hours • (Voluven®: 7 mg/kg) • Postoperative: no intravenous fluids	Liberal fluids • 10 mL/kg RL preload • 18 mL/kg/hour RL • Voluven®: 7 mg/kg Postoperative: 10 mL/kg RL	Intra-operative	Fluids	I: n=16 Wound infection: 1/16 (6%) C: n=16 Wound infection: 0/16 (0%) OR/p-value not specified

Table 2. Continued

Study	Type of surgery	End point	Intervention	Control	Timing	Modality of optimi-zation	Outcome
Kabon et al.[19] (2005)	Open elective colon resection	Urinary output >1 mL/kg/hour or mean arterial blood pressure	Small fluid management • Maintenance: 8-10 mL/kg/hour lactated Ringer's solution intraoperatively and first hour postoperatively.	Large fluid management • Fluid bolus of 10 mL/kg before induction of anesthesia • Maintenance: 16-18 mL/kg/hour lactated Ringer's solution intra operatively and first hour post-operatively. Additional fluid given to maintain urinary output >1 mL/kg/hour or mean arterial blood pressure >70% pre-induction value.	Intra-operative	Fluids	I: n=124 Superficial (6.5%)=8/124 Deep 5.7%=7/124 Peritoneal 0.0% Any CDC infection 10.5%= 13/124 Infection by pus and positive culture (5.7%)=7/124 Total infection by either criterion: 11.3%=14/124 C: n=129 Superficial (3.9%) =5/129 Deep 5.4%=7/129 Peritoneal 2.3%=3/129 Any CDC infection 7.0%=9/129 Infection by pus and positive culture (4.7%)=6/129 Total infection by either criterion: 8.5%=11/129 p (superficial)=0.354 P (deep)=0.939 P (peritoneal)=0.247 p (any CDC infection)=0.322 p (total infection)=0.462
Lobo et al.[20] (2002)	Elective hemi-colectomies and sigmoid-ectomies for cancer	PAC: DO2> 600 mL/min/m^2	Restricted treatment • No more than 77 mmol sodium and 2 L water per day (0.5 L 0.9% saline and 1.5 L 5% dextrose) or 2 L 4% dextrose (2 L 4% dextrose/0.18% saline)	Standard • Standard postoperative fluids as usual on surgical ward. • At least 154 mmol sodium and 3 L water per day (1 L 0.9% saline and 2 L dextrose 5%).	Post-operative	Fluids	Wound infection: I: 0/10 C: 1/10 p=not significant
Lopes et al.[16] (2007)	High-risk surgery (upper/lower gastro-intestinal, hepato-biliary, urology, other)	Variation in arterial pulse pressure (ΔPP) (IBP plus; Dixtal; Philips Healthcare, Amsterdam, the Netherlands); ΔPP ≤10%	Additional hydroxyethylstarch 6% boluses to minimize and maintain ΔPP ≤10%	Fluid at the discretion of the anaesthetist.	Intra-operative	Fluids	Abdominal infection: I: 3/17 C: 4/16 Anastomotic leak: I: 0/17 C: 1/16

Table 2. Continued

Study	Type of surgery	End point	Intervention	Control	Timing	Modality of optimi-zation	Outcome
Mayer et al.[6] (2010)	Major abdominal surgery (intestine resection, gastric resection, liver resection, esophageal resection, Whipple)	Vigileo™ monitor/ flotrac sensor: CI ≥2.5 L/min/m^2	SVI <35 mL/m^2: 500 mL crystalloids or dobutamine 10/hour+250 mL colloids, SVI >35 mL/mg^2: dobutamine 10 mL/hour, MAP <65 mmHg: norepinephrine 5 mL/hour.	MAP between 65-90 mmHg, CVP between 8-12 mmHg and urinary output >0.5 mL/kg/hour. Volume challenge with 500 mL crystalloids or 250 mL colloids, consider norepinephrine/ dobutamine/vasodilators when unresponsive.	Intra operative	Fluids and inotropes	Wound infection (clinical diagnosis): I: 3/30 C: 8/30 Abdominal infection (abdominal CT): I: 1/30 C: 4/30 OR/p-values not specified
McKendry et al.[24] (2004)	Elective cardiac surgery	Oesophageal doppler: stroke volume index >35 mL/m^2.	SV >35 mL/m^2 using repeated colloid challenges with nitrates and inotropes.	Management at discretion of the intensive care unit. Monitoring arterial and pressure and CPV with markers of tissue perfusion, such as urine output.	Post-operative	Fluids and inotropes	Chest/sternal wound infection: I: 1/89 C: 4/85 Infected leg wound: I: 1/89 C: 1/85 OR/p-values not specified
Mythen and Webb[7] (1995)	Elective cardiac surgery	Oesophageal doppler: SV optimization and rise in CVP <3 mmHg.	200 mL intravenous colloid boluses over 10 minutes until targets reached.	Routine administration of crystalloid or colloids.	Intra-operative	Fluids	Chest infection: I: 0/30 C: 1/30 OR/p-values not specified
Nisanevich et al.[21] (2005)	Major elective intra-abdominal surgery (colon/ rectum, small bowel resections, gastric resections, and pancreatico-duodenectomy/ partial pancreas resections)		Restricted protocol group 4 mL/kg/h RL solution throughout intraoperative period.	Liberal protocol group • Bolus of 10 mL/kg RL solution before skin incision • 12 mL/kg/hour RL solution throughout intraoperative period Fluid boluses provided when needed.	Intra-operative	Fluids	I: n=77 Wound dehiscence/infection: 7/77 Peritonitis/ anastomotic leak/intra-abdominal abscess: 2/77 C: n=75 Wound dehiscence/infection: 11/75 Peritonitis/ anastomotic leak/intraabdominal abscess: 3/75 p=not significant
Pearse et al.[25] (2005)	Elective or emergency major general surgery (vascular, upper and lower gastro-intestinal, hepato-biliary, urology)	LiDCO™ cardiac sensor system: DO2 >600 mL/min/m^2, SV >10%	GDFT challenge: 250 mL intravenous colloid solution until 10% rise in SV >20 minutes. Dopexamine if DO2I <600 mL/min.	Control fluid challenge: 250 mL intravenous colloid until 2 mmHg rise in CVP achieved >20 minutes.	Post-operative	Fluids and inotropes	Wound infection: I: 4/62 C: 20/60 Abdominal infection: I: 4/62 C: 5/60 Anastomotic leak: I: 1/62 C: 1/60 OR/p-values not specified

Table 2. Continued

Study	Type of surgery	End point	Intervention	Control	Timing	Modality of optimi-zation	Outcome
Pillai et al.[8] (2011)	Radical cystectomy	Oesophageal doppler: SV optimization with FTc>0.35 seconds.	Fluid challenge 3 mL/kg over 10 minutes with colloids until targets met.	Standard intraoperative fluids at discretion of the anesthetist.	Intra-operative	Fluids	Wound infections: Superficial: I: 1/32 C: 8/34 Deep: I: 1/32 C: 2/34 Combined: I: 2/32 C: 10/34 p<0.01
Sandham et al.[9] (2003)	Urgent or elective major abdominal, thoracic, vascular, or orthopaedic surgery	PAC: CI >3.5 and <4.5 L /minute/m^2, 550 < DO2 <600 mL/minute/m^2, MAP >70 mmHg, PCWP <18 mmHg	Fluid loading, inotropic therapy, vasodilator therapy, vasopressors for hypotension and blood transfusion for a hematocrit of less than 27% (guided by the use of a pulmonary-artery catheter placed before surgery).	Measurement of CVP (standard care without the use of a pulmonary artery catheter).	Intra-operative	Fluids and inotropes	Wound infections: I: 66/941 C: 83/965 p=0.23
Scheeren et al.[10] (2013)	High risk surgical patients (major abdominal surgery and radical cystectomy)	Vigileo™ FlowTrac, SVV >10%	200 mL HAES infused over 10 minutes until SVV <10%.	Treatment according to a standardized approach.	Intra-operative	Fluids	Wound infections: I: 0/26 C: 7/26 OR/p-values not specified
Senagore et al.[11] (2009)	Elective laparo-scopic segmental colectomy	Oesophageal Doppler probe (EDM™, Deltex, Chichester, UK) SV increase >10%	GD-H (Hetastarch) • Maintenance regimen of 5 mL/kg/h RL continued during surgery • 200 mL aliquot of HAES 6% • Bolus repeated until SV >10% increased GD-LR • Maintenance regimen of 5 mL/kg/hour, RL continued during surgery • 300 mL aliquot of RL • Bolus repeated until SV >10% increased.	Standard • Maintenance regimen of 5 mL/kg/h RL continued during surgery • Boluses given when triggered by haemo-dynamic variables.	Intra-operative	Fluids	Wound/infectious complications: GD-H: 6/21 GD-LR: 4/21 C: 1/22 OR/p-values not specified
Smetkin et al.[12] (2009)	Off pump cardiac bypass surgery	PiCCO Plus® (Pulsion Systems, Feldkirchen, Germany) monitor: ITBVI 850 to 1000 mL/m, $ScvO_2$ >60%	HAES (200 kDa, 6% Hemohes®, B.Braun, Melsungen, Germany), 500 mL over 30 minutes up to max 2 g/kg stepwise.	Fluid therapy based on CVP, HR, and MAP.	Intra-operative	Fluids and inotropes	Wound infection I: 1/20 C: 3/20 p=not significant

Table 2. Continued

Study	Type of surgery	End point	Intervention	Control	Timing	Modality of optimi-zation	Outcome
Venn et al.[13] (2002)	Ortho-paedic surgery	Oesophageal doppler: SV optimization with FTc >0.4 seconds	Repeated 200 mL gelofusine fluid challenges guided by central venous pressure (n=31) or oesophageal Doppler ultrasonography (n=30).	Intravenous fluids as thought appropriate by anaesthetist (conventional intraoperative fluid management, n=29).	Intra-operative	Fluids	Wound infection: CVP: 0/31 DOP: 0/30 Conventional: 2/29 OR/p-values not specified
Vermeulen et al.[26] (2009)	Elective major abdominal surgery (gastric resection, bowel procedures (small bowel, colon and/or rectum), bile duct restoring, pancreatico-duodenec-tomies or partial resections of the pancreas)	None	Restricted intravenous fluid regime • 1.5 L/24 hour RL	Hospital standard intravenous fluid regime • 2.5 L/24 hour RL	Post-operative	Fluids	Wound infection: I: 5/30 C: 1/32 Leakage of anastomosis: I: 6/30 C: 1/32 Wound dehiscence I: 1/30 C: 0/32 OR/p-values not specified
Wakeling et al.[14] (2005)	Elective major bowel surgery	Oesophageal Doppler: SV optimization and rise in CVP <3 mmHg	Routine cardiovascular monitoring as standard and 250 mL boluses of colloid solution or gelofusine. Fluid challenge was repeated if the SV failed to rise by 10% and/or the CVP rose by 3 mmHg or more.	Routine cardiovascular monitoring and CVP measurements. CVP was used to guide intravenous fluid administration and kept between 12-15 mmHg.	Intra-operative	Fluids	"Complication type": "Infectious" (unclear): I: 14/64 C: 11/64 p=0.532 "Wound": I: 5/64 C: 4/64 p=0.748 Anastamotic leakage: I: 1/64 C: 2/64
Wilson et al.[22] (1999)	Elective major surgery (repair of aortic or common iliac aneurysm, resection of upper gastro-intestinal malignancy, anterior resection, cystectomy)	PAC: DO2 >600 mL/min/m^2	1 L Hartmann's solution bolus, human albumin solution 4.5% until pulmonary artery occlusion pressure >12 mmHg achieved. Haemoglobin concentration <110 g/L red blood cell transfusion instead of albumin. Inotrope suppletion 0.025 mg/kg/min for adrenaline and 0.125 mg/kg/min for dopexamine.	No standardized protocol	Pre-operative	Fluids and inotropes	Wound sepsis: Adrenaline 3/46, Dopexamine 0/46 C: 3/46 Abdominal sepsis: Adrenaline 2/46, Dopexamine 0/46 C: 2/46 Anastomotic breakdown: Adrenaline 0/46, Dopexamine 0/46 C: 3/46 OR/p-values not specified

Table 2. Continued

Study	Type of surgery	End point	Intervention	Control	Timing	Modality of optimi-zation	Outcome
Arsian-Carlon et al.[27] (2020)	Open Radical Cystectomy	EV1000 clinical platform via a Flotrac sensor: SV augmentation >10%. SV variation <13%.	GDFT challenge: Preoperative: • 250-mL balanced crystalloid boluses until their SV was no longer responsive. Intraoperative: • 3 mL/kg/h, and albumin 5% to maintain SV variation <13%. packed red blood cells to maintain a hemoglobin level of at least 7 mg/dL. Postoperative: • 1 mL/kg/h.	Control: • Maintenance of 10 mL/kg/h of balanced crystalloid solution (Normosol-R, ICU Medical Inc., USA) with blood loss replaced 1:1 with albumin 5% or packed red blood cells to maintain a hemoglobin level of at least 7 mg/dL. • Postoperative; 1.5 mL/kg/ h	Intra- and post-operative	Fluids, albumin, and packed red blood cells	Wound infection: C: 42/141 I: 32/142 Sepsis C: 14/141 I: 14/142 Intraabdominal abscess C: 11/141 I: 12/142
Calvi-Vecino et al.[28] (2018)	Major abdominal, urological, gynaecological, or orthopaedic surgery	Oesophageal Doppler: MAP >70 mmHg, and CI ≥2.5 L/min/m^2	GDFT challenge; 250 mL boluses crystalloid solution or colloid boluses until SV increase <10% inotropes to reach a minimum CI (2.5 L/min/m^2) vasopressors, if MAP <65 mm Hg	Control: Balanced crystalloid fluids (Ringer's lactate) at 3-5 mL/kg/h for laparoscopic surgery, or 5-7 mL/kg/h for open surgery. Vasopressors, and inotropes at the discretion of the anesthetist.	Intra-operative	Fluids, inotropes, and vas-opressors	SSI (superficial) C: 10/211 I: 2/209 SSI (deep) C: 17/211 I: 4/209 SSI (organ-space) C: 7/211 I: 6/209
Davies et al.[29] (2019)	Repair of a proximal femoral fracture	ClearSight™ (Edwards Lifesciences, Irvine, USA): MAP ≤30% of baseline	GDFT challenge; 250 mL boluses crystalloid solution until SV increase <10% vasopressors at a rate of 10 mL/h inotrope at the discretion of clinicians	Conventional fluid therapy; fluid management and administration of inotrope or vasopressor therapy were at the discretion of the anaesthetist	Intra-operative	Fluids, inotropes, and vas-opressors	Wound infection C: 0/120 I: 2/121 Sepsis C: 8/120 I: 8/121
Kim et al.[30] (2018)	Free flap reconstruction for head and neck	FloTrac Sensor (Edwards Lifesciences, Irvine, CA, USA): SV variation <12%, CI ≥2.5 L/min/m^2 and MAP≥65 mmHg.	GD-H (Hetastarch) HAES was administered for 10 min if the SV variation was ≥12% If the CI <2.5 L/min/m^2, dobutamine starting at 3 μg/kg/min was administered and titrated. If the MAP <65 mmHg, then a bolus dose ≥4 mg of ephedrine was administered and norepinephrine starting at 0.03 mL/kg/min was administered and titrated	Conventional haemodynamic therapy: If the MAP <65 mmHg or the urine output was <0.5 mL/kg/h, then 200 mL of Plasma Solution A was administered for 10 min within the range of the CVP (<14 mmHg). If the MAP was <65 mmHg, even after additional fluid was administered, then ephedrine ≥4 mg or norepinephrine starting at 0.03 lg/kg/min was administered and titrated at the anesthesiologist's discretion.	Intra-operative	Fluids, inotropes, and vas-opressors	Wound infection C: 4/31 I: 4/31

Table 2. Continued

Study	Type of surgery	End point	Intervention	Control	Timing	Modality of optimi-zation	Outcome
Luo et al.[31] (2017)	Elective craniotomy (brain tumor resection, brain abscess, or intracranial aneurysm)	The FloTrac/Vigileo system (Edwards Lifesciences, Irvine, CA, USA)	GDFT challenge; • Fluid maintenance was restricted to 3 mL/kg/h of a crystalloid solution • Colloid boluses were allowed only in case of hypotension (MAP<65 mmHg) associated with a CI <2.5 L/min/m^2 and a SV variation >15% • In case of hypotension with a CI >2.5, the recommendation was to give a vasopressor. If CI was <2.5 and SVV <15%, the recommendation was to give an inotrope.	No recommendation	Intra-operative	Fluids, inotropes, and vas-opressors	Wound infection C: 0/72 I: 0/73
Pestaña et al.[32] (2014)	Open colorectal surgery, gastrectomy, or small bowel resection	Maintaining both a MAP ≥65 mmHg and a cardiac index (CI) ≥2.5 L/min/m^2	GDT; • For intravascular volume replacement, crystalloids (RL or saline 0.9%) were infused following standard procedures • Both the MAP and the CI were assessed every 5 minutes, and volume boluses (250 mL colloid in 10 minutes, starch or gelatin) and/or vasoactive drugs (dobutamine, norepinephrine) were added as necessary to achieve the hemodynamic goals. • The protocol was instituted after the induction of anesthesia and continued for 24 hours after ICU admission.	The institution's standard of care; fluids and vasoactive drugs at the discretion of the anesthesiologist, and the ICU specialist	Intra- and post-operative	Fluids, inotropes, and vas-opressors	Wound infection C: 14/70 I: 7/72 RR: 0.46 (0.19-1.13) Intraabdominal infection C: 10/70 I: 6/72 Anastomotic leak C: 5/70 I: 2/72 RR: 0.43 (0.08-2.13)
Piljic et al.[33] (2016)	Elective minilaparotomy abdominal aortic aneurysm repair	None	Restrictive fluid regimen; • Intraoperative fluid intake to be 10 mL/kg/h • Between 70 and 100 mL/h the three consecutive postoperative days.	Standard fluid administration; • Intraoperative fluid intake to be 15 mL/kg/h • Postoperative fluid intake was 150-200 mL/h	Intra- and post-operative	Fluid	Wound infection C: 0/30 I: 0/30 Other infections C: 2/30 I: 0/30

SVV: stroke volume variation, CI: cardiac index, CVP: central venous pressure, MAP: mean arterial pressure, I: intervention, C: control, OR: odds ratio, SSI: surgical site infection, PAC: premature atrial contraction, HAES: hydroxyethyl starch, LF: lost to follow-up, PVI: pleth variability index, SV: stroke volume, FTc: corrected flow time, CDC: Centers for Disease Prevention and Control, RL: Ringer's lactate, GD-H: goal-directed therapy with hetastarch, GD-LR: goal-directed therapy with lactated Ringer's solution, PCWP: pulmonary capillary wedge pressure, DOP: Doppler ultrasonography, GDFT: goal directed fluid therapy, RR: risk ratio.

Table 3. Summary of Finding Table

For
Patient or population: patients with
Settings:
Intervention:

Outcomes	Illustrative comparative risksa (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk Control	Corresponding risk				
GDFT vs. standard fluid management (intraoperative)						
SSI	107 per 1,000	65 per 1,000 (46 to 92)	RR 0.61 (0.43 to 0.86)	3,698 (18 studies)	⊕⊕⊕⊖ Moderate	
Restrictive vs. standard fluid management (intraoperative)						
SSI	154 per 1,000	120 per 1,000 (71 to 203)	RR 0.78 (0.46 to 1.32)	578 (4 studies)	⊕⊖⊖⊖ Very low	
GDFT vs. standard fluid management (postoperative)						
SSI	207 per 1,000	66 per 1,000 (35 to 128)	RR 0.32 (0.17 to 0.62)	296 (2 studies)	⊕⊕⊖⊖ Low	
Restrictive vs. standard fluid management (postoperative)						
SSI	31 per 1,000	99 per 1,000 (18 to 565)	RR 3.18 (0.56 to 18.07)	104 (2 studies)	⊕⊖⊖⊖ Very low	

GDFT: goal directed fluid therapy, SSI: surgical site infection, CI: confidence interval, RR: risk ratio. aThe basis for the assumed risk (e.g., the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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REVIEW ARTICLE

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근거 중심의 수술부위감염 예방 진료권고안: 수술포

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The Evidence-Based Practice Guidelines for Prevention of Surgical Site Infection: Surgical Drapes

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In the effort to reduce postoperative infection, there must be clear evidence that the use of surgical drape is really effective, and there must be evidence-based results to determine whether the use of disposable surgical drape and the use of recycled surgical drape show different results. In addition, there should be a conclusion on whether the use of adhesive surgical drape is recommended? On behalf of the Korean Surgical Infection Society, the practice guidelines committee collected data regarding use of surgical drape. Following the intensive review and analysis, the practice guidelines committee decided to recommend that disposable sterile surgical drape or sterilized recycled drape can be used during surgery to prevent surgical site infection (Do, strong recommendation, low quality of evidence). And adhesive surgical drape can be used to prevent surgical site infection (Do, strong recommendation, very low quality of evidence).

Key Words: Surgical drape, Surgical site infection, Adhesive

서론

수술 후 감염을 줄이고자 많은 노력들이 동반되고 있고 그중 하나가 수술 중 소독포의 사용이다. 수술 소독포의 사용이 과연 우리가 기대하고 있는 결과인 수술 후 감염을 줄일 수 있는지 알아보고자 하였고 수술포의 사용이 감염을 줄일 수 있다면 일회용 수술 소독포 사용하는 것과 재활용된 수술 소독포 사용하는 것이 수술 후 발생하는 감염 발생에 어떠한 결과를 나타내고 있는지 확인하고자 하는 노력이 필요해 보인다. 또한 근래 사용되고 있는 접착성 수술포의 사용이 수술 후 감염을 줄이기 위해 권고될 수 있는 근거가 있는지에 관하여 알아보고 진료지침을 마련하고자 하였다.

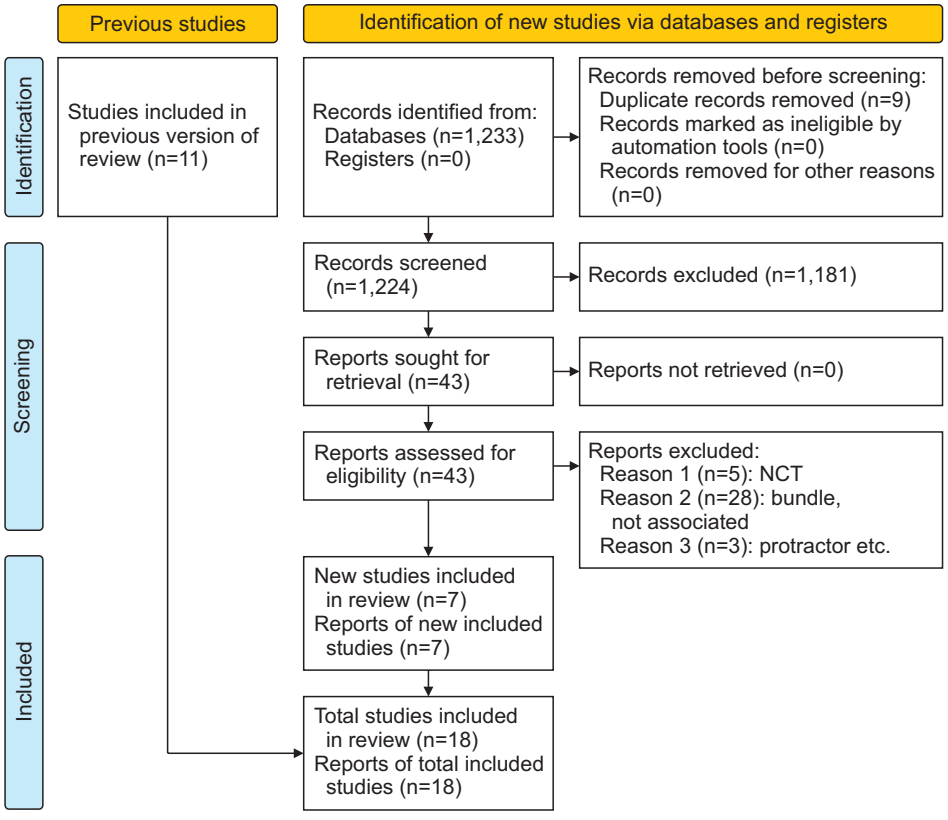

Fig. 1. Study selection. PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases and registers only. PRISMA: preferred reporting items for systematic reviews and meta-analyses.

대상 및 연구 방법

진료권고안 개발 방법은 수용개작 방식(adaptation)으로 개발되었으며, 2016년 발표된 세계보건기구(World Health Organization, WHO) 가이드라인[1]을 기준 진료권고안으로 최신성을 보강하는 GRADE-ADOLOPMENT 방법[2]을 적용하였다. WHO 가이드라인의 권고안에서 국내 수술환경에 적용할 대상을 핵심질문으로 선정하였고, 최신성 보강을 위해 문헌 검색을 시행하여 추가하였다. 국외 논문은 MEDLINE, EMBASE, CINAHL, Cochrane으로 WHO 가이드라인에서 적용한 기간(1990년 1월 1일부터 2014년 12월 31일)을 최신까지 연장하여 검색하였고, 국내 논문 검색은 KMBASE, KoreaMed를 기간 제한 없이 검색하였으며, 논문 검색은 2021년 1월 12일에 수행되었다(Fig. 1, Table 1).

핵심질문 8. 수술부위감염을 감소시키기 위한 수술포의 종류 및 사용방법은?

근거수준: 근거수준평가와 근거의 강도와 한계

근거 검토의 목적은 소독된 일회용 수술포를 사용하는 것이 재활용 수술포를 사용하는 것보다 감염 예방에 도움이 되는지 여부, 소독된 접착성 수술포가 수술부위감염 예방을 위해 사용되어야 하는가에 대한 점이다.

수술 시행 시에는 소독된 수술포를 사용하는 것이 좋다. 일회용 또는 재활용 수술포의 감염 차이의 연구 결과는 어느 것이 좋은지에 대해서 결론이 나지 않은 상태다. 2개의 무작위 대조군 연구와 3개의 관찰연구에 따르면 일회용을 사용하는 것이 재활용과 비교하여 수술 후 감염률에 있어 좋을 듯 결론을 내지만 근거가 부족하므로 일회용 또는 재활용 수술포와 가운 둘 모두를 사용할 수 있다(선택적 권고) (Tables 2, 3).[3-8]

Table 1. 포함 및 배제기준

대상환자(P)	대수술을 시행 받는 환자
중재(I)	일회용 수술포, 접착성 수술포 사용
비교군(C)	소독된 재활용 수술포, 비접착성 수술포 사용
결과(O)	수술부위 감염률 및 수술부위감염으로 인한 사망률
연구설계(S)	연구 설계를 제한하지 않음.
대상 사용자	수술을 시행하는 1-3차 의료기관의 의료진

P: patient, I: intervention, C: comparator/comparison/control, O: outcomes, S: setting.

접착성 수술포가 비 접착성군과 비교해서 수술 부위 감염률에서 크게 차이가 없다.

5개의 무작위 대조군 연구(임상적 근거단계 낮음) 결과 중 4개의 연구에서는 두군에서 감염 예방 효과의 차이가 없었으나 2020년에 발표된 1,187명의 환자를 대상으로 한 연구에서는 risk ratio가 0.65로 줄어들고 있음을 발표하였다. 전체적으로 접착성 수술포가 수술 부위 감염을 예방한다는 근거는 아직은 부족하다(선택적 권고) (Tables 2, 3).[9-20]

일회용 또는 재활용 수술포에 체액이 스며들 경우 의료팀이 그 체액에 노출될 수 있으며 또한 환자에게도 위험할 수 있다. 이상적인 수술포는 미생물의 이동을 방지할 만한 체액 불투과성이 있어야 한다. 따라서 판매되는 일회용 또는 재활용 수술포는 모두가 체액에 불 투과성이다.

결론

1. 수술 부위 감염 예방을 위해 수술 중 소독된 일회용 수술 포 또는 소독된 재활용 수술 포를 사용할 수 있다.

(선택적 권고[Do, Conditional recommendation], 낮은 수준의 근거 근거[Low quality of evidence])

2. 수술 부위 감염을 예방하기 위해 소독과 관계없이 접착성 수술포를 사용할 수 있다.

(선택적 권고[Do, Conditional recommendation], 매우 낮은 수준의 근거[Very low quality of evidence])

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Table 2. Evidence Table

Study	Type and duration of study/setting	Intervention	Comparator	Primary outcome	Results	Other comments/limitations
Comparison 1: Single-use disposable drapes and/or surgical gowns vs. reusable drapes and/or surgical gowns						
Bellchambers et al.[3] (1999)	RCT 18 months (July 1995-December 1996) Australia 505 coronary artery surgery patients Each patient followed up for 3 months Tertiary referral centre for cardiac surgery	Disposable paper drape system including an iodophor- impregnated adhesive plastic drape, which covered the central thorax and abdomen (no further specifications for this type of drape). The operating surgeon, assistants and scrub nurses wore gowns of the same material as the drapes.	Reusable fabric drapes (not specified) including an iodophor-impregnated adhesive plastic drape covering the anterior thorax. The operating surgeon, assistants and scrub nurses wore gowns of the same material as the drapes.	SSI using the wound scoring system ASEPSIS (Additional treatment, the presence of Serous discharge, Erythema, Purulent discharge and Separation of the deep tissues, the Isolation of bacteria and the duration of inpatient Stay). The total score used to reflect the severity of infection is as follows: 0–healing 11–of healing 21–wound infection 31–wound infection	Sternal wounds: Intervention: 13/250 Comparator: 12/236 p=0.87 Leg wounds: Intervention: 27/234 Comparator: 31/216 p=0.78	Allocation was stratified according to whether or not the patient had previous coronary artery surgery. Patients were allocated using sealed envelopes containing a series of computer-generated random numbers. Outcome assessor blinded. 15 patients died during the follow-up period of the study. No further comments on the cause of death.
Belkin[4] (1998)	Quasi-RCT (2-week alternate cycle use of intervention and comparator), 5 months USA Class 1 clean and class 2 clean-contaminated General, cardiothoracic, orthopaedic, neuro-surgery, plastic and other surgery Each patient followed up 7 to 28 days Teaching hospital	Disposable, non-woven gowns and drapes (spun-laced material identified commercially as Sontara®, Jacob Holm Group, Basel, Switzerland)	Reusable fabric gowns and drapes (128-thread count fabric consisting of a blend of 65% polyester, 34% cotton, and 1% stainless steel. Sleeves and front of the gowns were made with two-ply.	Infected wound: defined as when pus is visible in wound (not matching with CDC definition).	Wound infection: Intervention: 108/2,139 Comparator: 133/2,223 p=0.177	Excluded from the study: - Classes 3 and 4: contaminated or dirty - Ophthalmology - No visible wound - Any procedure performed outside the operating room - If no primary closure Outcome assessor blinded

Table 2. Continued

Study	Type and duration of study/setting	Intervention	Comparator	Primary outcome	Results	Other comments/limitations
Castro Ferrer et al.[5] (2004) (Full text in Spanish)	Observational, single non-teaching centre One year of observation (before intervention and after intervention); 6 months of training (wash-in phase)–single-use drapes Spain Type of procedures: general surgery	Single-use adhesive surgical drapes (the adhesive concept applies to how the drape is secured to the surrounding area of the surgical field). The intervention also included non-reusable gowns (Klinidrape, Molnlycke Health Care).	Conventional reusable drapes and gowns	Wound infection rate (incisional SSI)	Wound infection Single-use: 31/421 (7.4%) Reusable drapes 18/396 (4.5%) Stratified by type of surgical contamination: Clean: I: 8/204 (3.9%) C: 2/167 (1.29%) Clean-contaminated: I: 5/96 (5.2%) C: 3/100 (3%) Contaminated-dirty: I: 11/76 (14.5%) C: 8/83 (9.6%) Dirty: I: 7/45 (15.6%) C: 5/46 (10.8%)	Additional outcomes were also analyzed, such as staff satisfaction. Analysis of the different properties of the new material was done, that is: - Impermeability - Isolation - Liquid absorption - Resistance. Potential bias may have been introduced due to different patient populations in the 2 study periods. Nevertheless, the type of surgery regarding the degree of contamination seems equipoise between both periods. No data on additional risk factors that may have influenced SSI, such as the ASA score, are reported. No data on the degree of wound infection. - No data about blinding assessment of SSI is reported or participant blinding. - Interestingly, adverse effects of adhesive drapes are taken into consideration (9% of skin rash or eczema).
Gallagher et al.[6] (2007)	Prospective non-randomized study, 3 years Italy 364 pacemaker and implantable cardioverter defibrillator patients	Simplified draping method: disposable single adhesive fenestrated drape designed originally for use in cardiac catheterization.	Traditional draping: involves the use of multiple cloth drapes; adhesive strips and draping clamps are used to maintain the position of drapes.	Suspected and confirmed infection Definition not provided	Intervention: 1/250 Comparator: 6/114 p=0.014	Intervention procedures performed by the same experienced operator (first operator experience >500 pacing procedures before the current series); control procedures performed by 3 other operators in the same catheterization laboratory over the same period. These operators were less experienced, each having first operator experience of <100 cases at the start of the study period. Cephalic access was used for 71% of ventricular leads and 60% of atrial leads; in both cases significantly lower proportions than in the study group (p=0.001) Poor comparability between intervention and comparator.

Table 2. Continued

Study	Type and duration of study/setting	Intervention	Comparator	Primary outcome	Results	Other comments/limitations
Treggiari et al.[7] (1992) (Full text in Italian)	Prospective, non-randomized, non-controlled study Italy	Disposable non-woven fabric drapes and gowns (TNT fabric 450).	Conventional reusable cotton drapes and gowns.	Wound infection (named as "postoperative infection")	Wound infection: Non-woven fabric drapes: 4/25 Conventional cotton drapes: 4/25 Non-significant	SSI definitions not reported Surveillance only until postoperative day 10.
Comparison 2: Single use disposable adhesive incise drape (antimicrobial or non-impregnated) vs. no adhesive incise drapes						
Al Qahtani et al.[8] (2015)	Quasi-RCT January-December 2012 Saudi Arabia 91 patients >12 years of age presenting to the emergency department with signs of acute appendicitis Open appendectomy Each patient followed up for 6 weeks Tertiary care hospital	Standard 5-minute skin preparation with 10% povidone-iodine soap followed by the application of an antimicrobial film incise drape (Loban_2 incise drapes; 3M, St Paul, MN, USA)	Standard skin preparation alone No description of conventional draping in this group.	Superficial SSI infection using the CDC definition	Intervention: 6/52 Comparator: 2/39 Relative risk: 2.2 (95% CI: 0.50-10.5). (p=0.459)	- Patient assignment done initially on an alternating-day schedule, then on a weekly basis. - Excluded cases done laparoscopically or by a different surgical team. - Excluded cases in which the research criteria were breached, such as the use of a different antibiotic regimen or incision closure in a different way. - 4 (50%) of the 8 patients with a postoperative SSI had pelvic drain insertion, whereas only - 11 (13%) of the 83 patients without SSI had pelvic drain insertion (p=0.007). - Incise drapes were easy to use and there were no reported sensitivity reactions. - Of the 6 patients in the antimicrobial film group with postoperative SSI, 3 had a perforated appendix, 2 had a gangrenous appendix and one had an inflamed appendix. - In group 2, one patient had an inflamed appendix and the other had a perforated appendix.

Table 2. Continued

Study	Type and duration of study/setting	Intervention	Comparator	Primary outcome	Results	Other comments/limitations
Segal and Anderson[11] (2002)	RCT USA 184 high risk cardiac patients Each patient followed up for 6 weeks 900-bed tertiary hospital	Group 4: one-step iodophor/alcohol water insoluble film with iodine- impregnated incise drape.	Group 3: one-step iodophore/alcohol water insoluble film. This study had 2 more arms: Group 1: povidone–iodine soluble paint. Group 2: povidone–iodine 5-minute soluble scrub with paint.	Sternal SSI (according to the CDC definition)	Intervention (group 4): 3/51 Comparator (group 3): 1/50	- The study primary objective was to compare preoperative skin preparations. - Only high-risk patients were included. - Outcome assessor blinding is not clear. - Secondary analysis of soluble vs. insoluble iodine is significant, p=0.02. - Demographics: matching/differences between groups not provided.
Swenson et al.[14] (2008)	Observational retrospective cohort study March 1 2002 to June 30 2006 USA Clean, elective, laparoscopic ventral and incisional hernia repair with mesh implementation. Department of surgery, university hospital	Group 1: use of antimicrobial incise drape impregnated with iodophore containing adhesive compound (Loban™, 3M)	Group 2: No antimicrobial-impregnated adhesive drape.	SSI was defined as all mesh infections in the first 30-day postoperative period, as well as SSI not related to the mesh. Mesh infection was defined as infection that necessitated the operative removal of the mesh.	SSI: Drape group: 25/206 Non-drape group: 45/300 p=0.36 Mesh infection: Drape group: 16/206 Non-drape group: 26/300 p=0.72	Antimicrobial-impregnated drapes were used more: - In laparoscopic procedures - By residents - By high volume surgeons - For urgent or emergency repair Clean wound classification Current or recent smoking habit Haemodialysis patients Chronic steroid use Peripheral vascular disease

Table 2. Continued

Study	Type and duration of study/setting	Intervention	Comparator	Primary outcome	Results	Other comments/limitations
Yoshimura et al.[15] (2003)	Retrospective study April 1994 to end December 2001 Japan Age range: 29 to 80 years Follow-up: 30 days Clean-contaminated liver resection for hepatocellular carcinoma University hospital	Plastic adhesive incise drape impregnated with an iodophor (Loban™ 2 incise drapes; 3M)	No antimicrobial-impregnated incise adhesive drape	Wound infection (purulent drainage from the superficial incision with or without laboratory confirmation plus one or more of the following signs was required: pain or tenderness, localized swelling or redness or heat)	Wound infection: Impregnated drape: 4/122 No drape: 21/174 p=0.0096	- There were significant differences between the groups in terms of gender, the indocyanine retention test at 15 minutes, aspartate aminotransferase and alanine aminotransferase levels, duration of the preoperative hospital stay, intraoperative blood loss, and the percentage of autologous blood transfusion. - By multivariate regression analysis, body mass index, smoking and lack of drape use were independent risk factors for wound infection. - Most of the bacteria isolated were skin bacteria, including *Staphylococcus aureus* and *S. epidermidis*. - Patients who had had a simultaneous operation for other cancers, including carcinoma of the gastrointestinal tract, were excluded. - Wound infections associated with intra-abdominal infections were omitted because an intra-abdominal infection might cause a wound infection.
Chiu et al.[10] (1993)	RCT January-December 1991 Hong Kong (SAR, China) Follow-up: 6 months Age range: 43-97 years Fixation of hip fractures University hospital	Cover the operation site with plastic adhesive incise drape (Opsite™, Smith & Nephew, London, UK; not antimicrobial-impregnated).	Operation site left uncovered "no drape"-	Wound infection Positive swab at wound closures	Wound infection: Intervention: 6/65 Comparator: 5/55 p=0.90 Positive swab at wound closures: Intervention: 4/65 Comparator: 1/55 p=0.25	- In both groups the operation site was prepared with povidone solution and draped with sterile towels. - None of the skin swabs taken before incision grew bacteria. - In the drape group, 2/6 of patients with wound infection had positive swabs. - Positive swab at wound closure in the no-drape group was not associated with wound infection.

Table 2. Continued

Study	Type and duration of study/setting	Intervention	Comparator	Primary outcome	Results	Other comments/limitations
Ward et al.[13] (2001)	RCT, double-blind 18 August 1992-29 January 1993 South Africa Caesarean section Regional referral university hospital	Plastic adhesive (not impregnated) incise drapes (Opsite™, Smith & Nephew; not antimicrobial-impregnated).	No plastic adhesive incise drapes	Wound infection: Infection was diagnosed if 2 of 3 features were present: - Erythematous cellulitis (erythematous induration either side of the incision line) - Seropurulent discharge from the wound - Positive swab culture (organisms and leucocytes) Secondary outcome: postoperative length of stay	Wound infection Intervention group: 34/305 Control group: 30/298 p=0.6933	- 8 patients were excluded from randomization due to clinically suspected ruptured uterus. - 2 women from the control group were subsequently excluded, one having a coincidental appendix rupture discovered at caesarean section and the other requesting early discharge on day 2 after caesarean section wound. - Standard sterile double-towel draping applied for all cases. - Sepsis developing after 5 days was not included.
Milandt et al.[16] (2016)	RCT, double-blind January 2015-May 2015 20 patients Both knee South Denmark TKA Odense university hospital	Plastic adhesive (impregnated) incise drapes.	No plastic adhesive incise drapes	Colony formation unit (CFU) Secondary outcome: Undiluted growth plates	Colony count Similar number (p=0.6)	Do not support the hypothesis that the use of iodine-impregnated incision drapes increased bacterial recolonization during surgery.
Felbaum et al.[17] (2015)	Observation September 2014-September 2015 Cranial, Nurosurgery Medstar Georgetown university hospital	Post OP Adhesive incise drapes.	No plastic adhesive incise drapes	Wound infection	One infection 157 (35 cranial 124 spinal) 5 infection 143 (46 cranial 97 spinal)	The implementation of a sterile surgical drape as a closed postoperative surgical site dressing has led to a decrease in surgical site infections.

Table 2. Continued

Study	Type and duration of study/setting	Intervention	Comparator	Primary outcome	Results	Other comments/limitations
Hesselvig et al.[9] (2020)	RCT Two arm, non blinded Muticenter, randomised, controlled at five different hospitals in Denmark. Twenty-four surgeons primary knee arthroplasty. We swabbed for bacteria at the surgical site and in a rinse from the surgeons' gloves	Plastic adhesive (impregnated) incise drapes.	No plastic adhesive incise drapes	The difference in the proportion of contaminated patients between the two randomized groups	Contamination 10% (60/603) in drape 15% (90/584) in No Odds ratio 0.61 (95% CI 0.43-0.87)	
Moores et al.[18] (2017)	Observation Prospective 104 patients Ventral hernia repair Cleveland Clinic university hospital USA	Ioban drap 3M Ioban (56 patients)	No (48 patients)	SSI	SSI 4/56 Control 1/48	Use of an iodine-impregnated drape does not result in a reduction in surgical site occurrences or superficial surgical site infections.
Le et al.[12] (2017)	Double blinded Randomized trial 101 patients Spinal surgery Over 10 weeks n=15 Flocked swabs on wounds Ottawa hospital Canada	Iodine impregnated PAD Adhesive drape	No	Bacterial CFU SSI	There were no significant differences There were no surgical site infections	

Table 2. Continued

Study	Type and duration of study/setting	Intervention	Comparator	Primary outcome	Results	Other comments/limitations
Karapınar and Kocatürk[19] (2019)	Observation Retrospective Jenuary 2015-Jauary 2017 654 patients 380 (iodine) Anatomic pulmonary resection Thoracic surgery Yedikule University hospital Turkey	Adhesive incise drapes (iodine impinged).	No plastic adhesive incise drapes	SSI	SSI 2.9% (11/380) Control 9.12% (25/274)	The implementation of a sterile surgical drape as a closed postoperative surgical site dressing has led to a decrease in surgical site infections
Bejko et al.[20] (2015)	Matched study Jenuary 2008-March 2015 5,100 consecutive Cardiac surgery Match study University hospital Italy (pauda)	Adhesive incise drapes (iodine impinged).	No plastic adhesive incise drapes	SSI	SSI (15/808) Control (53/808)	

RCT: randomized controlled trial, SSI: surgical site infection, CDC: Centers for Disease Prevention and Control, I: intervention, C: control, TNT: trinitrotoluene, 95% CI: 95% confidence interval, SAR: special administrative region, OP: operation.

Table 3. Summary of Finding Table

Disposable drapes and surgical gowns compared to reusable drapes and surgical gowns for Patient or population: patients with Settings: Intervention: disposable drapes and surgical gowns Comparison: reusable drapes and surgical gowns						
Outcomes	Illustrative comparative risksa (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk Reusable drapes and surgical gowns	Corresponding risk Disposable drapes and surgical gowns				
SSI	59 per 1,000	51 per 1,000 (40 to 64)	RR 0.86 (0.68 to 1.09)	4,848 (2 studies)	⊕⊕⊖⊖ Low	
Disposable adhesive incise drape compared to no adhesive incise drapes for Patient or population: patients with Settings: Intervention: disposable adhesive incise drape Comparison: no adhesive incise drapes						
Outcomes	Illustrative comparative risksa (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk No adhesive incise drapes	Corresponding risk disposable adhesive incise drape				
SSI	122 per 1,000	114 per 1,000 (74 to 177)	RR 0.94 (0.61 to 1.46)	2,157 (7 studies)	⊕⊖⊖⊖ Very low	

SSI: surgical site infection, CI: confidence interval, RR: risk ratio. aThe basis for the assumed risk (e.g., the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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REVIEW ARTICLE

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근거 중심의 수술부위감염 예방 진료권고안: 수술 장갑의 사용

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The Evidence-Based Practice Guidelines for Prevention of Surgical Site Infection: Use of Surgical Gloves

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The protective barriers such as the surgical gloves may reduce surgical site infection by preventing the transfer of pathogens from hands to the surgical fields. On behalf of the Korean Surgical Infection Society, the practice guidelines committee collected data regarding surgical gloves including double-gloving or changing of gloves. Following the intensive review and analysis, the practice guidelines committee decided to recommend that double-gloving or changing of gloves can be at the discretion of the surgical team, since the evidence is insufficient to prove the effect of double-gloving or changing of the gloves for surgical site infection. However, it could be considered to use double gloves for clean wounds (Do, Conditional recommendation, very low quality of evidence).

Key Words: Surgical gloves, Surgical site infection, Practice guideline

서론

장갑 사용과 관련하여 권장 사항을 발표한 기관은 거의 없다. 수술 중 이중장갑을 사용하는 것, 혹은 수술 중 일정 시간에 장갑을 교체하는 것이 수술부위감염을 줄이는 데 도움이 되는지에 대해서는 이견이 있을 수 있다. 수술 중 장갑 천공의 위험으로 인해 이중장갑 혹은 장갑 교체가 지지 받을 수는 있으나, 실제적으로 수술부위감염을 줄이는 지는 연구가 필요하다. 따라서 본 진료권고위원회에서는 가용한 근거를 수집하고 체계적인 검토 및 분석을 통해 수술부위감염을 줄이기 위한 효과적인 수술 장갑의 사용에 대해 진료지침을 마련하고자 하였다.

대상 및 연구 방법

진료권고안 개발 방법은 수용개작 방식(adaptation)으로 개발되었으며, 2016년 발표된 세계보건기구(World Health Organization, WHO) 가이드라인[1]을 기준 진료권고안으

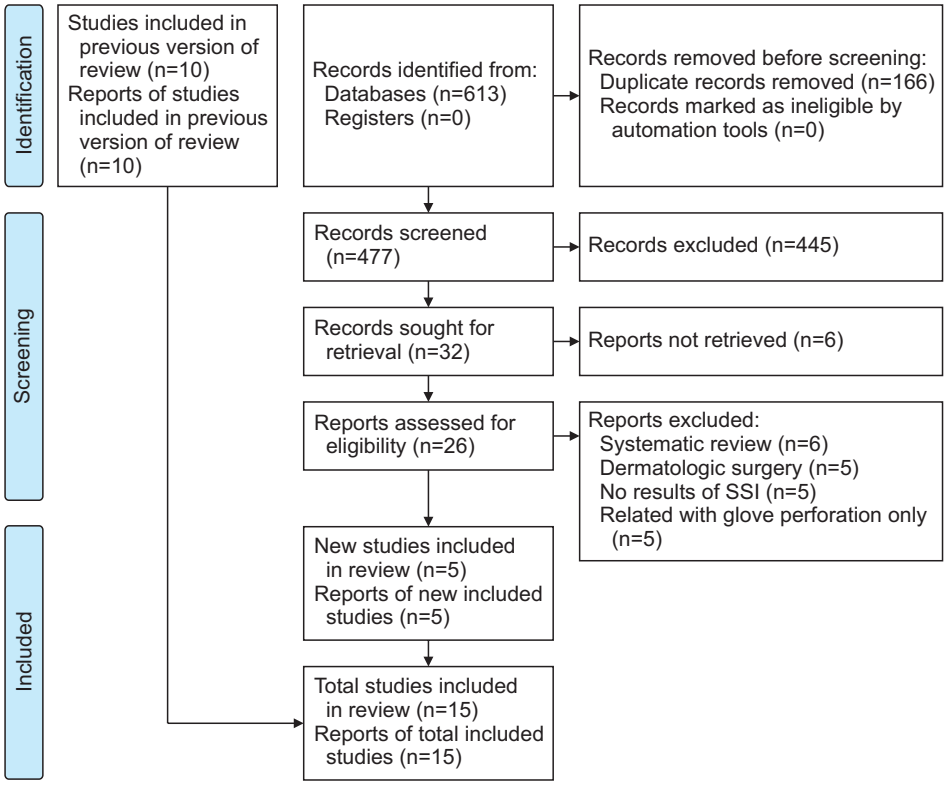

Fig. 1. Study selection. PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases and registers only. PRISMA: preferred reporting items for systematic reviews and meta-analyses.

로 최신성을 보강하는 GRADE-ADOLOPMENT 방법[2]을 적용하였다. WHO 가이드라인의 권고안에서 국내 수술환경에 적용할 대상을 핵심질문으로 선정하였고, 최신성 보강을 위해 문헌 검색을 시행하여 추가하였다. 국외 논문은 MEDLINE, EMBASE, CINAHL, Cochrane으로 WHO 가이드라인에서 적용한 기간(1990년 1월 1일부터 2014년 4월 24일)을 최신까지 연장하여 검색하였고, 국내 논문 검색은 KMBASE, KoreaMed를 기간 제한 없이 검색하였으며, 논문 검색은 2021년 1월 12일에 수행되었다(Fig. 1).

핵심질문 9. 이중 수술 장갑 사용, 또는 수술 중 수술 장갑을 교체하거나 특정 유형의 수술 장갑을 사용하는 것이 수술부위감염 예방에 효과적인가(Table 1)?

근거수준: 근거수준평가와 근거의 강도와 한계

수술의 침습적인 특성은 수술부위감염뿐만 아니라 환자 또는 수술팀에서 혈액 매개성 감염을 유발할 수 있는 병원체의 전이 위험을 높인다. 수술용 장갑의 착용과 같은 보호장벽을 구현하면 이 같은 위험을 줄일 수 있다. 분석에 포함된 연구는 기존 WHO 가이드라인에 사용된 10개의 연구[3-12]와 추가된 5개(관찰연구 4개,[13-16] 무작위 연구 1개[17])의 연구이다(Table 2).

2009년에 발표된 Cochrane review 1에서는 추가적인 장갑 착용이 환자 또는 수술팀의 surgical site infection (SSI) 또는 혈액 매개성 감염의 발생을 감소시키는지, 또 가장 안쪽의 수술용 장갑에 대한 천공을 감소시키는지 조사했다. 수술팀이 추가로 착용한 장갑이 환자의 수술부위감염을 감소시킨다는 직접적인 증거는 없었다. 그러나 수술부위감염을 1차 결과로 본 연구 결과가 단 두 개의 연구만 발견되어 이 결과에 대한 충분한 통계학적 파워가 부족했다. 이번에 한 개의 관찰논문이 추가되었다. 하지만 3개의 연구가 모두 관찰연구였으며 두 연구는 신경외과수술,[12,13] 한 개의 연구는 탈장수술[11] 등의 청결창상에서만 이뤄져서 결과적으로 비뚤림 위험이 높아 근거 수준은 매우 낮음(very low)으로 평가되었다(Table 3).

대부분의 시험에서 무작위 배정, 할당 방법, 표본 크기의 계산 및 가림 과정에 대한 충분한 세부 정보를 제공하지 않았기 때문에 대부분의 선택된 연구의 방법론적 질이 좋지 않다. 수술부위감염의 정의는 연구마다 다양했고 SSI를 주요 결과로 사용한 연구는 거의 없었다. 대리 결과로서 박테리아 오염에 대해 시행한 연구는 환경, 설계 및 결과 측정에서 큰 이질성을 보여주었으며, 박테리아 오염과 수술부위감염의 발생률 사이의 연관성을 보여주는 직접적인 증거는 없었다. 회수된 증거는 성인 환자에 초점을 맞추었으며 소아 집단에 대한 연구는 없었다. 문헌 검색에서 수술부위감염의 귀속 사망률에 대해 보고한 연구는 확인하지 못했다.

Table 1. 포함 및 배제기준

대상환자(P)	수술 대상 환자
중재(I)	(1) 이중 수술 장갑, (2) 수술 중 수술 장갑 교체, (3) 특정 유형의 수술 장갑
비교군(C)	(1) 단일 수술 장갑, (2) 수술 중 수술 장갑 교체 안함, (3) 라텍스 장갑
결과(O)	수술부위 감염률, 장갑 내 세균 오염 정도
연구설계(S)	연구 설계를 제한하지 않음.
대상 사용자	수술을 시행하는 1-3차 의료기관의 의료진

P: patient, I: intervention, C: comparator/comparison/control, O: outcomes, S: setting.

결론

수술 중 장갑을 이중으로 착용하거나, 또는 교체하거나 특정 유형의 장갑을 사용하는 것이 수술부위 감염의 위험을 감소시키는 지를 평가할 근거가 충분하지 않기 때문에 수술자의 판단에 따라 사용할 것을 권고한다. 다만, 청결 창상에서는 이중장갑을 사용하는 것을 고려할 수 있다.

(선택적 권고[Do, Conditional recommendation], 매우 낮은 수준의 근거[Very low quality of evidence])

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Table 2. Evidence Table

Study	Country/study period	Type of study/setting	Intervention	Comparator	Primary outcome	Results	Limitations
Tulipan and Cleves[12] (2006)	USA 1998-2003	Retrospective, non-randomized, "before/after". Neurosurgery (n=863)	Single-gloving (n=521)	Double-gloving (n=342)	CSF shunt infections 6-month follow-up.	6.7% in double- gloving 15.2% in single- gloving OR: 2.48 (95% CI: 1.50-4.22)	No clear inclusion and exclusion criteria. No validated SSI definition. No a priori sample size calculation. Number of patients lost to follow-up unknown.
Dodds et al.[11] (1990)	United Kingdom Unknown period	Non-randomized, "before/after". Hernia repair (n=200)	Single-gloving (n=100)	Double-gloving (n=100)	Wounds were inspected for signs of infection at 7-10 days. Unknown criteria.	8% in double-gloving 10% in single-gloving (p-value not provided)	Study period unknown. No clear inclusion and exclusion criteria. Follow-up period unknown. No validated SSI definition. No a priori sample size calculation. Number of patients lost to follow-up unknown.
Kashkoush et al.[13] (2020)	USA 2012-2017	Retrospective, non-randomized Neurosurgery (n=14,220)	Single-gloving (n=271)	Double-gloving (n=9,398)	90-day SSI NHSN infection criteria 90-day follow-up.	2.0% in double-gloving 2.6% in single-gloving OR: 1.08 (95% CI 0.83-1.42, p=0.621)	No clear inclusion and exclusion criteria. No a priori sample size calculation.
Ventolini et al.[8] (2004)	USA 1996-1999	RCT: randomized by opening sealed, consecutive envelopes. Caesarean section (n=92)	Change of gloves following the delivery of the placenta by the entire team (n=46)	Retaining gloves, that is, no change of surgical gloves during the procedure (n=46)	Wound infection was defined as the presence of cellulitis (hyperemia, induration and tenderness, purulent drainage from the incision and/or fluctuant, tender, erythematous incision margins). Unknown follow-up.	5.5% in the change group. 25% in the no change group. Relative risk: 4.5 (95% CI: 0.982-29.8)	Blinding unknown. Follow-up period unknown. No validated SSI definition.

Table 2. Continued

Study	Country/study period	Type of study/setting	Intervention	Comparator	Primary outcome	Results	Limitations
Cernadas et al.[5] (1998)	USA 1995-1996	RCT: randomized by opening a consecutively numbered and sealed envelope. Caesarean section (n=108) Group A (n=26): no glove change with manual placental delivery. Group B (n=27): no glove change with expressed placental delivery. Group C (n=27): glove change with manual placental delivery. Group D (n=28): glove change with expressed placental delivery.	Change of gloves If a patient was assigned to a glove change group, the delivery hands of the primary surgeon were double-gloved prior to surgery. The external second glove was removed by a circulating nurse after delivery of the fetus (Group C+D: n=55)	No change of surgical gloves during the procedure (Group A+B: n=53)	Postpartum febrile morbidity The diagnosis of endometritis was assigned based on the attending physician's clinical impression in conjunction with the presence of a maternal temperature ≥100.4º F (38°C) occurring 24 hours after caesarean section in combination with a greater than expected uterine tenderness in the absence of another source of infection. Unknown follow-up.	For febrile morbidity: 27.3% with glove change; 18.9% with no glove change. Relative risk: 0.7 (95% CI: 0.3-1.4) For endometritis: 14.5% in the glove change group; 17% in the no glove change group Relative risk: 1.2 (95% CI: 0.5-2.8)	Follow-up period unknown. No validated SSI definition.
Atkinson et al.[4] (1996)	USA 1993-1994	RCT: randomized by opening the next numbered, opaque sealed envelope. Caesarean section (n=643) Four study groups A: No glove change plus manual placental extraction. B: No glove change plus spontaneous placental delivery. C: Glove change plus manual extraction. D: Glove change plus spontaneous delivery.	Change of gloves. If a patient was assigned to either of the glove change groups, the contaminated gloves were removed by the circulating nurse after delivery of the fetus and a sterile pair of gloves was donned (n= 317)	No change of surgical gloves during the procedure (n=326)	Endometritis was diagnosed by the finding of a maternal temperature of at least 38ºC and either uterine tenderness or foul-smelling lochia in the absence of another clinically obvious source. Unknown follow-up.	27% in the glove change group. 26% in the no change group. Relative risk: 1.0 (95% CI: 0.79-1.3; p=0.9)	Blinding unknown. No clear inclusion and exclusion criteria. Follow-up period unknown. No validated SSI definition. Number of patients lost to follow-up unknown. Crude results unknown.
Rehman et al.[14] (2015)	USA 2004-2012	Retrospective, non-randomized, "before/after". Lumbar spinal fusion with instrumentation (n=389)	Change of gloves (2 pairs of gloves on each hand and removed the outer pair of gloves before handling the instrumentation) (n=210)	No change of surgical gloves during the procedure (n=179)	Infection No definition of infection 1-year follow-up.	0.48% in the glove change group. 3.35% in the no change group. p=0.0369	Retrospective study No validated SSI definition. No a priori sample size calculation.

Table 2. Continued

Study	Country/study period	Type of study/setting	Intervention	Comparator	Primary outcome	Results	Limitations
Bashir and Sørensen[15] (2017)	Denmark 2003-2006	Retrospective, non-randomized, "before/after". Shunt surgery (n=295)	Change of gloves (outer pair of the initial double gloves was changed before the first contact with the shunt material) (n=172)	No change of surgical gloves during the procedure (n=123)	Shunt infection Diagnosis: (1) At least two or more of the following clinical features: fever, neck stiffness, headache, nausea/vomiting, abdominal pain, altered mental status, and/or seizures. (2) Erythema along the shunt tract, wound breakdown overlying shunt material with or without purulent discharge (3) Isolation of microorganism(s) from the CSF specimen and/or shunt valve or catheter tip >6 months follow-up.	11.6% in the glove change group. 17.1% in the no change group. p=0.183	Retrospective study No validated SSI definition. No a priori sample size calculation.
Scrafford et al.[17] (2018)	USA 2015-2016	RCT The randomization allocation was concealed in an opaque sealed envelope and was only opened in the operating room C-sec	Glove changing prior to abdominal closure (n=236)	No change of gloves (n=250).	A composite endpoint of any wound complication occurring within eight weeks following delivery	Intraoperative glove changing led to a significant decrease in composite wound complications from 13.6% in the control group to 6.4% in the intervention group (p=0.008)	
Reese et al.[16] (2020)	USA Between October 2015 and March 2018.	Observational Emergent/elective colon surgery	Glove changing prior to abdominal closure (n=148)	No change of gloves (n=34).	30 days SSI	Staff glove change (8.1% vs. 14.7%, OR: 0.51, 95% CI: 0.17-1.57) p=0.23	
Ward et al.[9] (2014)	USA Not specified	RCT Clean orthopaedic surgery (n=251)	Exchange of outer pair of gloves one hour into surgery (n=143).	No change of gloves (n=108).	Bacterial contamination of gloves (presence of bacterial CFUs vs. absence).	Positive glove contamination rate of 23% for surgeons retaining outer gloves one hour into surgery. Positive glove contamination rate of 13% among surgeons exchanging their outer gloves. OR: 1.97 (95% CI: 1.02-3.80); p=0.04	Study period unknown. Randomization method unknown. Blinding unknown. Allocation concealment unknown. No clear inclusion and exclusion criteria. No *a priori* sample size calculation.

Table 2. Continued

Study	Country/study period	Type of study/setting	Intervention	Comparator	Primary outcome	Results	Limitations
Al-Maiyah et al.[3] (2005)	United Kingdom Not specified	RCT: randomization by pre-prepared sealed envelopes. Primary total hip arthroplasty (n=50)	Change of outer gloves after draping, either at 20-minute intervals or immediately before cementation if this occurred before the end of a 20-minute interval. In addition, gloves were changed whenever a visible puncture was detected (n=25).	Change of outer gloves after draping and before cementation of the components. In addition, gloves were changed whenever a visible puncture was detected (n=25).	Bacterial contamination of gloves.	4.8% in the intervention group. 13.9% in the control group. Significant difference reported by authors only.	Study period unknown. Blinding unknown. No *a priori* sample size calculation.
Zdanowski et al.[10] (2000)	Sweden Unknown period	RCT Implantation of vascular graft (n=40)	Change of gloves before contact with graft (n=20).	No change of gloves before contact with graft (n=20).	The growth of all bacterial species from graft segments and gloves was recorded. Secondary outcome reported: superficial SSI Group 1: 2/20 Group 2: 5/20 p<0.02	Group "change of gloves" before contact with graft: 10% no growth, 70% with one bacterial species, 20% with ≥2 bacterial species. Group "no change of gloves" before contact with graft: 5% no growth, 50% with one bacterial species, 45% with ≥2 bacterial species. (p=0.04)	Study period unknown. Randomization unknown. Blinding unknown. Allocation concealment unknown. No clear inclusion and exclusion criteria. No *a priori* sample size calculation.
Sanders et al.[6] (1990)	USA 1988	RCT: randomized by opening a consecutively numbered and sealed envelope. Orthopaedic surgery (n=50)	Inner pair of standard latex gloves+cotton-cloth outer gloves (n=25).	Inner pair of standard latex gloves+latex outer gloves (n=25).	Postoperative infection Unknown criteria Follow-up period unknown.	No reports of postoperative infection.	Blinding unknown. No clear inclusion and exclusion criteria. Follow-up period unknown. No validated SSI definition. No *a priori* sample size calculation. Number of patients lost to follow-up unknown.
Sebold and Jordan[7] (1993)	USA 1990	RCT: randomized by opening a consecutively numbered and sealed envelope. Orthopaedic surgery (arthroplasties and revision) (n=71)	Inner pair of standard latex gloves+outer "orthopaedic" gloves (n=25). Repel gloves between 2 regular latex gloves (n=24).	Inner pair of standard latex gloves+latex outer gloves (n=22).	Postoperative infection Unknown criteria Follow-up period unknown.	No reports of postoperative infection	Blinding unknown. No clear inclusion and exclusion criteria. Follow-up period unknown. No validated SSI definition. No *a priori* sample size calculation. Number of patients lost to follow-up unknown.

CSF: cerebrospinal fluid, SSI: surgical site infection, NHSN: National Healthcare Safety Network, OR: odda ratio, 95% CI: 95% confidence interval, RCT: randomized controlled trial, CFU: colony-forming unit.

Table 3. Summary of Finding Table

Studies related to double- vs. single-gloving: SSI outcome
Patient or population: patients with
Settings:
Intervention: double- vs. single-gloving: SSI outcome

Outcomes	Illustrative comparative risks[a] (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	KQ1				
SSI Follow-up: 1-3 days	108 per 1,000	61 per 1,000 (41 to 91)	RR 0.57 (0.38 to 0.85)	10,732 (3 studies)	⊕⊖⊖⊖ Very low	

Studies related to changing of gloves vs. retaining gloves: SSI outcome
Patient or population: patients with
Settings:
Intervention: changing of gloves vs. retaining gloves: SSI outcome

Outcomes	Illustrative comparative risks[a] (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	KQ2				
SSI (RCT)	209 per 1,000	182 per 1,000 (146 to 224)	RR 0.87 (0.70 to 1.07)	1,329 (4 studies)	⊕⊖⊖⊖ Very low	
SSI (NRS)	95 per 1,000	56 per 1,000 (34 to 92)	RR 0.59 (0.36 to 0.97)	866 (3 studies)	⊕⊖⊖⊖ Very low	

Studies related to changing of gloves vs. retaining gloves - bacterial contamination as primary outcome
Patient or population: patients with
Settings:
Intervention: changing of gloves vs. retaining gloves - bacterial contamination as primary outcome

Outcomes	Illustrative comparative risks[a] (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	KQ3				
SSI	307 per 1,000	215 per 1,000 (160 to 292)	RR 0.70 (0.52 to 0.95)	341 (3 studies)	⊕⊕⊖⊖ Low	

SSI: surgical site infection, RCT: randomized controlled trial, NRS: non-randomized study, CI: confidence interval, RR: risk ratio. [a]The basis for the assumed risk (e.g., the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

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REVIEW ARTICLE

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근거 중심의 수술부위감염 예방 진료권고안: 수술 예방적 항생제 연장 사용

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The Evidence-Based Practice Guidelines for Prevention of Surgical Site Infection: Prolonged Use of Surgical Antibiotic Prophylaxis

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Some guidelines on prophylactic antibiotics use for preventing surgical site infection (SSI) recommend using prophylactic antibiotics up to 24 hours after operations. However, many studies have shown no evidence of benefit for prolongation of surgical antibiotic prophylaxis after operation over single preoperative use with possible intraoperative additional dose in terms of SSI prevention. This study was aimed to investigate that postoperative prolongation of surgical antibiotic prophylaxis would decrease the SSI rates compared to single preoperative surgical antibiotic prophylaxis by systematic review and meta-analysis. The GRADE-ADOLOPMENT method was adopted, and the World Health Organization (WHO) guideline was used as a reference guideline. MEDLINE, EMBASE, CINAHL, CENTRAL, KMBASE and KoreaMed were searched on January 12th 2021. Following thorough review, the practice guidelines committee decided not to recommend prolonged use of surgical antibiotic prophylaxis after operation (conditional recommendation/moderate quality of evidence).

Key Words: Surgical site infection, Antibiotic prophylaxis, Surgical incisions, Prevention and control, Practice guideline

서론

청결 상처가 아니거나 보형물 삽입이 필요한 수술 시 일상적인 예방적 항생제의 사용이 수술부위감염 예방에 효과가 있다는 사실은 잘 알려져 있으나, 수술 후에도 예방적 항생제를 지속적으로 사용하는 것이 수술부위감염 예방에 대한 더 큰 이득이 있는지 여부는 아직 명확히 밝혀지지 않았다. 여러 임상진료지침에서는 수술 후 최대 24시간까지 예방적 항생제 투여를 권장하고 있으나[1-3] 수술 전 예방적 항생제의 일 회 투여 및 수술 시간에 따른 수술 중 예방적 항생제의 추가 투여는 24시간까지의 연장 투여에 비해 수술부위 감염 예방에 열등하지 않다는 근거가 늘어나고 있는 추세이다. 그럼에도 불구하고 의료 현장에서 여전히 수술 후 수 일 간 예방적 항생제를 일상적으로 지속적으로 사용하는 경향이 있다.

대상 및 연구 방법

진료권고안 개발 방법은 수용개작 방식(adaptation)으로 개발되었으며, 2016년 발표된 세계보건기구(World Health Organization, WHO) 가이드라인[4]을 기준 진료권고안으로 최신성을 보강하는 GRADE-ADOLOPMENT 방법[5]을 적용하였다. WHO 가이드라인의 권고안에서 국내 수술환경에 적용할 대상을 핵심질문으로 선정하였고, 최신성 보강을 위해 문헌 검색을 추가적으로 시행하였다(Table 1). 국외 논문은 MEDLINE, EMBASE, CINAHL, Cochrane으로 WHO 가이드라인에서 적용한 기간(1990년 1월 1일부터 2015년 10월 1일)을 최신까지 연장하여 검색하였고, WHO 가이드라인에서 포함되지 않은 국내 논문 검색을 KMBASE, KoreaMed에서 추가적으로 수행하였다. 최종 문헌 검색은 2021년 1월 12일에 수행되었다(Fig. 1).

Table 1. 포함 및 배제기준

대상환자(P)	예방적 항생제 사용의 적응증에 해당하는 수술을 시행 받은 환자
중재(I)	예방적 항생제의 수술 후 지속 사용
비교군(C)	예방적 항생제의 수술 전 일 회 투여 및 수술 시간에 따른 수술 중 추가 투여
결과(O)	수술부위 감염
연구설계(S)	무작위 대조 연구
대상 사용자	수술적 치료를 하는 1-3차 의료기관의 의료진

P: population, I: intervention, C: comparator, O: outcome, S: setting.

핵심질문 10. 수술 후 항생제를 계속 사용하는 것이 수술 전 예방적 항생제만을 사용하는 것보다 수술부위감염 예방에 효과적인가?

근거수준: 근거수준평가와 근거의 강도와 한계

수술 후 예방적 항생제의 지속적인 사용법이 수술 전 예방적 항생제 일 회 사용법(혹은 수술 중 수술 시간에 따라 추가적인 예방적 항생제의 투여 포함)보다 수술부위 감염을 줄이는 데 더 효과적인지 분석하기 위하여 수술 시 예방적 항생제를 사용하는 모든 연령대의 환자를 대상으로 한 무작

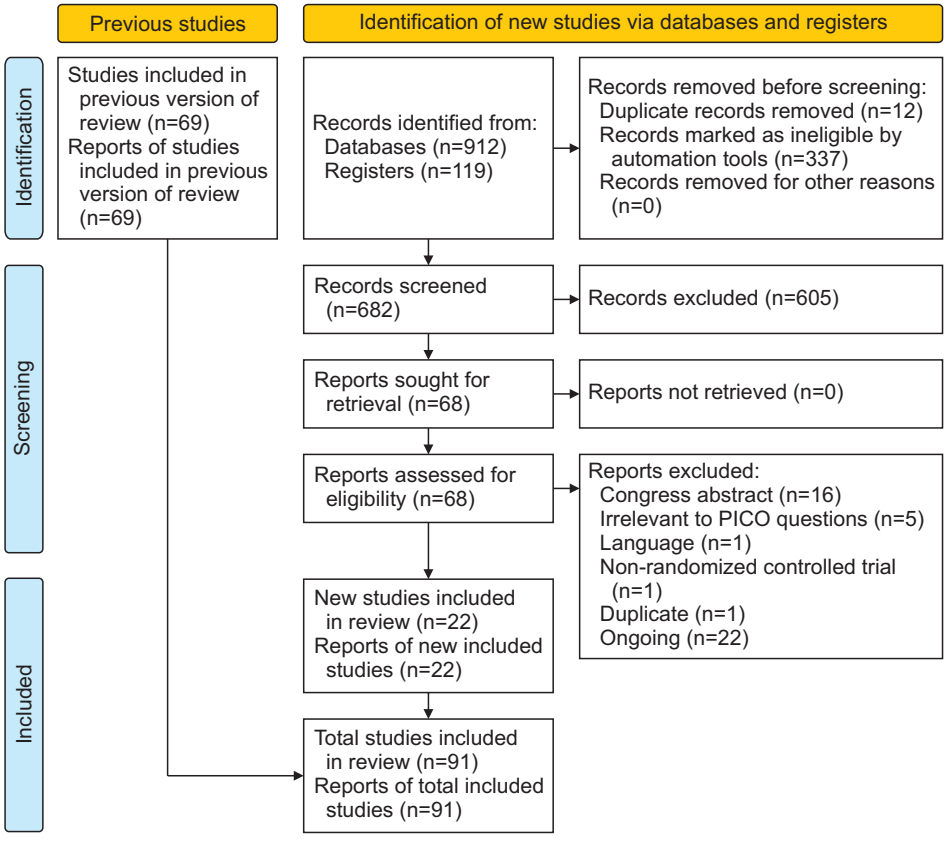

Fig. 1. Study selection. PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases and registers only. PRISMA: preferred reporting items for systematic reviews and meta-analyses, PICO: population, intervention, comparator, outcome.

위 대조 연구(randomized controlled trial, RCT)를 포함하였다. 일차 목표는 수술부위 감염이었다.

포함된 연구에서, "일 회 투여 용량"는 일반적으로 약물의 작동 기간 및 반감기에 따라 수술 중 예방적 항생제의 재투여가 있거나 혹은 재투여가 없는 수술 전 투여 용량을 지칭한다. 포함된 개별 연구는 동일한 항생제를 투여 당 동일 용량으로 비교하였다.

예방적 항생제 사용의 최적 사용 기간을 분석하기 위하여 지침개발위원회는 수술 전 일 회 투여요법과 수술 후 지속 투여 요법만을 비교하지 않고, 수술 후 다양한 지속 투여 요법들 사이의 비교 연구들도 함께 평가하기로 결정하였다. 따라서 최종적으로 평가에 포함된 RCT는 91개였고, 총 27,039명의 환자가 분석에 포함되었다.

따라서 91개의 RCT를 이용하여 아래와 같이 4가지의 하위 그룹에 대한 메타분석을 각각 수행하였다(Table 2).

1. 수술 후 예방적 항생제 지속 사용 vs. 수술 후 예방적 항생제 미사용(54개 RCT)

2. 수술 후 24시간 이내의 예방적 항생제 지속 사용 vs. 수술 후 일 회 추가 투여(1개 RCT)

3. 수술 후 24시간 이상의 예방적 항생제 지속 사용 vs. 수술 후 24시간 이내의 예방적 항생제 지속 사용(33개 RCT)

4. 수술 후 48시간 이상의 예방적 항생제 지속 사용 vs. 수술 후 48시간 이내 예방적 항생제 지속 사용(5개 RCT)

각 하위그룹에 대한 메타 분석의 결과는 다음과 같다.

1. 수술 후 예방적 항생제 지속 사용 vs. 수술 후 예방적 항생제 미사용을 비교하는 54개의 RCT로부터 20,522명의 환자가 분석에 포함되었다. 분석에 포함된 수술은 다양하였으며, 충수절제술,[6-13] 대장절제술,[14-16] 상부위장관수술,[17-20] 담낭절제술,[21-23] 간담도 수술,[24] 종합적인 일반외과 수술,[25-33] 제왕절개,[34-37] 부인과 수술,[38,39] 정형외과 및 외상 수술,[40,41] 척추수술,[42] 심장수술,[43,44] 흉부수술,[45] 혈관수술,[46] 이식수술,[47,48] 두경부수술,[49,50] 귀, 코 및 목 수술,[51] 악안면 수술,[52-55] 정형외과 수술,[56-58] 비뇨기수술[59]이 포함되었다.

3개의 RCT만[15,44,46]이 수술 후에도 예방적 항생제를 지속 투여한 환자에서 수술부위 감염률이 낮은 것으로 보고하였고 나머지 51개의 RCT에서는 두 군 간의 수술부위감염

Table 2. Evidence Table

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Aberg and Thore[25] (1991)	RCT single center (428)	Elective abdominal surgeryIncluding paediatric patients (16 years and over)	II-III	B) Triple dose (A).	A) Single dose of cefuroxime with addition of metronidazole if needed.	30 days	Discharge of pus.	A) 8/207 B) 15/221	NR	Single vs. prolonged
Abro et al.[26] (2014)	RCT single center (208)	Clean-contaminated elective surgery	I-III	B) A+1 g at 8 and 16 hours post-operatively.	A) 2 g ceftriaxone at induction of anaesthesia (gastrointestinal and urinary tract: +250 mg gentamicin and 500 mg metronidazole).	35 days	Pain at the operative site, persistent fever >38°C wound erythema, tenderness, wound discharge and dehiscence.	A) 10/104 B) 7/104	NR	Single vs. prolonged
Abubaker and Rollert[81] (2001)	RCT single center (30)	Uncomplicated fractures of the mandible requiring closed reduction and mandibulo-maxillar fixation or with open reduction and internal fixation	II	B) A+500 mg penicillin post-operatively every 6 hours for 5 days.	A) 2 million units aqueous penicillin IV every 4 hours from admission through to the preoperative and intraoperative phase and for 12 hours postoperatively+oral placebo every 6 hours for 5 days.	6 weeks	1. Purulent drainage from the surgical or fracture site. 2. Increased facial swelling beyond postoperative day 7. 3. Fistula formation at the surgical or fracture site, with evidence of drainage. 4. Fever associated with local evidence of infection (swelling, erythema, or tenderness).	A) 2/16 B) 2/14	NR	<24 hours vs. >24 hours
Adaji et al.[94] (2020)	RCT single center (248)	Cesarean section	II	B) A+cefuroxime 500 mg oral 12 hourly for 5 days+ metronidazole 400 mg oral for 5 days	A) cefuroxime 750 mg IV at the induction of anesthesia, 12, 24, 36, 48 hours post-operatively+metroni-dazole 500 mg IV at the induction of anesthesia, 8, 16, 24, 36, 40, and 48 hours postoperatively	6 weeks post-natal visit	Presence of purulent or serous wound discharge	A) 3/122 B) 8/121	NR	48 hours vs. >48 hours

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Akgür et al.[62] (1992)	RCT single center (30)	Colostomy closure Paediatric patients	II-III	B) Both agents started orally 48 hours before the operation+A, continued until the end of postoperative day 5	A) cotrimoxazole 8 mg/kg IM 1 hour preoperatively+ ornidazole 20 mg/kg IV at induction of anaesthesia+repeat at 12 hours after initial dose.	30 days	Drainage from the wound that yielded micro-organisms in at least one of the two cultures obtained.	A) 1/15 B) 1/15	NR	<24 hours vs. >24 hours
Baqain et al.[83] (2004)	RCT single center (34)	Orthognathic surgery	II	B) A+500 g amoxicillin postoperatively every 8 hours for 5 days instead of placebo	A) 1 g amoxicillin IV at induction of an aesthesia+500 mg IV 3 hours post-operatively+placebo every 8 hours for 5 days.	6 weeks	A score system based on facial swelling and/or pain; presence or absence of extraoral erythema; wound exudate;isolation of pathogens; pyrexia; and wound dehiscence.	A) 4/17 B) 2/17	NR	<24 hours vs. >24 hours
Bates et al.[27] (1992)	RCT multi-center (900)	At-risk abdominal surgery with potential opening of a viscus Including paediatric patients (age 16 years and over)	II-IV	B) A+additional dose of A at 8 hours and 16 hours	A) 250 mg amoxicillin/ clavulanic acid 125 mg on clavulanic acid 125 mg on induction of anaesthesia (IV bolus 1.2 g).	30 days	A clear collection of pus which empties itself spontaneously or after incision.	A) 48/449 B) 49/451	NR	Single vs. prolonged
Becker and Alexander[63] (1991)	RCT single center (40)	Elective colorectal surgery	II-III	B) A+cefoxitin 1 g IV 6 hourly for 5 days, beginning 6 hours after the fixed postoperative dose.	A) Cefoxitin 2 g IV before operation and at 6 hours and 12 hours after the initial dose.	56 days	Purulent drainage, regardless of culture results, or if non-purulent material contained pathogenic bacteria.	A) 0/22 B) 0/18	NR	<24 hours vs. >24 hours
Becker et al.[28] (2008)	RCT single center (44)	Elective repair of abdominal incisional hernia >6 cm with onlay polyprolene mesh	I	B) A+3 times daily until drain tubes removed.	A) 1 g cefazoline IV 30 minutes prior to surgery.	30 days	CDC	A) 4/21 B) 7/21	No AE	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Bentley et al.[84] (1999)	RCT single center (30)	Orthognathic surgical procedures	II	B) A+penicillin G, one million units IV every 6 hours for 8 doses, followed by penicillin V suspension 300 mg postoperatively every 6 hours for 8 doses instead of placebo.	A) Penicillin G, two million units IV immediately preoperatively, and one million units IV every 3 hours intraoperatively and once postoperatively 3 hours after the last intraoperative dose with placebo using the same schedule of intervention group	30 days	CDC	A) 9/15 B) 1/15	NR	<24 hours vs. >24 hours
Berry et al.[47] (2019)	RCT single center (102)	Liver Transplant Surgery	II	B) A+piperacillin/ tazobactam 8 hourly for 72 hours from the initial dose	A) piperacillin/ tazobactam 3.375 g in 30 minutes prior to incision (vancomycin 1,000 mg and of ciprofloxacin 400 mg for patients with allergies to cephalosporins or piperacillin/ tazobactam)+second dose of piperacillin/ tazobactam intraoperatively based on the half-life (4 hours after initiation of the transplant procedure)	Up to 30 days from the operation	Purulent drainage or organisms isolated aseptically from the superficial incision; pain, tenderness, erythema, or heat and opened by the surgeon; or a diagnosis by a surgeon	A) 9/48 B) 13/49	30-day mortality A) 1/48 B) 1/49	Peri-operative vs. prolonged
Bidkar et al.[80] (2014)	RCT single center (78)	Tympanoplasty with cortical mastoidectomy for active and inactive mild chronic otitis media Included paediatric patients (12-60 years)	I-III	B) A+oral cefixime 200 mg 12-hourly for 8 days or more.	A) IV cefuroxime 1.5 g 30 minutes before incision, followed by 750 mg 12-hourly until 24 hours postoperatively.	3 weeks	Wound infection	A) 1/39 B) 2/39	A) 19 B) 1 (gastro-intestinal distur-bance)	<24 hours vs. >24 hours

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Bozorgzadeh et al.[89] (1999)	RCT single center (300)	Surgery for penetrating abdominal trauma Included paediatric patients (12-69 years)	II-III	B) 5 days of IV cefoxitin, with the first 1 g dose given in the emergency department immediately after the determination of the requirement for laparotomy followed by administration every 6 hours for a total of 20 doses.	A) 24 hours of IV cefoxitin with the first 1 g dose given in the emergency department immediately after the determination of a requirement for laparotomy, followed by administration every 6 hours for a total of 4 doses.	30 days	CDC	A) 24 /148 B) 26 /152	NR	<24 hours vs. >24 hours
Buckley et al.[40] (1990)	RCT single center (204)	Hip pinning or Austin Moore hemiarthroplasty. Intertrochanteric/ subcapital hip fracture	I	B) A+1 g every 6 hours IV for 3 doses (total 4).	A) Cefazolin 2 g IV at induction of anaesthesia.	6 weeks	Clinical criteria/purulent discharge with or without+culture.	A) 2/83 B) 2/121	NR	Single vs. prolonged
Campos et al.[52] (2015)	RCT single center (74)	Surgery for facial fracture reduction and fixation Intra and extra oral. When required, titanium plates and screws were used.	I-II	B) A+4x1 g cefazolin in 24 hours.	A) 2 g cefazolin IV preoperative Redose when duration >4 hours.	6 weeks	a) Pus drainage at the fracture site or in the vicinity of the surgical intervention site; b) increased swelling 7 days after the operation; c) presence of a fistula in the area of the surgical intervention or at the site of the fracture, with active drainage; d) other clinical features observed by the evaluator, including typical signs of infection such as fever, oedema and localized redness.	A) 6/42 B) 1/32	NR	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classification	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Carroll et al.[77] (2003)	RCT single center (74)	Surgical ablation of head and neck malignancies with free flap reconstruction involving the upper aero digestive tract	II	B) A extended to 15 doses (5 days).	A) Clindamycin 900 mg IV initiated immediately preoperatively and repeated every 8 hours for a total of 3 doses.	7 days/ discharge	Clinical signs of infection in wound colour and drainage.	A) 4/35 B) 4/39	No AE	<24 hours vs. >24 hours
Cartaña et al.[38] (1994)	RCT single center (58)	Wertheim megs	II	B) A+repeat 6 hours and 12 hours postoperatively.	A) 4 g piperacillin 30 minutes before surgery	4 days	Surgical wound exudate cultures, if present, or culture of the liquid obtained by puncturing the wound's edges to isolate aerobic and anaerobic organisms.	A) 5/28 B) 1/30	No AE	Single vs. prolonged
Chang et al.[91] (2005)	RCT single center (156)	Laparoscopically-assisted vaginal hysterectomy	II	B) A up to 30-60 hours.	A) 2 g cephalothin (+1 g every 6 hours) and 80 mg gentamicin (+60-80 mg every 8 hours) for <24 hours	7 days after discharge	Pelvic cellulitis, vaginal cuff abscess, pelvic abscess, wound infection	A) 2/74 B) 3/82	NR	<24 hours vs. >24 hours
Chauhan et al.[21] (2018)	RCT Single center (210)	Laparoscopic cholecystectomy	II	B) A+ceftriaxone 1 g IV postoperatively twice daily for 2 days	A) ceftriaxone 1 g IV at induction of anesthesia	1 month	Port site discharge or inflammation	A) 2/112 B) 3/98	NR	Single vs. prolonged
Cheshani et al.[59] (2015)	RCT Single center (90)	Suprapubic open prostatectomy	II	B) A+cefazolin 1 g IV 16 hours after surgery and cephalexin 500 mg PO at the time of catheter removal C) A+cefazolin 1 g IV 6 hours after surgery and then continued with cephalexin 500 mg PO every 6 hours until catheter removal	A) cefazolin 1 g IV 1 hour before surgical incision.	2 weeks	Presence of exodative discharge, erythema and tenderness of surgical site	A) 2/30 B) 2/30 C) 0/30	NR	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Cioacã et al.[53] (2002)	RCT single center (140)	Aseptic oral and maxillofacial surgery that does not involve the implantation of foreign material Included paediatric patients (17-70 years)	II	C) A+5-day redose every 8 hours instead of placebo. D) B+5-day redose every 8 hours instead of placebo.	A) 2.4 mg amoxicillin-clavulanate IV at induction+5-day placebo. B) 2 g cefazolin at induction+5-day placebo.	14 days	Purulent discharge	A) 1/35 B) 2/34 D) 2/35 C) 0/33 A+B) 3/69 C+D) 2/68	NR	Single vs. prolonged
Cuthbertson et al.[14] (1991)	RCT multi-center (278)	Elective abdominal surgery where the large bowel was opened	II-III	B) A+same dose (A) 2 hours after commencement of surgery	A) Timentin 3.1 g just before skin incision.	30 days	Purulent discharge from the suture line or if there was a non-purulent discharge that contained pathogenic bacteria.	A) 16/143 B) 17/128	NR	Single vs. prolonged
Danda et al.[56] (2010)	RCT single center (150)	Orthognathic surgery Included paediatric patients (15-37 years)	II	B) A+500 g ampicillin IV instead of placebo.	A) 1 g ampicillin IV at induction+placebo saline every 6 hours for 24 hours.	4 weeks	1. Purulent discharge from an incision. 2. Sero-sanguineous drainage and a wound culture positive for a known pathogen. 3. Clinician diagnosis of infection.	A) 7/75 B) 2/75	No AE	Single vs. prolonged
Davis et al.[85] (2017)	RCT single center (171)	Orthognathic surgery	II	B) A+cephalexin 500 mg PO or clindamycin 300 mg PO four times per day for 2 days additionally	A) cefazolin 2 g IV prior to incision (clindamycin 600 mg IV in allergic patients)+3 post-operative IV doses of cefazolin 1 g IV 8 hourly for 24 hours postoperatively (clindamycin 600 mg IV 8 hourly for 24 hours postoperatively in allergic patients)	1 year	1) Superficial incisional SSI 2) Deep incisional SSI 3) Organ or space SSI	A) 6/86 B) 15/85	NR	<24 hours vs >24 hours
Eshghpour et al.[86] (2014)	RCT single center (50)	Bi-maxillary orthognathic surgery Included paediatric patients (17-35 years)	II	B) A+500 mg amoxicillin syrup postoperatively every 8 hours for a total of 1 week.	A) 1 g cefazolin 30 minutes prior to surgery+same dose 4 hours after 1st injection+placebo.	6 weeks	Facial swelling, purulent discharge from the incision site, drainage, wound dehiscence, pain, or erythema.	A) 0/25 B) 0/25	No AE	<24 hours vs. >24 hours

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Fridrich et al.[87] (1994)	RCT single center (30)	Orthognathic surgical procedures Including paediatric patients (15-55 years)	II	B) Penicillin G 2 million units IV preoperatively+ every 4 hours until the IV was discontinued on postoperative day 1. 500 mg penicillin VK was continued 4 times daily for 1 week. (NB: intra-operative redose differs in frequency)	A) Penicillin G 2 million units IV, preoperatively +every 2 hours until participants reached the recovery room where the final dose was given	8 weeks	Infection	A) 1/16 B) 1/14	NR	<24 hours vs. >24 hours
Fujita et al.[15] (2007)	RCT multi-center (377)	Elective colorectal surgery	II-III	B) Single dose of 1 g IV cefmetazole just before skin incision+ postoperatively at 8 hours and 16 hours after the first dose.	A) Single dose of 1 g cefmetazole just before skin incision.	NR	NR	According to groups (inter-vention vs. control): A) 32/190 B) 17/187	NR No redosing Longer procedure duration in single dose group	Single vs. prolonged
Fujita and Daiko[17] (2015)	RCT single center (257)	Thoracoscopic oesophagectomy or transthoracic oesophagectomy	II	B) A+2 times daily until postoperative day 2	A) 4×1 g cefmetazole every 3 hours starting from induction of anaesthesia	30 days	CDC	A) 31/129 B) 34/128	No AE	Single vs. prolonged
Garotta and Pamparana[41] (1991)	RCT multi-center (614)	All fracture	I	B) A+2 g at 12 hours postoperatively.	A) Ceftizoxime 2 g preoperatively.	1 year	Wound infection (purulent exudation with positive microbiologic culture).	A) 2/301 B) 3/313	NR	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Gupta et al.[95] (2010)	RCT single center (227)	CABG/valve replacement under cardiopulmonary bypass	I	B) A+24 hours (without placebo) (73 hours).	A) IV ceftazidime pentahydrate+ amikacin at anaesthesia induction and a second dose if surgery exceeded 5 hours. Antibiotics were continued for (48 hours)+24 hours placebo.	Definition 30 days	CDC	A) 5/119 B) 8/108	NR	48 hours vs. >48 hours
Haga et al.[18] (2012)	RCT single center (325)	Elective surgery for gastric cancer	II	B) A+5 additional doses every 12 hours postoperatively	A) After induction of anaesthesia 1 g of cefazolin was administered IV+ additional dose when surgery exceeded 3 hours	30 days	CDC	A) 15/164 B) 10/161	NR	Single vs. prolonged
Hall et al.[46] (1998)	RCT single center (302)	Vascular surgery (open arterial)	I	B) A+6-hourly interval repeat until lines were removed <5 days.	A) Ticarcillin 3.0 g clavulanate 0.1 g IV immediately after induction of anaesthesia.	42 days after surgery	Discharge of pus or a serous discharge containingpathogenic organisms	A) 28/153 B) 15/149	NR	Single vs. prolonged
Hanif et al.[90] (2015)	RCT Single center (220)	Penetrating hollow viscus Injury	II-III	B) A+8 hourly postoperatively for 4 days additionally	A) Sulbactam+ Cefoperazone 1 g IV, Metronidazole 500 mg IV one hour before surgery+8 hourly postoperatively for 24 hours	Not defined	Not defined	A) 18/92 B) 7/103	NR	<24 hours vs. >24 hours

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classification	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Hellbusch et al.[42] (2008)	RCT multi-center (233)	Clean instrumented lumbar spinal fusion for degenerative disease	I	B) A+1 g of cefazolin IV every 8 hours for 3 days followed by 7 days of oral cephalexin 500 mg every 6 hours.	A) Cefazolin IV 30 minutes before incision (1 g<100 kg<2 g)+redose if procedure duration exceeded 3 hours.	21 days at least	If the wound appeared red or oedematous or if there was drainage.	A) 5/117 B) 2/116	NR	Single vs. prolonged
Hussain et al.[6] (2012)	RCT single center (377)	Appendectomy (open) Uncomplicated	II-III	B) A+single dose of cefuroxime and metronidazole 8 hours postoperatively.	A) Cefuroxime+ metronidazole 1-2 hours before surgery.	30 days post-operatively	Pus discharge from the wound that necessitated wound opening and drainage.	According to groups (inter-vention vs. control): A) 9/195 B) 8/182	NR	Single vs. prolonged
Imamura et al.[19] (2012)	RCT multi-center (355)	Elective surgery for gastric cancer	II	B) A+1 g of cefazolin on postoperative day 0 and every 12 hours until postoperative day 2	A) 1 g of cefazolin 30 minutes after anaesthesia and an additional dose every 3 hours during surgery	30 days	CDC	A) 8/176 B) 16/179	No AE	Single vs. prolonged
Ishibashi et al.[64] (2009)	RCT single center (275)	Elective surgery for colon cancer	II-III	B) A+4 additional doses (A) for 2 consecutive days.	A) 1 g of cefotiam or cefmetazole after induction of anaesthesia+ 1 additional dose 1 hour postoperatively.	30 days	CDC	According to groups (inter-vention vs. control): A) 7/136 B) 9/139	NR	<24 hours vs. >24 hours
Ishibashi et al.[65] (2014)	RCT single center (297)	Elective resectional surgery for rectal cancer	II-III	B) A+4 postoperative doses of flomoxef 1 g over 2 consecutive postoperative days (total of 5).	A) 1 dose of flomoxef IV+1 dose of flomoxef 1 hour after completion of surgery	30 days	CDC	According to groups (inter-vention vs. control): A) 7/139 B) 10/140	NR	<24 hours vs. >24 hours

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Jansisyanont et al.[88] (2008)	RCT multi-center (122)	Orthognathic surgery Included paediatric patients (17-47 years)	II	C) A (without postoperative dose)+625 mg amoxicillin/ clavulanic acid postoperatively every 8 hours for 5 days. D) B (without postoperative dose)+500 mg amoxicillin postoperatively every 8 hours for 5 days.	A) 1.2 g amoxicillin/ clavulanic acid 30 minutes preoperatively+every 8 hours during the procedure+ 1 single dose 8 hours postoperatively. B) 2 million units of aqueous penicillin IV 30 minutes preoperatively+every 4 hours during the procedure+ 1 single dose 4 hours postoperatively.	6 weeks	CDC	A) 1/33 C) 0/28 B) 0/29 D) 1/32 A+B) 1/62 C+D) 1/60	NR	<24 hours vs. >24 hours
Kang et al.[57] (2009)	RCT single center (56)	Orthognathic surgery	II	B) A+1 g cefpiramide two times daily until 3 days after surgery.	A) 1 g of a third-generation cephalosporin (cefpiramide) IV 30 minutes before surgery.	2 weeks	CDC	A) 3 /28 B) 2 /28	No AE	Single vs. prolonged
Karran et al.[60] (1993)	RCT single center (227)	Elective colorectal surgery	II-III	B) A+500 mg imipenem IV 8 hours+16 hours after surgery.	A) 1 g imipenem IV at induction+1 g 3 hours after surgery.	6-8 weeks	Purulent discharge from the wound, positive bacteriological culture, deep abscess.	A) 44/113 B) 39/114	A) 2 phlebitis B) 1 rash, 1 erythema, 1 phlebitis, 2 hypo-tension	Single post-operative vs. multiple post-operative <24 hours
Ko et al.[70] (2010)	RCT Multi-center (413)	Elective cesarean section	II	B) A+at 36, and 48 hours postoperatively	A) cefazolin 1 g IV before skin incision+at 12 and 24 hours postoperatively	2-3 weeks after discharge	Erythema, pus discharge, and incisional drainage	A) 2/220 B) 5/193	NR	<24 hours vs. >24 hours
Kow et al.[29] (1995)	RCT single center (1,010)	All types of surgery involving the viscera (elective and emergency) Including paediatric patients (age 16 years and over)	II-III	C) A+repeat at 6 hours and 12 hours. D) B+repeat of cefotaxime at 6 hours and 12 hours.	A) Cefoxitin 2 g on induction of anaesthesia. B) Cefotaxime 1 g+ metronidazole 500 mg on induction of anaesthesia.	4-6 weeks	Presence of purulent discharge from the wound or a serous discharge with a positive culture of pathogenic organism(s).	A) 17/252 B) 14/264 C) 17/254 D) 10/240	NR	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classification	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Kim et al.[22] (2017)	RCT Multi-center (200)	Laparoscopic cholecystectomy	II	B) Cefoxitin 1 g IV 30 minutes before surgery+cefoxitin 1 g IV 3 times a day postoperatively+ cefaclor 250 mg per pill, 2 times a day throughout hospitalization+ 3-day supply of cefaclor after discharge	A) Cefoxitin 1 g IV 30 minutes before surgery+normal saline 10 mL IV 3 times a day post-operatively+ascorbic acid, 1,000 mg per pill, 2 times a day throughout hospitali-zation+3-day supply of placebo after discharge	4 weeks after discharge.	1) Superficial incisional SSI 2) Deep incisional SSI 3) Organ or space SSI	A) 4/95 B) 4/93	NR	Single vs. prolonged
Lau et al.[67] (1990)	RCT single center (203)	Early open cholecystectomy for acute cholecystitis	II-III	B) A+continuation of 500 mg doses at 6-hour intervals for 7 days	A) Cefamandole 2 g IV just before surgery+ 500 mg 6 hours and 12 hours later.	1 year	Purulent discharge, serous discharge+positive bacteriological cultures, serous discharge after the patient had returned home. lntraperitoneal abscess was diagnosed by ultrasonic evidence of an abscess and by laparotomy.	A) 7/100 B) 6/103	NR	<24 hours vs. >24 hours
Liberman et al.[7] (1995)	RCT single center (99)	Appendectomy (open) Uncomplicated Including paediatric patients (children under 12 years excluded)	II-III	B) A+3 additional doses every 6 hours.	A) 2 g cefoxitin 15 minutes preoperatively+ postoperative placebo	3 weeks post-operatively	If peri incisional erythema and incisional drainage present, it was classified as a wound infection.	According to groups (inter-vention vs. control): A) 5/45 B) 1/54	NR	Single vs. prolonged
Lin et al.[75] (2011)	RCT single center (231)	Non-emergency CABG surgery	I	B) A+2 days (72 hours)	A) 1 g cefazolin within 1 hour prior to incision+additional dose when surgery was prolonged (every 3-4 hours)+3 doses every 8 hours after surgery (24 hours)	30 days	CDC	A) 13/120 B) 9/111	NR	<24 hours vs. >24 hours

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classification	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Lindeboom et al.[55] (2003)	RCT single center (70)	Bilateral sagittal ramus osteotomy of the mandi	II	B) A+clindamycin IV instead of placebo.	A) 400 mg clindamycin IV 15 minutes before incision+placebo every 6 hours for 24 hours.	3 months	Presence of purulent drainage (either spontaneously or by incision), accompanied by pain or tenderness, localized swelling, redness, and heat or fever (>38.5°C) or an increase in localized swelling after an initial postoperative decrease of oedema, together with pain, discomfort, induration, and an increase in body temperature (>38.5°C).	A) 2/35 B) 1/35	No AE	Single vs. prolonged
Lindeboom et al.[54] (2005)	RCT single center (124)	Intraoral bone grafting for endosseous implantation	II	B) A+300 mg clindamycin instead of placebo.	A) 600 mg clindamycin orally 60 minutes preoperatively+ 4xplacebo every 6 hours.	8 weeks post-operatively	CDC	A) 6/62 B) 5/62	NR	Single vs. prolonged
Liu et al.[78] (2008)	RCT single center (53)	Head and neck surgery that would enter the upper aero digestive tract (including free flap)	II	B) A extended to 72 hours.	A) Clindamycin300 mg IV 1 hour before incision and then at 6-hour intervals over a period of 24 hours.	30 days	CDC	A) 8/26 B) 5/27	No AE	<24 hours vs. >24 hours
Lyimo et al.[34] (2013)	RCT single center (500)	Emergency caesarean section	II	B) A+metronidazole 500 mg every 8 hours for 24 hours postoperatively.	A) Gentamicin (3 mg/kg) plus metronidazole (500 mg) IV 30 to 60 minutes before the operation.	30 days	CDC	A) 12/250 B) 16/250	NR	Single vs. prolonged
Maier and Strutz[49] (1992)	RCT single center (106)	Parotidectomy, sinus surgery, neck dissection with no transcutaneous exploration of the aerodigestive tract	I-II	B) A+8 hours and 16 hours postoperatively. Three shot 24-hour regimen of 1.5 g cefuroxime.	A) 1.5 g cefuroxime directly preoperative	NR	Wound infection	A) 0/53 B) 0/53	No AR	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classification	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Mann and Maurer[50] (1990)	RCT single center (113)	Procedures for benign and malignant processes in the head and neck region	II	B) A+repeat at night and the next morning (24 hours).	A) Preoperative 2 g cefotiam+500 mg metronidazole+ redose cefotiam when duration >3 hours	NR	Purulent discharge.	A) 8/55 B) 10/58	NR	Single vs. prolonged
Marimuthu et al.[72] (2016)	RCT single center (326)	Spinal fusion surgery.	II	B) Cefazolin 1 g IV 8-hour intervals for 48 hours additionally	A) Cefazolin 1 g IV 8-hour intervals for 24 hours (dosage was initiated at least 30 min before the surgical incision)	1 year	Definition of Centers for Disease Control and Prevention	A) 2/170 B) 4/156	NR	<24 hours vs. >24 hours
McArdle et al.[66] (1995)	RCT single center (169)	Colorectal surgery	II-III	B1) A1+80 mg gentamicin+ 500 mg metronidazole IV 3×3 times daily. B2) A2+750 mg ciprofloxacin 3×2 times daily postoperatively and 500 mg metronidazole IV 3×3 times daily	500 mg metronidazole IV at induction of anaesthesia A1)+gentamicin 120 mg IV at induction of anaesthesia+at 8 and 16 hours (80 mg gentamicin+500 mg metronidazole). A2)+ciprofloxacin 1,000 mg orally 1 hour prior to surgery+ 500 g metronidazole at 8 hours & 16 hours postoperatively.	4 weeks after discharge	Pus either discharging spontaneously or requiring drainage. Major wound sepsis was defined as the discharge of pus with constitutional disturbance. Minor wound infections include patients with cellulitis and a positive wound culture.	A1) 13/45 A2) 4/40 B1) 7/42 B2) 4/42	NR	<24 hours vs. >24 hours <24 hours vs. >24 hours
Meijer and Schmitz[24] (1993)	RCT multi-center (1,004)	Biliary surgery	II	B) A+instead of placebo 0.75 g cefuroxime.	A) 1.5 g cefuroxime IV at time of induction+placebo at 8 hours and 16 hours postoperatively.	4-6 weeks	0: No sign of infection. 1: Minor infection (erythema, stitch abscess or skin edge necrosis). 2: Major infection (purulent discharge or wound dehiscence). Pus could bedetected within a few days of operation (in hospital wound infection) or its appearance could be delayed for as long as 3 weeks (delayed wound infection).	A) 64/501 B) 64/503	NR	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Mohammed et al.[71] (2020)	RCT single center (160)	Elective or emergency cesarean section	II	B) A+amoxicillin-clavulanic acid+Metroni-dazole for 6 days additionally	A) amoxicillin-clavulanic Acid 1.2 g IV 60 min before commencement of the skin incision+ amoxicillin+clavulanic Acid 1.2 g IV 12 hours postoperatively	30 days	(1) purulent drainage, (2) organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision, and (3) at least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat, fever ≥38°C, and superficial incision is deliberately opened by surgeon, unless incision is culture-negative	A) 5/78 B) 8/76	Adverse effects of treatment on the woman (e.g., allergic reactions, nausea, vomiting, diarrhea, skin rashes, thrush)	<24 hours vs. >24 hours
Mohri et al.[20] (2007)	RCT multi-center (486)	Elective gastric cancer surgery	II	B) A+7 additional doses at 12-hour intervals.	A) 1 g cefazolin IV or 1.5 g ampicillin sulbactam IV 30 minutes preoperatively+repeat if duration >3 hours	6 weeks	CDC	A) 23/243 B) 21/243	No AE	Single vs. prolonged
Mui et al.[8] (2005)	RCT single center (269)	Appendectomy (open) Uncomplicated Including paediatric patients (age 15-70 years)	II-III	B) A+2 more IV antibiotic doses (A). C) A+5-day course of antibiotics. IV (A) until orally was tolerated (cefuroxime 250 mg 2 times daily+ metronidazole 400 mg 3 times daily).	A) Cefuroxime 1.5 g IV metronidazole 500 mg IV at introduction of general anaesthesia.	30 days post-operatively	Discharge of pus that required surgical drainage before discharge.	According to groups (inter-vention vs. control): A) 6/92 B) 6/94 C) 3/83	B) 1 C. difficile C) 4 C. difficile	Single vs. prolonged <24 hours vs. >24 hours

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Niederhäuser et al.[76] (1997)	RCT single center (53)	Patients with severe heart failure who could not be weaned from cardiopulmonary bypass without IABP	I	B) A+thereafter: ticarcillin/ clavulanate 5.2 g every 8 hours for 2 days+ vancomycin 500 mg every 12 hours until removal of IABP (NB: Different postoperative agent)	A) 1 g of cefazolin at induction of anaesthesia, 1 g after 8 hours, 1 g after 16 hours.	3-540 days	CDC	A) 1/25 B) 1/28	NR	<24 hours vs. >24 hours
Nooyen et al.[43] (1994)	RCT single center (844)	CABG	I	B) A+750 mg cefuroxime 3 times daily for 3 consecutive days.	A) 20 mg/kg cefuroxime IV at induction of anaesthesia.	NR	Redness, purulent discharge and a positive culture	A) 12/419 B) 6/425	NR	Single vs. prolonged
Nusrath et al.[30] (2020)	RCT single center (315)	Clean-contaminated oncological surgeries	II	B) A+cefuroxime 1.5 g IV three times a day for 3 days postoperatively	A) Cefuroxime 1.5 g IV immediately before surgery (colonic and esophageal surgeries: metronidazole additionally)	30 days	Incision site infection and organ/space infection according to the CDC definitions	A) 18/159 B) 23/156	NR	Single vs. prolonged
Olak et al.[45] (1991)	RCT single center (199)	Thoracotomy/lung resection	II	B) A+5 doses of cefazolin 1 g every 8 hours (without placebo)	A) 1 dose of 2 g cefazolin IV at induction of anaesthesia+ 5xplacebo every 8 hours.	6 weeks	Any wound that discharged, spontaneously or otherwise, purulent material with or without culture of a pathogen.	A) 0/99 B) 2/100	NR	Single vs. prolonged
Orlando et al.[48] (2015)	RCT multi-center (205)	Renal transplant surgery	I	B) A+cefazolin 1 g or cefotaxim 1 g every 12 hours until removal of Foley catheter (postoperative days 3-5).	A) 1 Shot of broad-spectrum antibiotic (cephalosporin cefazolin 2 g, cefotaxim 1 g).	30 days	CDC	A) 2/103 B) 1/102	NR	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classification	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Phillips et al.[82] (2016)	RCT single center (112)	Tissue expander-based immediate breast reconstruction	I	B) A+Keflex 500 mg PO four times per day or Clindamycin 300 mg PO three times per day until all drains were removed.	A) Cefazolin 1 g or 2 g IV (BMI>30) or Clindamycin 600 mg or 900 mg (BMI>30) if allergic to penicillin 4-6 hour intervals for 24 hours	Follow-up was continued until all patients reached one of the study endpoints (Surgical site infection, one-year post-expander placement, 2nd stage implant exchange, re-operation, or loss of an implant)	SSI within 365 days of operation with presence of an implant	A) 12/62 B) 11/50	A) 13/62 B) 14/50	<24 hours vs. >24 hours
Rafiq et al.[9] (2015)	RCT single center (400)	Non-perforated appendectomy	II	B) A+additional single dose of cefuroxime sodium and metronidazole 8 hours post-operatively	A) cefuroxime sodium and metronidazole half-an-hour preoperatively i.e. before induction	6 weeks	Wound tenderness, fever or pus discharge	A) 15/192 B) 18/198	NR	Single vs. prolonged
Rajabi-Mashhadi et al.[10] (2012)	RCT single center (291)	Appendectomy (open) Uncomplicated Included paediatric patients (age 15-70 years)	II-III	B) A+1 day ceftriaxone (1 g) IV every 12 hours, metronidazole 500 mg IV every 8 hours. C) A+3 days ceftriaxone (1 g) every 12 hours, metronidazole 500 mg every 8 hours.	A) Ceftriaxone 1 g IV+metronidazole 500 mg IV at induction.	10 days after discharge	Discharge of pus that required surgical drainage before discharge.	According to groups (intervention vs. control): A) 8/97 B) 6/97 C) 5/97	No AE	Single vs. prolonged <24 hours vs. >24 hours

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Rajan et al.[51] (2005)	RCT single center (200)	Septorhinoplasty	II	B) A+postoperative oral course of amoxicillin clavunate 1,000 mg 2 times daily.	A) Preoperative IV amoxicillin clavulanate 2.2 g 30 minutes before incision.	30 days	Wound infection.	A) 0/100 B) 3/100	B) 29 A) 2 (nausea, diarrhoea, skin rash, pruritus)	Single vs. prolonged
Regimbeau et al.[23] (2014)	RCT multi-center (414)	Cholecystectomy for acute mild or moderate calculous cholecystitis Open or laparoscopic	II-III	B) A+the same regimen for 5 days IV or oral if tolerated.	A) 2 g amoxiclav 3 times daily before surgery and at injection of general anaesthesia.	30 days	CDC	A) 22/207 B) 21/207	No AE	Single vs. prolonged
Righi et al.[79] (1996)	RCT single center (162)	Oncologic surgery in the head and neck involving the upper aero digestive tract (excluding free flap)	II	B) A+extended to 9 doses of clindamycin and 3 doses of cefonicid for 72 hours	A) Clindamycin 600 mg IV at induction, followed by 3 doses, one every 8 hours Followed by 1 g after 12 hours. 24 hours	20 days	Purulent drainage (either spontaneously or by incision) or muco-cutaneous fistula interpreted as wound infection.	A) 2/81 B) 3/81	No AE	<24 hours vs. >24 hours
Saar et al.[61] (2019)	RCT Single center (80)	Appendectomy (grade 2, gangrenous; grade 3, perforated with localized free fluid; grade 4, perforated with a regional abscess)	II	B) A+amoxicillin with clavulanic acid 1.2 g IV or ampicillin with sulbactam 3 g IV 8-hour intervals for 24 hours additionally+ continued intravenous or an oral administration per the treating physician's assessment	A) amoxicillin with clavulanic acid 1.2 g IV or ampicillin with sulbactam 3 g IV every 8 hours for 24 hours	30 days	Surgical site infection including superficial and deep incisional and organ/space SSI (intra-abdominal abscess) was defined per Centers for Disease Control and Prevention guideline	A) 8/39 B) 8/41	NR	<24 hours vs. >24 hours

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Sadraei-Moosavi et al.[11] (2017)	RCT single center (152)	Emergency open appendectomy	II	B) A+ceftriaxone 1 g IV and metronidazole 500 mg IV up to 24 hours	A) ceftriaxone 1 g IV and metronidazole 500 mg IV	30 days	Pus discharge from the wound, redness, tenderness and edema	A) 1/76 B) 1/76	NR	Single vs. prolonged
Salih et al.[12] (2018)	RCT single center (123)	Appendicectomy	II	B) A+metronidazole 500 mg IV 8 hour interval for 3 days postoperatively.	A) metronidazole 500 mg IV preoperatively at time of incision	10 days	Local edema, erythema, local tenderness, fever or discharging pus	A) 4/51 B) 4/60	NR	Single vs. prolonged
Sawyer et al.[96] (1990)	RCT multi-center (50)	Major head and neck procedures involving the upper aerodigestive tract	II	B) Preoperative dose plus at least 7 days of antibiotics. Metronidazole 500 mg every 6 hours, cefazolin 1 g every 8 hours IV	A) Preoperative dose plus 2 days of antibiotics. Metronidazole 500 mg every 6 hours, cefazolin 1 g every 8 hours IV	NR	Major wound infection was defined as wound breakdown and undermining of tissues sufficient to allow packing of the wound. Lesser complications, such as cellulitis or a tiny fistula, allowing only entry of a cotton-tipped applicator were considered as minor.	A) 8/25 B) 5/25	No AE	<48 hours vs. >48 hours
Scher[31] (1997)	RCT single center (768)	Elective clean-contaminated operations on the gastrointestinal or biliary tracts	II	B) A+3 additional 1 g doses of cafazolin every 8 hours.	A) 1 g of cefazolin 15-30 minutes preoperatively+repeat if procedure duration >3 hours.	NR	NR "Wound surveillance by infection control nurses."	A) 15/382 B) 14/386	NR	Single vs. prolonged
Shaheen and Akhtar[35] (2014)	RCT single center (100)	Elective caesarean section	II	B) A+2 doses of 1 g cefotaxime IV every 12 hours followed by cefuroxime 400 mg postoperatively for 5 days.	A) 1 g of cefotaxime IV 30 minutes before the operation.	6 weeks	Superficial or deep infection, pus discharge, abscess formation, wound dehiscence, and haematoma formation.	A) 5/50 B) 6/50	NR	Single vs. prolonged
Su et al.[39] (2005)	RCT single center (532)	Gyn aecological surgery Hysterectomy, abdominal laparoscopic and vaginal, ovarian cystectomy	II	B) A+another 3 doses (A) every 6 hours postoperatively.	A) Cefazolin 1 g at induction of anaesthesia+redose if duration >4 hours .	90 days	1) Abdominal wound infection or trocar wound infection (including wound discharge or abscess). 2) Pelvic abscess or tubo-ovarian abscess. 3) Vaginal cuff abscess. 4) Post operative septicemia.	A) 1/267 B) 1//264	NR	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classification	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Sugawara et al.[92] (2018)	RCT single center (86)	Combined liver and extrahepatic bile duct resection	II-III	B) A+every 8 hours postoperatively for 2 days additionally	A) Antibiotics IV 30 minutes before surgery+every 3 hours during surgery+every 8 hours postoperatively for 2 days (When the bile culture was negative, first or second-generation cephalosporins were used. When the bile culture was positive, antibiotics were selected according to the susceptibility of the specific microorganisms detected)	30 days	Purulent discharge was observed from any incision or space that was manipulated intraoperatively or as fluid collection requiring a new drainage procedure within 30 days after the operation according to the Guidelines for Prevention of Surgical Site Infection established by the Centers for Disease Control and Prevention	A) 8/43 B) 10/43	NR	<48 hours vs. >48 hours
Suzuki et al.[16] (2011)	RCT single center (370)	Elective laparotomy for colon cancer	II-III	B) A+2 times a day 1 g flomoxef (until post-operative day 3).	A) Single dose of flomoxef 1 g before surgery.	30 days	Macroscopic abscess or purulent discharge observed on the operative wound. Organ/space SSI was defined as infection in the organ subjected to surgery	According to groups (intervention vs. control): A) 16/179 B) 15/181	No AE	Single vs. prolonged
Takayama et al.[68] (2019)	RCT multi-center (480)	Liver cancer surgery	II	B) A+flomoxef 1 g every 12 hour for 2 days additionally.	A) Flomoxef 1 g IV 30 min before surgery+ Flomoxef 1 g every 3 hour during surgery, and at 6 hour postoperatively for 1 day	30 days	(1) Inflammatory findings such as fever and flare, (2) drainage of pus from the incision or drain, (3) detection of pathogen by culture of fluid or tissue sample, and (4) fluid retention on enhanced CT indicating the presence of pus in a deep region	A) 22/232 B) 23/235	NR	<24 hours vs. >24 hours

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classification	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Takemoto et al.[73] (2015)	RCT single center (314)	Thoracic/lumbar spine surgery+ drain for degenerative/ idiopathic spine deformity	I	B) A for drain duration (average of 3.2 days). Dose and regimen not specified beyond duration.	A) 24 hours of cefazolin (methicillin-resistant Staphylococcus aureus, allergy, or recent surgery: vancomycin or clindamycin). Dose and regimen not specified beyond duration.	1 year	CDC	A) 21/170 B) 19/144	NR	<24 hours vs. >24 hours
Tamayo et al.[44] (2008)	RCT single center (838)	CABG, valve or both	I	B) A+2×1 g every 8 hours (24 hours).	A) 2 g cefazolin IV 20-30 minutes after induction of anaesthesia+redose when procedure exceeded >3 hours	12 months	CDC	A) 35/419 B) 15/419	NR	Single vs. prolonged
Tan et al.[36] (2020)	RCT single center (324)	Cesarean section	II	B) A+cefuroxime 2 g IV 3 days after surgery	A) cefuroxime 2 g IV 30 minutes before surgery	3 days	Abdominal incision infection: postoperative maternal body temperature of >38°C; with incision bleeding, redness and pain, inflammatory exudate, or possible dehiscence of incision/Puerperal infection: postoperative maternal body temperature of >38°C for 2 days after delivery; serum WBC count of $>10\times10^9$/mL, neutrophils of >80%, and CRP level of >10 mg/L, or complication with symptoms of systemic infection/ Intrauterine infection: fever accompanied by significant tenderness at the uterus and parametrium, increase of smelly lochia and positive bacterial culture of cervical secretions	A) 4/162 B) 7/162	NR	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classi-fication	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Togo et al.[93] (2007)	RCT single center (180)	Hepatectomy without reconstruction of biliary/intestinal tract	II	B) A for 5 days.	A) 1 g of flomoxef 30 minutes before surgery+redose every 3 hours during surgery, 1 g 2 hours after the completion of surgery and then 2 g a day after the operation day (1 g every 12 hours) for 2 days.	30 days	CDC	A) 4/89 B) 4/91	NR	<48 hours vs. >48 hours
Tsang et al.[13] (1992)	RCT single center (103)	Appendectomy (open) Uncomplicated Paediatric patients	II-III	B) A+2 more postoperative doses (A) at 8 hour intervals.	A) 1.5 mg/kg gentamicin+ 7.5 mg/kg metronidazole with the pre-anaesthetic medication.	4 weeks	Evidence of purulent discharge from the wound with or without a positive bacteriological culture.	According to groups (inter-vention vs. control): A) 1/48 A) 1/55	NR	Single vs. prolonged
Turano[32] (1992)	RCT single center (3,567)	Abdominal, gynaecological and urology Including paediatric patients (age 2-97 years)	II-III	C) A+2 1 g doses IV at 6-hour intervals after the first dose.	A) 1 g of cefotaxime IV 30 minutes prior to incision (repeat in 6 hours if procedure >3 hours).	7 days/ discharge	Discharge of serous or seropurulent material from the wound within 7 days of operation	A) 28/1802 B) 39/1765	Unspecified systemic side-effects: A) 20 B) 20 Unspecified local side effects: A) 10 B) 40	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classification	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Urquhart et al.[74] (2019)	RCT single center (655)	Posterior, open thoracolumbar spine procedures	II	B) A+cefazolin 1 g IV every 8 hours for additional 48 hours postoperatively (or vancomycin 1 g IV every 12 hours)	A) Cefazolin 2 g IV 1 hour to no later than 15 minutes prior to the surgical incision (vancomycin within 1 hour of incision if the patient was allergic to penicillin or cephalosporin)+ cefazolin 1 g IV every 8 hours postoperatively for 24 hours (or vancomycin 1 g IV every 12 hours)	12 months	U.S. Centers for Disease Control and Prevention definitions for superficial, deep, and organ or space surgical site infection were used in the diagnosis	A) 44/282 B) 36/270	NR	<24 hours vs. >24 hours
Wahab et al.[58] (2013)	RCT single center (60)	Bilateral sagittal split osteotomy Orthognathic surgery Included paediatric patients (age 17-37 years)	II	B) A+2 doses of 500 mg amoxicillin IV every 4 hours	A) 1 g amoxicillin at induction+2 saline solution doses IV every 4 hours	2 months	CDC	A) 6/30 B) 1/30	NR	Single vs. prolonged
Westen et al.[37] (2015)	RCT multi-center (176)	Elective and emergency caesarean section	II	B) A+500 mg amoxicillin and 500 mg metronidazole IV at 8 and 16 hours followed by 500 mg moxicillin and 400 mg metronidazole postoperatively 3 times daily on days 3-5.	A) 1 g ampicillin and 500 mg metronidazole IV 20 minutes before caesarean section.	30 days	All clinical signs of infection starting from presence of erythema (not exclusively serous discharge or gaping).	A) 6/89 B) 9/87	NR	Single vs. prolonged

Table 2. Continued

Study	Design, scope, participants (number)	Type of surgery	CDC wound classification	Intervention	Control	Follow-up	Primary outcome	Results	Adverse events/ remarks	Comparison
Yalagachin et al.[33] (2018)	RCT single center (822)	Elective clean surgical procedures (hernia, breast, thyroid, others) and laparoscopic cholecystectomy	II	B) A+Ceftriaxone 1 g IV postoperatively for 3 days or more	A) Ceftriaxone 1 g IV 1 hour prior or at the time of incision	1 year	Incision site discharge, pain, tenderness, swelling, and redness	A) 4/413 B) 4/427	NR	Single vs. prolonged
Yamamoto et al.[69] (2018)	RCT Multi-center (89)	Pancreaticoduodenectomy following biliary drainage	II-III	B) A+Cefozopran 1 g IV every 12 hours for another 4 consecutive days	A) Cefozopran 1 g IV 30 minutes immediately after induction, and additional doses were given once every 3 hours during the operative procedure+ Cefozopran 1 g IV postoperatively on the day of surgery	NR	Intra-abdominal abscess, postoperative cholangitis and wound infection	A) 4/40 B) 11/42	NR	<24 hours vs. >24 hours

RCT: randomized controlled trial, CDC: Centers for Disease Control and Prevention, IV: intravenous, AE: adverse event/s, AB: antibiotic, NR: not recorded, SSI: surgical site infection, IM: intramuscular, CABG: coronary artery bypass grafting, IABP: intra-aortic balloon pumping, PO: per oral, BMI: body mass index, CT: computed tomography, WBC: white blood cell, CRP: C-reactive protein.

률에 차이가 관찰되지 않았다.

수술 종류에 따른 하위분석 시 심장수술, 혈관수술 그리고 정형외과수술에서만 수술 후 예방적 항생제 지속 투여가 수술부위 감염을 줄이는 것으로 나타났다.

54개의 RCT에 대한 메타분석 결과 수술 후 예방적 항생제 지속 투여는 수술 전 예방적 항생제 일 회 투여와 비교하여 수술부위 감염 예방 효과에 차이를 보이지 않았다(risk ratio [RR]: 0.95; 95% confidence interval [CI]: 0.85-1.06). 근거 수준은 중등도 근거 수준으로 평가하였다.

2. 수술 후 24시간 이내의 예방적 항생제 지속 사용 vs. 수술 후 일 회 추가 투여 요법 비교에 포함된 1개의 RCT[60]는 227명의 대장절제술을 시행 받은 환자를 대상으로 하였으며 수술 후 예방적 항생제 일 회 추가 투여군과 수술 후 16시간까지 예방적 항생제 사용을 유지한 환자군을 비교한 연구였다. 수술 후 16시간까지 예방적 항생제 사용을 유지한 경우 수술부위 감염 예방 효과에 차이를 보이지 않았다(RR: 0.88; 95% CI: 0.62-1.24). 근거 수준은 낮은 근거 수준으로 평가하였다.

3. 수술 후 24시간 이상의 예방적 항생제 지속 사용 vs. 수술 후 24시간 이내의 예방적 항생제 지속 사용의 비교에는 33개의 RCT, 5,642명의 환자가 분석에 포함되었다. 분석에 포함된 수술의 종류에는 충수절제술,[61] 대장절제술,[8,10,62-66] 담낭절제술,[67] 간담도 수술,[68,69] 제왕절개,[70,71] 척추수술,[72-74] 심장수술,[75,76] 두경부수술,[77-79] 귀, 코 및 목 수술,[80] 악안면수술,[81] 가슴재건수술,[82] 정형외과 수술,[83-88] 외상 수술,[89,90] 그리고 부인과 수술[91]이 포함되었다. 2개의 RCT[84,90]가 수술 후 24시간 이상 예방적 항생제 지속 사용이 수술부위 감염률을 낮춘 것으로 보고했고, 1개의 RCT[85]는 수술 후 24시간 이내에 예방적 항생제 사용을 중단한 경우가 24시간 이상 지속한 경우보다 오히려 수술부위 감염이 더 낮았다고 보고하였다. 그 외 30개의 RCT는 두 군 간의 수술부위 감염률 차이를 보이지 않았다.

33개 RCT에 대한 메타분석 결과 수술 후 24시간 이상 예방적 항생제 지속 사용은 수술 후 24시간 이내 예방적 항생제 사용 중단에 비해 수술부위 감염 예방 효과에 차이를 보이지 않았다(RR: 0.97; 95% CI: 0.82-1.15). 근거 수준은 중등도 근거 수준으로 평가하였다.

4. 수술 후 48시간 이상의 예방적 항생제 지속 사용 vs. 수술 후 48시간 이내 예방적 항생제 지속 사용의 비교에는 5개의 RCT, 786명의 환자가 분석에 포함되었다. 분석에 포함된 수술의 종류는 간담도 수술,[92,93] 제왕절개,[94] 심장수술,[95] 그리고 두경부수술[96]이 포함되었다. 모든 개별 연구들이 수술 후 48시간 이상의 예방적 항생제 지속 사용에 대한 이득이 없는 것으로 보고하였고 메타분석 결과도 수술 후 48시간 이상의 예방적 항생제 지속 사용이 수술 후 48시간 이내 예방적 항생제 중단에 비해 수술부위 감염 예방 효과에 차이를 보이지 않았다(RR: 1.22; 95% CI: 0.76-1.95). 근거 수준은 낮은 근거 수준으로 평가하였다.

2개[13,62]의 연구만이 소아청소년 환자만을 대상으로 하였으며, 20개의 연구[7-12,25,27,29,32,33,53,56,58,80,86-90] 소아청소년 환자를 일부 포함하는 대다수의 성인환자를 대상으로 하였고, 그 외 나머지 연구들은 성인만을 대상으로 하였다.

분석에 포함된 연구는 54개의 RCT이다(Fig. 1). 많은 수의 RCT에서 얻은 중간 등급의 근거수준은 수술 후 예방적 항생제의 지속적인 투여가 수술 전 예방적 항생제 단일 투여와 비교하여 수술부위 감염률의 차이가 없음을 보여주었다.

더불어 예방적 항생제의 수술 후 지속 사용과 관련한 항생제 내성 위험 증가 및 비용 증가 등의 피해를 고려하여 권고사항개발그룹은 수술부위 감염을 줄이기 위한 목적으로 수술 후 예방적 항생제의 지속적인 투여는 권장하지 않기로 합의하였으며 수술의 종류와 사용된 항생제의 종류 및 창상 분류가 다양한 연구들이 혼재해 있어 선택적 권고로 결정하였다(Table 3).

결론

수술 후 예방적 항생제의 추가적인 사용은 권고하지 않는다.

(제한적 권고(Do not, Conditional recommendation], 중등도 수준의 근거[Moderate quality of evidence])

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Table 3. Summary of Finding Table

Comparison 1: Postoperative continuation vs. single dose of antibiotic prophylaxis, outcome SSI											
Certainty assessment							Summary of findings				
							Study event rates (%)			Anticipated absolute effects	
Participants (studies) Follow-up	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall certainty of evidence	With no postoperative	With Any prolonged	Relative effect (95% CI)	Risk with no postoperative	Risk difference with any prolonged
SSI											
20522 (54 RCTs)	Serious[a]	Not serious	Not serious	Not serious	None	⊕⊕⊕◯ Moderate	619/10,155 (6.1%)	588/10,367 (5.7%)	RR 0.95 (0.85 to 1.06)	64 per 1,000	3 fewer per 1,000 (from 9 fewer to 4 more)
Comparison 2: Continuation of antibiotic prophylaxis for up to 24 hours compared to no postoperative for surgical site infection											
Certainty assessment							Summary of findings				
							Study event rates (%)			Anticipated absolute effects	
Participants (studies) Follow-up	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall certainty of evidence	With no postoperative	With up to 24 hrs	Relative effect (95% CI)	Risk with no postoperative	Risk difference with any prolonged
SSI											
227 (1 RCT)	Serious[a]	Not serious	Not serious	Very serious[b]	None	⊕⊕◯◯ Low	44/113 (38.9%)	39/114 (34.2%)	RR 0.88 (0.62 to 1.24)	389 per 1,000	47 fewer per 1,000 (from 148 fewer to 93 more)
Comparison 3: postoperative continuation for more than 24 hours vs. continuation for up to 24 hours, outcome SSI											
Certainty assessment							Summary of findings				
							Study event rates (%)			Anticipated absolute effects	
Participants (studies) Follow-up	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall certainty of evidence	With less than 24	With more than 24	Relative effect (95% CI)	Risk with less than 24	Risk difference with more than 24
SSI											
5,642 (33 RCTs)	Serious[a]	Not serious	Not serious	Not serious	None	⊕⊕⊕◯ Moderate	267/2,860 (9.3%)	252/2,782 (9.1%)	RR 0.97 (0.82 to 1.15)	93 per 1,000	3 fewer per 1,000 (from 17 fewer to 14 more)

CI: confidence interval, RCTs: randomized controlled trials, RR: risk ratio, SSI: surgical site infection. [a]Downgraded for study limitations: high risk of bias or some concerns for multiple domains. [b]Downgraded for imprecision: wide CI crosses assumed threshold of appreciable benefit and harm (absolute risk reduction 5%).

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

Conceptualization: Jae Hung Jung. Data acquisition: Youn Young Park, Youngki Hong. Formal analysis: Youn Young Park, Jae Hung Jung, Sung Uk Bae. Supervision and validation: Youngki Hong, Sung Uk Bae, Ji Young Jang, Gyoung Tae Noh, Sung Huhn Kim, Jongrim Choi, Yong Won Seong, Hye Jin Kim, Yoon Bin Jung, Chong Bum Chang, Bo Young Oh, Kyoung Sik Park, Yonghae Baik, Chan-Young Kim, Ji Won Park, Chang Hyun Kim, Hyung Soon Lee, Young Seok Kim, Hyun Jung Kim. Writing of original draft: Youn Young Park, Jae Hung Jung. Review and editing: Youngki Hong, Hyun Jung Kim, Suk-Hwan Lee, Jun Won Um.

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근거 중심의 수술부위감염 예방 진료권고안: 배액관

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The Evidence-Based Practice Guidelines for Prevention of Surgical Site Infection: Surgical Drains

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The continuous use of perioperative antibiotic prophylaxis before and after surgery to prevent surgical site infection (SSI) is controversial when drain are present in the postoperative wound. In addition, there are still debate about when is the optimal time to remove the drain to prevent SSI. On behalf of the Korean Surgical Infection Society, the practice guidelines committee collected data regarding the antimicrobial prophylaxis in the presence of a drain and optimal timing for wound drain removal. Following the intensive review and analysis, the practice guidelines committee decided to recommend that continued use of antibiotics is not recommended because of the presence of a wound drain after surgery (Do not, Conditional recommendation, low quality of evidence). And early removal of the wound drain is recommended when clinically indicated (Do, Conditional recommendation, low quality of evidence).

Key Words: Antibiotic prophylaxis, Surgical site infection, Drainage

서론

배액관은 수술 후 체내 수술 부위 또는 체내 조직에 혈액이나 장액 등이 고여 수술부위감염을 유발하는 것을 방지하기 위해 삽입한다. 그러나 수술 후 상처에 배액관이 존재할 경우, 수술부위감염을 예방하기 위해 수술 전후로 예방적 항생제를 계속 사용하는 것은 논란의 여지가 있다. 또한, 수술부위감염 예방하기 위한 상처 배액관 제거의 최적의 시기가 언제 인지에 대해서도 여전히 다양한 의견이 존재한다. 따라서 본 진료권고위원회에서는 가용한 근거를 수집하고 체계적인 검토 및 분석을 통해 수술 후 배액관이 존재할 경우에 예방적 항생제 사용 및 상처 배액관 제거를 위한 최적의 시기에 대한 진료지침을 마련하고자 하였다.

대상 및 연구 방법

진료권고안 개발 방법은 수용개작 방식(adaptation)으로 개발되었으며, 2016년 발표된 세계보건기구(World Health Organization, WHO) 가이드라인[1]을 기준 진료권고안으로 최신성을 보강하는 GRADE-ADOLOPMENT 방법[2]을 적용하였다. WHO 가이드라인의 권고안에서 국내 수술환경에 적용할 대상을 핵심질문으로 선정하였고, 최신성 보강을 위해 문헌 검색을 시행하여 추가하였다(Table 1). 국외 논문은 MEDLINE, EMBASE, CINAHL, Cochrane으로 WHO 가이드라인에서 적용한 기간(1990년 1월 1일부터 2015년 2월 16일)을 최신까지 연장하여 검색하였고, 국내 논문 검색은 KMBASE, KoreaMed를 기간 제한 없이 검색하였으며, 논문 검색은 2021년 1월 12일에 수행되었다(Fig. 1).

Table 1. 포함 및 배제기준

1. 배액관이 있을 때 수술 후 항생제를 계속 사용해야 하는가?	
대상환자(P)	배액관이 있는 수술 환자
중재(I)	수술 후 항생제 사용
비교군(C)	수술 후 항생제 사용 안함
결과(O)	수술부위 감염률, 수술부위감염으로 인한 사망률
연구설계(S)	무작위 대조군 연구
대상 사용자	수술을 하는 1-3차 의료기관의 외과계열 전문의
2. 수술부위감염을 감소시키기 위한 적절한 배액관 제거 시기는?	
대상환자(P)	배액관이 있는 수술 환자
중재(I)	배액관 일찍 제거
비교군(C)	배액관 늦게 제거
결과(O)	수술부위 감염률, 수술부위감염으로 인한 사망률
연구설계(S)	무작위 대조군 연구
대상 사용자	수술을 하는 1-3차 의료기관의 외과계열 전문의

P: population, I: intervention, C: comparison, O: outcomes, S: setting.

핵심질문 11. 배액관이 있을 때 수술 후 항생제를 계속 사용해야 하는가? 수술부위감염을 감소시키기 위한 적절한 배액관 제거 시기는?

근거수준: 근거수준평가와 근거의 강도와 한계

1. 전반적으로 낮은 수준의 근거 들에서(9편의 무작위 대조군 연구[3-11]) 상처 배액관이 있을 때, 장기간 예방적 항생

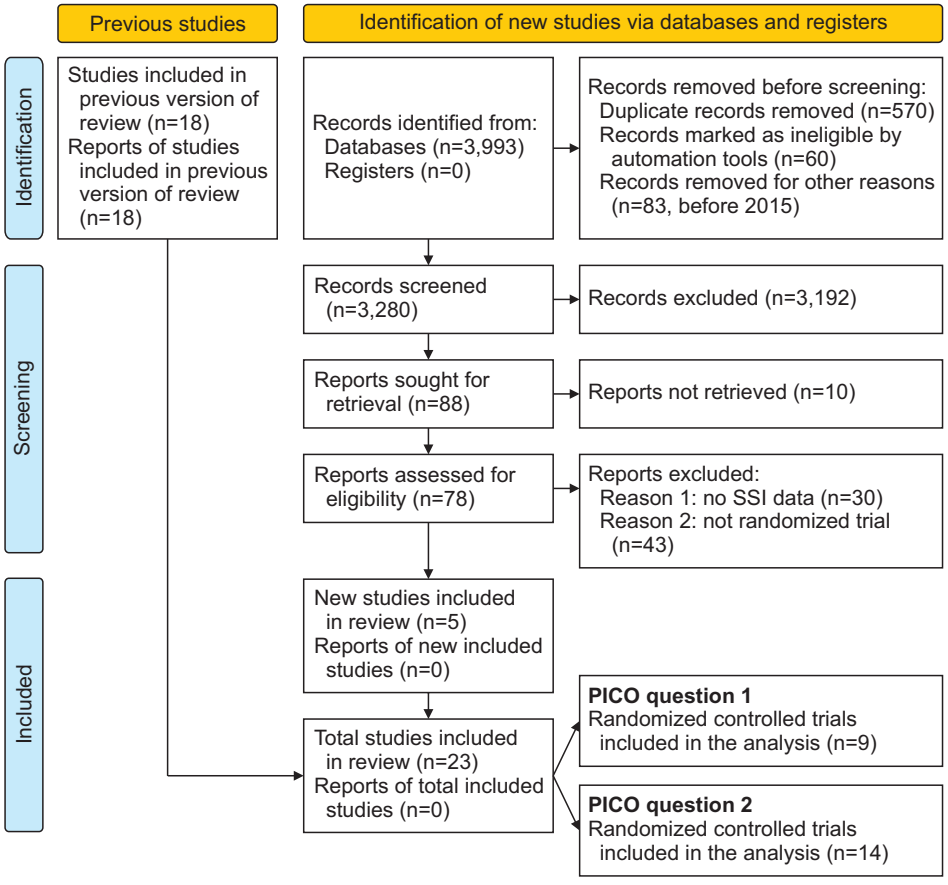

Fig. 1. Study selection. PRISMA 2020 flow diagram for updated systematic reviews which included searches of databases and registers only. PRISMA: preferred reporting items for systematic reviews and meta-analyses, SSI: surgical site infection, PICO: population, intervention, comparison, outcomes.

제 사용이 수술 전 단독 예방 요법과 비교했을 때, 수술부위감염을 줄이는 데 도움이 되지 않으며, 해롭지도 않다는 것을 보여주었다. 장기간 예방적 항생제 사용이 수술부위감염과 관련된 합병증을 예방한다는 근거가 없다는 것을 고려할 때, 진료지침 개발 위원회는 상처 배액관이 있을 때 예방적 항생제 사용을 계속해서는 안 된다는 결론을 도출하였다. 증거의 quality가 낮기 때문에 이 권고 사항의 강도는 제한적 권고로 간주된다(Tables 2A, 3).

2. 낮은 수준의 근거는(14편의 무작위 대조군 연구[12-25]) 상처 배액관의 조기 제거가 배액관의 늦은 제거(수술 후 6일 이상)와 비교했을 때, 수술부위감염을 감소시키는데 도움이 되거나 해가 되지 않음을 보여주었다. 특히 수술 후 1일부터 5일 이내의 조기 제거와 수술 후 6일 이후의 상처 배액관 제거를 비교했을 때, 뚜렷한 이득이 나타나지 않았다. 낮은 수준을 가진 근거의 본문에서 수술부위감염 예방과 관련하여 상처 배액관 제거를 위한 최적의 시점을 식별하지 못한다는 것을 고려하여, 진료권고안 개발 위원회는 임상적으로 적응증에 해당될 경우, 상처 배액관을 조기에 제거할 것을 권고했다. 증거의 수준이 낮으므로, 이 권고 사항의 강도는 선택적 권고로 간주된다(Tables 2B, 3).

결론

1. 수술 후 상처 배액관이 있다고 해서 항생제를 계속 사용하는 것을 권고하지 않는다.

(제한적 권고[Do not, Conditional recommendation], 낮은 수준의 근거[low quality of evidence])

2. 임상적으로 적응증에 해당할 경우, 상처 배액관을 조기에 제거할 것을 권고한다.

(선택적 권고[Do, Conditional recommendation], 낮은 수준의 근거[low quality of evidence])

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Table 2. Evidence Table

Study	Country/ study period	Type of study/ setting	Intervention	Comparator	Primary outcome	Results	Limitations
A. Evidence table: studies related to prolonged vs. single-dose antibiotic prophylaxis							
Becker et al.[3] (2008)	Israel Not provided	RCT: randomization by drawing envelopes 42 general surgery patients General hospital	Prolonged ABP (n=21) 1 g cefazolin at 8-hour intervals until drain removal (drainage <40 mL/day)	Single-dose ABP (n=21) Single dose of 1 g cefazoline at 30 minutes prior to incision.	SSI: CDC definitions Length of follow-up unknown	33% in prolonged ABP group 19% in single-dose ABP group p-value not provid OR not provided	Sequence generation unknown. Participants not blinded. Blinding of care-providers and outcome assessors unknown. No a priori sample size calculation. Number of patients lost to follow-up unknown.
Hall et al.[4] (1998)	Australia 1993-1998	RCT: randomized by random number table and opening a sealed envelope 302 general surgery patients Teaching/university hospital	Prolonged ABP (n=149) 3 g ticarcillin/0.1 g clavulanate at 6-hour intervals until drain removal.	Single-dose ABP (n=153) Single dose of 3 g ticarcillin/0.1 g clavulanate immediately after induction of anaesthesia.	Wound infection was defined as the discharge of pus or a serous discharge that contains pathogenic organisms. 42-day follow-up	10% in prolonged ABP group 18% in single-dose ABP group Difference: 2; 95% CI: −1.02, 3.92 p=0.041	Participants not blinded. Blinding of care-providers and outcome assessors unknown. No validated SSI definition. Number of patients lost to follow-up unknown.
Mohri et al.[5] (2007)	Japan 2001-2004	RCT: randomization by a central computerized system in a 1:1 ratio 486 gastric cancer surgery patients Multicentre	Prolonged ABP (n=243) 1 g cefazolin or 1.5 g ampicillin–sulbactam at 12-hour intervals to achieve a total of 7 doses.	Single-dose ABP (n=243) Single dose of 1 g cefazolin or 1.5 g ampicillin sulbactam at 30 minutes prior to incision.	SSI: CDC definitions 6-week follow-up 0 lost to follow-up	8.6% in prolonged ABP group 9.5% in single-dose ABP group Difference: 0.9; 95% CI: −0.3, 5.9 p-value not provided	Allocation concealment unknown. Participants not blinded.
Orlando et al.[6] (2015)	Italy 2006-2012	RCT: randomization by random number table 205 transplant surgery patients Multicentre	Prolonged ABP (n=102) 1 g cefazolin or 1 g cefotaxime at 12-hour intervals until drain removal.	Single-dose ABP (n=103) Single dose of 2 g cefazolin or 1 g cefotaxime at the time of anesthesia induction	SSI: CDC definitions 30-day follow-up 0 lost to follow-up	1% in prolonged ABP group 2% in single-dose ABP group p-value not provided OR not provided	Allocation concealment unknown. Participants not blinded. Blinding of care-providers and outcome assessors unknown.
Oxman et al.[7] (2013)	USA 2008-2011	RCT: randomization by random number table and central allocation 245 thoracic surgery patients Teaching/university hospital	Prolonged ABP (n=121) Cefazolin (1 g for patients ≤80 kg and 2 g for patients >80 kg) or 1 g vancomycin if allergic to beta lactams at 8-hour intervals for 2 days or until chest tubes removal, whichever occurred first.	Single-dose ABP (n=124) Single dose of cefazolin (1 g for patients ≤80 kg and 2 g for patients >80 kg) or 1 g vancomycin if allergic to beta lactams+ Placebo at 8-hour intervals for 2 days or until chest tubes removal	SSI: CDC definitions 28-day follow-up 22 lost to follow-up	5% in prolonged ABP group 4% in single-dose ABP p=0.77 OR not provided	Incomplete outcome data.

Table 2. Continued

Study	Country/ study period	Type of study/ setting	Intervention	Comparator	Primary outcome	Results	Limitations
Şeker et al.[8] (2011)	Turkey Not provided	RCT: randomization by opening a sealed envelope 30 pilonidal sinus surgery patients Teaching/university hospital	Prolonged ABP (n=16) 0.5 g cefazolin and 0.5 g metronidazole just before anaesthesia induction, and oral administration of 0.5 g cefazolin and 0.5 g metronidazole for 5 days.	Single-dose ABP (n=14) Single dose of 0.5 g cefazolin and 0.5 g metronidazole just before anaesthesia induction.	Wound infection was defined as redness and swelling at the wound edges or abscess. 1-month follow-up 0 lost to follow-up	6.25% in prolonged ABP group 35.71% in single-dose ABP group p=0.04 OR not provided	Sequence generation unknown. Participants not blinded. Blinding of care-providers and outcome assessors unknown. No a priori sample size calculation. No clear inclusion and exclusion criteria. No validated SSI definition. Stopped early due to unacceptable high rates of wound infections in the single-dose ABP group.
Suzuki et al.[9] (2011)	Japan 2002-2007	RCT: randomization by random number table 360 colon cancer patients Teaching/university hospital	Prolonged ABP (n=181) 1 g flomoxef at 12-hour intervals until POD 3	Single-dose ABP (n=179) Single dose of 1 g flomoxef before surgery	SSI: CDC definitions 30-day follow-up 0 lost to follow-up	8.3% in prolonged ABP group 8.9% in single-dose ABP group p-value not provided OR not provided	Allocation concealment unknown. Participants not blinded. Blinding of care-providers and outcome assessors unknown.
Takemoto et al.[10] (2015)	USA 2008-2011	RCT: randomization by a central computerized system 314 multilevel thoracolumbar spinal surgery patients Teaching/university hospital	Prolonged ABP (n=144) Cefazolin, clindamycin, and vancomycin	Single-dose ABP (n=170) Cefazolin, clindamycin, and vancomycin	SSI: CDC definitions 1-year follow-up	12.4% in single- dose ABP group 13.2% in prolonged ABP group p=0.48 OR not provided	Infections are rather rare and the detection of a small difference would require a much larger sample size.
Urquhart et al.[11] (2019)	Canada 2011-2016	RCT: randomization by a central computerized system 552 spinal surgery patients Teaching/university hospital	Prolonged ABP (n=270) 2 g of cefazolin intravenously, 1 hour to no later than 15 minutes prior to the surgical incision. Postoperatively, patients received either 1 g of cefazolin every 8 hours or 1 g of vancomycin every 12 hours according to their randomization.	Single-dose ABP (n=282) 2 g of cefazolin intravenously, 1 hour to no later than 15 minutes prior to the surgical incision, or 1 g of vancomycin within 1 hour of incision if the patient was allergic to penicillin or cephalosporin.	SSI: CDC definitions 1-year follow-up	6.0% in single-dose ABPgroup 5.2% in prolonged ABP group p=0.714 OR not provided	Single center study Criteria for drain insertion were not standardized, leading to a lack of clarity on indications and the potential for an unrecognized difference between groups Physicians were not blinded

Table 2. Continued

Study	Country/ study period	Type of study/ setting	Intervention	Comparator	Primary outcome	Results	Limitations
B. Evidence table: studies related to early vs. late drain removal							
Ackroyd and Reed[12] (1997)	United Kingdom 1992-1995	RCT: randomization by opening sealed envelopes 120 breast surgery patients Teaching/university hospital	Early removal (n=59) Drain removal at POD 5	Late removal (n=61) Drain removal when drainage <30 mL/24 hours.	Wound infection No definition 1-year follow-up	8% in early removal 5% in late removal p=0.68 OR not provided	Sequence generation unknown. Participants and care-providers not blinded, outcome assessors blinding unknown. No validated SSI definition. Number of patients lost to follow-up unknown.
Baas-Vrancken Peeters et al.[13] (2005)	The Netherlands 2000-2002	RCT: randomization by opening sealed envelopes 100 breast surgery patients Multicentre	Early removal (n=50) Drain removal at POD 1	Late removal (n=50) Drain removal when drainage <50 mL/24 hours, but no later than POD 7.	Wound infection was defined as every inflammation that prompted the attending physician to start antibiotic treatment or when an abscess requiring drainage occurred. 3-month follow up	12% in early removal 20% in late removal p=0.18 OR not provided	Sequence generation unknown. Participants and care-providers not blinded, outcome assessors blinding unknown. No clear inclusion and exclusion criteria. No validated SSI definition. No *a priori* sample size calculation.
Barton et al.[14] (2006)	Canada 2004	RCT: randomization by random number table and opening a sealed envelope 24 breast surgery patients Teaching/university hospital	Early removal (n=10) Drain removal at POD 2.	Late removal (n=14) Drain removal when drainage <30 mL/24 hours or POD 14.	Wound infection was defined as a cloudy aspirate with an associated temperature greater than 38°C or as a purulent discharge from the wound. 1-month follow up	10% in early removal 7% in late removal p>0.05 OR not provided	Participants and care-providers not blinded, outcome assessors blinding unknown. No validated SSI definition. Stopped early due to the finding that patients in the early removal group had significantly higher rates of complications when the interim analysis was performed.
Clegg-Lamptey et al.[15] (2007)	Ghana Not provided	RCT: randomization not specified 87 breast surgery patients Teaching/university hospital	Early removal (n=45) Drain removal at POD 4	Late removal (n=42) Drain removal at POD 10.	Wound infection No definition 1-month follow up	2% in early removal 2% in late removal p=0.18 OR not provided	Sequence generation unknown. Allocation concealment unknown. Participants and care-providers not blinded, outcome assessors blinding unknown. No validated SSI definition. No *a priori* sample size calculation.

Table 2. Continued

Study	Country/ study period	Type of study/ setting	Intervention	Comparator	Primary outcome	Results	Limitations
Dalberg et al.[16] (2004)	Sweden 1993-1997	RCT: randomization not specified 198 breast surgery patients Multicentre	Early removal (n=99) Drain removal at POD 1	Late removal (n=99) Drain removal when drainage <40 mL/24 hours.	Wound infection was defined as any wound condition treated by antibiotics. 4- to 6-year follow-up	4% in early removal 3% in late removal Difference: 0.01; 95% CI: −0.04, 0.06 p=0.70	Sequence generation unknown. Allocation concealment unknown. Participants and care-providers not blinded, outcome assessors blinding unknown. No validated SSI definition. No *a priori* sample size calculation.
Gupta et al.[17] (2001)	United Kingdom 1996-1997	RCT: randomization not specified 121 breast surgery patients Teaching/university hospital	Early removal (n=64) Drain removal at POD 5	Late removal (n=57) Drain removal at POD 8.	Wound infection No definition. Lengths of follow-up not provided	0% in early removal 0% in late removal p=1.0 OR not provided	Sequence generation unknown. Allocation concealment unknown. Participants and care-providers not blinded, outcome assessors blinding unknown. No clear inclusion and exclusion criteria. No validated SSI definition. No *a priori* sample size calculation. Number of patients lost to follow up unknown
Inwang et al.[18] (1991)	United Kingdom Not provided	RCT: randomization not specified 84 breast surgery patients Teaching/university hospital	Early removal (n=41) Drain removal at POD 5	Late removal (n=43) Drain removal when drainage < 20 mL/24 hours.	Wound infection No definition Length of follow-up not provided.	5% in early removal 2% in late removal p-value not provided OR not provided	Sequence generation unknown. Allocation concealment unknown. Participants and care-providers not blinded, outcome assessors blinding unknown. No validated SSI definition. No *a priori* sample size calculation. Number of patients lost to follow up unknown.
Kopelman et al.[19] (1999)	Israel Not provided	RCT: randomization not specified 90 breast surgery patients Multicentre	Early removal (n=42) Drain removal at POD 3	Late removal (n=48) Drain removal when drainage <35 mL/24 hours, but no later than POD 12.	Wound infection No definition. 2-week follow up.	14% in early removal 17% in late removal p=0.8 OR not provided	Sequence generation unknown. Allocation concealment unknown. Participants and care-providers not blinded, outcome assessors blinding unknown. No clear inclusion and exclusion criteria. No validated SSI definition. No *a priori* sample size calculation.

Table 2. Continued

Study	Country/ study period	Type of study/ setting	Intervention	Comparator	Primary outcome	Results	Limitations
Parikh et al.[20] (1992)	England Not provided	RCT: randomization not specified 98 breast surgery patients General hospital	Early removal (n=49) Drain removal at POD 3	Late removal (n=49) Drain removal at POD 6.	Wound infection No definition. Length of follow-up not provided.	4% in early removal 2% in late removal p-value not provided OR not provided	Sequence generation unknown. Allocation concealment unknown. Participants and care-providers not blinded, outcome assessors blinding unknown. No clear inclusion and exclusion criteria. No validated SSI definition. No *a priori* sample size calculation. Number of patients lost to follow-up unknown.
Strahovnik et al.[21] (2010)	Slovenia 2005-2006	RCT: randomization by drawing lots and random numbers in a non-transparent box 97 orthopaedic surgery patients Teaching/university hospital	Early removal (n=51) Drain removal at POD 1	Late removal (n=46) Drain removal at POD 2.	Wound infection No definition. 3-month follow up	0% in early removal 2% in late removal p-value not provided OR not provided	Participants and care-providers not blinded, outcome assessors blinding unknown. No validated SSI definition.
Zamora-Navas et al.[22] (1999)	Spain Not provided	RCT: randomization not specified 32 orthopaedic surgery patients Teaching/university hospital	Early removal (n=22) Drain removal at POD 12 hours and 24 hours	Late removal (n=10) Drain removal at POD 2.	Wound infection No definition. Length of follow-up not provided.	0% in early removal 0% in late removal p=1.0 OR not provided	Sequence generation unknown. Allocation concealment unknown. Participants and care-providers not blinded, outcome assessors blinding unknown. No clear inclusion and exclusion criteria. No validated SSI definition. No *a priori* sample size calculation. Number of patients lost to follow-up unknown.
Migita et al.[23] (2015)	Japan 2011-2013	RCT: randomization not specified 100 patients with gastrectomy Teaching/university hospital	Early removal (n=50) Drain removal at POD 1	Late removal (n=50) Drain removal at POD 3 or later	Overall postoperative complications	18% in the early removal 18% in the late removal p>0.999 OR not provided	Small sample size

Table 2. Continued

Study	Country/ study period	Type of study/ setting	Intervention	Comparator	Primary outcome	Results	Limitations
Vos et al.[24] (2018)	Belgium 2015-2016	RCT: randomization by sealed envelopes which were prepared prior to the start of the study 99 patients scheduled for breast cancer surgery Teaching/university hospital	Early removal (n=51) Drains removed at hospital discharge	Late removal (n=49) Flow less than 30 mL/day	Wound infection	6% in early removal 13% in late removal p=0.31 OR not provided	Use of non-validated questionnaires.
Dembinski et al.[25] (2019)	France 2011-2015	RCT: randomization by elec-tronic module integrated in an electronic case report form according to a 1:1 ratio 141 patients with pancreaticoduodenec-tomy Multicenter (four university hospitals and one general hospital)	Early removal (n=71) Drain removal at POD 4	Late removal (n=70) Drain removal at drain output was less than 100 cm^3	30-day SSI rate	14.1% in early removal 24.3% in late removal OR=0.74 (95% CI 0.35-1.13, p=0.38)	Patients with chronic pancreatitis were excluded at the beginning of recruitment, prior to an amendment designed to improve recruitment

RCT: randomized controlled trial, ABP: antibiotic prophylaxis, SSI: surgical site infection, CDC: Centers for Disease Control and Prevention, OR: odds ratio, CI: confidence interval, POD: postoperative day.

Table 3. Summary of Finding Table

1. Prolonged vs. single-dose antibiotic prophylaxis, outcome SSI

PROLONGED compared to SINGLE for
Patient or population: patients with
Settings:
Intervention: PROLONGED
Comparison: SINGLE

Outcomes	Illustrative comparative risks[a] (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	SINGLE	PROLONGED				
SSI	94 per 1,000	82 per 1,000 (63 to 105)	RR 0.87 (0.67 to 1.12)	2,536 (9 studies)	⊕⊕⊖⊖ Low	

2. Early (up to postoperative day 5) vs. late drain removal, outcome SSI

Early compared to late drain removal for
Patient or population: patients with
Settings:
Intervention: early
Comparison: late drain removal

Outcomes	Illustrative comparative risks[a] (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Late drain removal	Early				
SSI	94 per 1,000	73 per 1,000 (51 to 104)	RR 0.77 (0.54 to 1.10)	1,392 (14 studies)	⊕⊕⊖⊖ Low	

CI: confidence interval, RR: risk ratio, SSI: surgical site infection. [a]The basis for the assumed risk (e.g., the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

콜 다기관 중재 및 효과분석(20210708848-01)" 연구기금(PI: 이석환)으로 이루어졌으며, 질병관리청 연구 지원은 현재의 진료권고안의 내용이나 진료권고안 개발 과정에 직접적인 혹은 잠재적인 영향은 없었다.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

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제1장 연구 관련 윤리규정

제1절 저자가 지켜야 할 연구윤리규정

제1조 표절, 위조, 변조 금지

저자는 연구의 제안, 연구의 수행, 연구결과의 보고 및 발표 등에서 연구부정행위를 하여서는 안 된다. 연구부정행위라 함은 존재하지 않는 데이터 또는 연구결과 등을 허위로 만들어 내는 행위(위조), 연구 자료나 연구 과정 등을 인위적으로 조작하거나 데이터를 임의로 변형·삭제함으로써 연구 내용 또는 결과를 왜곡하는 행위(변조), 타인의 아이디어, 연구내용·결과 등을 정당한 승인 또는 인용 없이 도용하는 행위 또는 자신의 이전에 출판된 아이디어, 연구내용·결과 등을 사실을 밝히지 않고 중복 게재 내지 이중 출판하는 경우(표절) 등의 경우와 부당한 논문저자 표시(제2조)를 포함한다.

제2조 출판 업적의 명기

부당한 논문저자 표시는 연구내용 또는 결과에 대하여 학술적 공헌 또는 기여를 한 사람에게 정당한 이유 없이 논문저자 자격을 부여하지 않거나, 학술적 공헌 또는 기여를 하지 않은 자에게 논문저자 자격을 부여하는 행위를 말한다. 연구나 저술에 대한 기여도가 낮을 경우 저자로 포함하기보다는 각주, 서문, 사등 등에서 감사의 표시를 한다.

제3조 연구물의 중복 투고 및 게재 혹은 이중 출판 금지

저자는 국내외를 막론하고 이전에 출판된 자신의 연구물(게재예정이거나 심사 중인 연구물 포함)을 새로운 연구물인 것처럼 출판하거나 투고해서는 안 되며, 동일한 연구물을 유사 학회 등에 중복하여 투고해서도 안 된다. 투고 이전에 출판된 연구물의 일부를 사용하여 출판하고자 할 경우에는 출판사의 허락을 얻어서 출판한다.

제4조 인용 및 참고 표시

저자는 타인의 학술 자료 혹은 자신의 자료라 하더라도 이미 출판된 자료를 인용할 경우에는 인용 사실을 명확하게 밝혀야 한다. 더불어 자료의 출처에 대해 정확하게 기술하여야 한다.

제2절 편집위원이 지켜야 할 연구윤리규정

제5조 편집위원은 투고된 논문의 게재 여부를 결정하는 권한 및 책임이 있다. 투고된 논문을 어떠한 선입견이나 친분과 무관하게 취급하여야 하고, 심사위원의 평가와 과학적 타당성에 근거하여 그 게재 여부를 결정하여야 한다.

제6조 편집위원은 투고된 논문의 게재 여부를 결정하기 위해 해당 분야의 전문적 지식과 공정한 판단 능력을 지닌 심사위원에게 논문의 평가를 의뢰해야 한다. 따라서 투고된 논문에 가장 적절한 심사위원을 찾고 선택하기 위해 노력하여야 한다. 공정한 심사를 위해서 저자의 인적 사항이 심사위원에게 노출되게 하여서는 안 된다. 또한 투고된 논문의 심사를 담당한 심사위원이 누구인지도 노출되어서는 안 된다.

제7조 편집위원은 심사위원의 평가가 과학적 근거에 맞춰 공정하게 되었는지를 판단하고 심사위원의 평가에 근거하여 투고된 논문의 게재 여부를 결정한다.

제8조 편집위원은 심사위원의 투고 논문심사와 관련한 문제제기 등의 사항이 발생할 경우, 윤리위원회에 신속히 알리고 적절히 대응하여야 한다.

제3절 심사위원이 지켜야 할 연구윤리규정

제9조 심사위원은 학술지의 편집위원이 의뢰하는 논문을 심사규정이 정한 기간 내에 성실하게 평가하고 평가 결과를 편집위원에게 통보해 주어야 한다. 만약 자신이 논문의 내용을 평가하기에 적임자가 아니라고 판단될 경우에는 편집위원에게 그 사실을 통보하여야 한다. 또한 투고된 논문의 추정하는 저자와 이해관계가 있거나 원고 내용과 이해관계가 있다고 판단하면 사유를 밝히고 편집위원에서 심사 거부를 알려야 한다.

제10조 심사위원은 투고된 원고의 내용을 출판 이전에 어떤 형태고든 누출시키면 안 된다. 원고를 복사하면 안 되고, 원고 내용을 심사위원 자신이 작성하는 논문에 인용해서도 안 된다. 투고된 원고를 작성하였다고 추정되는 저자와도 어떠한

방법이라도 원고와 관련된 사항으로 연락해서는 안 된다.

제11조 심사위원은 원고를 심사하면서 중립적이면서 긍정적인 자세를 유지하여야 하고 저자에게 협력하는 태도로 예의바르게 심사하여야 한다. 개인적인 학술적 신념이나 저자와의 사적인 친분 관계를 떠나 객관적 기준에 의해 공정하게 평가하여야 한다. 충분한 근거를 명시하지 않은 채 논문을 탈락시키거나, 심사자 본인의 관점이나 해석과 상충된다는 이유로 논문을 탈락시켜서는 안 된다. 원고에 대한 지적사항은 구체적이고 납득할 내용이어야 하며 원고가 향상되도록 하는 내용을 담는다.

제12조 심사위원은 게재 여부에 대한 의견과 연구부정행위 가능성이나 중복투고, 중복게재 시도 등을 인지하였을 때에는 편집인에게 별도의 용지에 작성하여 보내고 저자에게 보내는 심사의견서에는 기록하지 않는다.

제2장 연구윤리규정 시행지침

제1조 연구윤리규정 서약

대한수술감염학회의 모든 회원과 본 학회지에 투고하는 모든 저자는 본 연구윤리규정을 준수할 것을 서약해야 한다. 단, 본 윤리규정의 발효 시의 기존회원은 본 윤리규정에 서약한 것으로 간주한다.

제2조 윤리위원회의 구성

윤리위원회는 위원 3인 이상으로 구성되며, 이사회의 추천을 받아 회장이 임명한다. 단, 각 위원은 당해 사건과 직접적인 이해갈등 관계가 있는 경우 그 안건의 조사·심의·의결에 참여할 수 없다.

제3조 부정행위 제보 및 접수

1) 본 학회가 규정한 저자, 편집위원, 심사위원 등이 지켜야할 연구윤리규정을 위반하는 연구부정행위나 부정행위를 행할 것을 제안 혹은 강요하는 행위에 대해서는 윤리위원회에 제보할 수 있다.
2) 제보자는 구술, 서면, 전화, 전자우편 등 가능한 모든 방법으로 제보할 수 있으며 실명으로 제보함을 원칙으로 한다.

제4조 제보자 및 조사 대상자에 대한 비밀 보호

1) 연구윤리위원회는 제보자의 신원을 노출시켜서는 안 된다. 단, 의도적으로 제보 내용을 허위로 꾸며 내었거나, 허위인 줄 알았음에도 불구하고 이를 신고한 제보자는 보호 대상에 포함되지 않는다.
2) 연구윤리규정 위반에 대해 학회의 최종적인 징계 결정이 내려질 때까지 조사 대상자의 신원을 외부에 공개해서는 안 된다. 또한 무혐의로 판명된 경우, 조사 대상자의 명예회복을 위해 노력해야 한다.

제5조 윤리위원회의 권한

윤리위원회는 연구윤리규정 위반으로 제보된 사안에 대하여 제보자, 조사 대상자, 증인, 참고인 및 증거자료 등을 통하여 폭넓게 조사를 실시한 후, 연구윤리규정 위반이 사실로 판정된 경우에는 회장에게 적절한 제재조치를 건의할 수 있다.

제6조 윤리위원회의 조사 및 심의

연구윤리규정 위반으로 제보된 회원은 윤리위원회에서 행하는 조사에 협조해야 한다. 정당한 조사에 협조하지 않거나 방해하는 것은 그 자체로 연구윤리규정 위반이 된다.

제7조 이의제기 및 변론 기회의 보장

연구윤리위원회는 제보자와 조사 대상자에게 의견진술, 이의제기 및 변론의 권리와 기회를 동등하게 보장하여야 하며 관련 절차를 사전에 알려주어야 한다.

제8조 징계의 절차 및 내용

윤리위원회의 징계 건의가 있을 경우, 회장은 이사회를 소집하여 징계 여부 및 징계 내용을 최종적으로 결정한다. 연구윤리규정을 위반했다고 판정된 회원에 대해서는 경고, 투고 제한, 회원자격 정지 내지 박탈 등의 징계를 할 수 있고, 이 조처를 소속기관을 포함한 대외에 공표할 수 있다.

제9조 연구윤리규정의 개정

연구윤리규정의 개정 절차는 본 학회의 규정 개정절차에 준한다.

부칙: 이 윤리 규정은 2016년 3월 30일부터 시행한다.

Instructions for Authors

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본 학술지의 명칭은 대한수술감염학회지이며 영문으로는 *Journal of Surgical Infection* (JSI)이다. 본 학술지는 2016년 3월, 대한수술감염학회의 공식 학술지로 창간되어 연 1회 발행되었으나, 2018년부터는 연 2회 3월 30일, 9월 30일에 발행한다. 본 학술지에 투고되는 원고는 대한수술감염학회의 독창적인 원고이어야 함을 원칙으로 한다. 본 학술지의 투고자격은 수술감염에 관한 내용이면 특별히 문제가 되지 않는다. 학회 간행정보위원회의 심의를 거쳐 게재기준에 합당하여야 하며, 학회 초청기고인 경우에는 비회원이라도 게재할 수 있다.

1. 원고의 종류

1) 수술감염과 관련된 내용으로 종설, 원저, 증례보고, 편집인에게 보내는 글(letter to the editor) 단신(brief communication) 등으로 한다.

2) 종설, 최신연구 소개는 간행정보위원회의 청탁한 원고에 국한한다.

2. 원고의 제출

1) 원고는 한글 및 영어로 작성할 수 있다. 단, 한글논문의 경우 초록, 그림, 표는 모두 영어로 표기해야 한다. MS 워드나 아래아 한글프로그램을 사용하며 A4용지에 12포인트 글자크기, 2열 간격으로 2.5 cm 정도의 여백을 둔다.

2) 국문의 경우 의학용어는 대한의사협회 발간 용어집(최신판)에 수록된 것을 준용하며, 고유명사, 약품명, 단위 등과 적절한 한글 번역이 없는 의학용어는 영어로 직접 표기한다. 번역어는 있지만 이해가 쉽지 않은 경우에는 그 용어가 최초로 등장할 때 번역어 다음 괄호 속에 원어로 표시하고 다음부터는 번역어만 쓴다.

3) 영문 약어는 반복되는 경우에 한하여, 첫 번째 등장할 때 괄호 안에 표기한 후 사용한다.

4) 논문 접수는 대한수술감염학회 홈페이지(www.sisk.or.kr)에 접속하여 온라인 논문 투고 시스템 상의 온라인 투고규정을 확인하고 저작권 인계 동의서 및 주저자/공저자에 관한 규정을 다운받아 서명한 후 스캔한 파일을 첨부한다. 심사과정을 거쳐 간행정보위원회의 논문게재 승인이 나면 게재예정 논문 최종파일을 제출한다.

5) 중복 게재에 대한 원칙: 타 학술지에 이미 발표되었거나 게재가 예정된 원고의 내용과 동일 또는 유사한 원고는 게재할 수 없다. 본 학술지에 게재 발표된 원고를 임의로 타 학술지에 게재할 수 없고 중복 출간(multiple or duplicate publication)은 Uniform Requirements for Manuscripts Submitted to Biomedical Journals (Ann Intern Med 1997;126:36-47)에서 규정한 요건을 갖춘 경우에만 가능하다. 단, 초록이나 포스터 발표는 중복 게재로 간주되지 않는다. 중복 게재가 발견된 경우 학회 규정에 따라 저자에게 불이익을 줄 수 있다.

6) 제출 및 문의처

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3. 연구윤리규정

1) 논문의 저자는 ICMJE international 권고안에 의거하여 다음 4가지 기준을 모두 충족될 경우 저자로 인정된다.

(1) 연구의 구상이나 설계 또는 자료의 획득, 분석, 해석에 기여한 자

(2) 연구 결과에 대한 논문을 작성 또는 중요한 학술적 부분에 대한 비평적으로 수정을 기여한 자

(3) 출판되기 전 최종본에 대해 승인한 자

(4) 연구의 정확성 또는 진실성에 관련된 문제를 적절히 조사하고 해결하는 것을 보증하고 연구의 모든 부분에 책임을 진다는 점에 동의한 자

이 중 책임저자는 논문을 대표하는 사람으로서 편집인이 보내는 논문 심사의 논평, 수정사항 등을 받아 연락하고 독자와 연락이 가능한 연락처를 기재하여야 한다.

2) 저자들은 제출된 원고와 관련된 이해관계(conflict of interest)나 경제적 지원여부(financial support)를 밝혀야 하며, 그 내용은 논문의 게재 여부에 영향을 주지 않는다.

3) 본 학회지에 투고하는 원고는 연구의 대상이 사람인 경우(인체실험의 경우), 헬싱키선언(Declaration of Helsinki [1964년 발표, 2013년 개정], https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/)에 입각하여, 피험자 또는 보호자에게 연구의 목적

과 연구 참여 중 일어날 수 있는 정신적, 신체적 위해를 충분히 설명하고 시행되어야 하며, 연구기관 임상시험 윤리위원회(institutional review board)의 승인을 받았음을 기재하여야 한다.

4) 환자의 성명 또는 머리글자를 표기해서는 안되고, 환자와 관련된 사진을 제출할 때에는 환자의 신원을 알 수 없도록 하여야 하며, 조금이라도 신원이 노출될 가능성이 있는 경우에는 이에 대한 서면 동의를 받았음을 명시하여야 한다.

5) 연구의 대상이 동물인 경우에는 동물 이용에 관한 위원회(animal utilization committee)나 상응하는 위원회의 승인 여부를 기술하여야 한다.

6) 본 학술지에 투고하는 논문의 정당성과 윤리성에 관해 투고규정에 명시되어 있지 않은 부분은 대한의학학술지편집인협의회에서 제정한 "의학논문 출판윤리 가이드라인 개정판(http://www.kamje.or.kr/intro.php?body=publishing_ethics)"이나 "국제 의학논문 편집인 위원회의 가이드라인(http://publicationethics.org/international-standards-editors-and-authors)"이 준용될 수 있다.

7) 연구윤리규정 위반이 확인되면, 논문의 저자에게 징계 조치가 내려질 수 있다. 저자에게 경고, 투고 제한, 회원자격 정지 혹은 박탈 등이 행해질 수 있으며, 편집위원회는 저자의 소속기관 및 기타 관련 기관에 이 사실을 공지할 수 있다. 만일 편집위원회에서 위반사항을 인식하지 못하고 이미 논문이 게재된 경우 저자의 설명이나 동의 없이 이에 관한 경고 기사가 게재될 수 있다. 또한 연구부정행위의 처리는 COPE (Committee on publication ethics) Flowchart (http://publicationethics.org/resources/flowcharts)에 따른다.

4. 원고 심사과정

1) 원고 접수는 수시로 하고 접수일은 편집위원장에게 접수된 날로 한다.

2) 접수된 원고는 간행정보위원회에서 게재 적합성에 대하여 2인 이상의 위원에게 심의를 의뢰하여 그 결과에 따라 논문의 수정/보완을 저자에게 요구할 수 있고, 3회의 심사 후 부적격 판정 시 '게재불가'처리 할 수 있으며 최종적으로 편집위원회에서 원고의 게재 여부와 재심사 여부 그리고 순서를 결정한다.

3) 간행정보위원회는 필요 시 원문에 영향을 미치지 않는 범위 내에서 편집방침에 따라 저자의 동의를 얻어 수정할 수 있다. 심사에 통과하여 채택된 원고는 인쇄 후 1회 이상 저자에게 최종 교정을 의뢰한다. 저자의 교정이 모두 끝난 후 편집인이 1회 이상 교정을 한다.

4) 편집인의 게재, 게재불가, 또는 원고의 수정 등의 결정이 내려지면 교신저자(corresponding author)에게 통지된다. 최종 수정된 원고가 본 학술지의 출판 양식과 기준에 완전히 부합하면 게재가 결정되고 발행 시기가 예정된다. 게재불가 판정을 받은 원고는 다시 심의하지 않는다.

5) 심사 후 원저의 경우는 8주, 증례의 경우는 4주 이내에 특별한 이유 없이 수정 원고가 제출되지 않는다면 게재 불가 판정을 할 수 있다.

5. 원저 형식의 작성 요령

1) 일반적 사항

(1) MS 워드로 작성하는 것을 원칙으로 하되 영문 원고도 게재 할 수 있다. MS 워드를 사용하여 A4용지에 12 포인트의 그리고 좌측 정렬하여 2열 간격으로 작성하되, 사방으로 최소한 2.5 cm의 여백을 둔다.

(2) 원고는 표지, 영문초록, 서론, 대상 및 방법, 결과, 고찰, 감사의 글, 참고문헌, 그림 또는 사진 설명, 표, 그림 또는 사진의 순서로 배열한다.

(3) 표지 외의 원고에 저자의 성명이나 소속을 기록하지 않는다.

(4) 어깨번호가 문장 말미에 위치하는 경우 마침표나 쉼표 뒤에 어깨 번호를 표기한다.

예) -한다.[1,3] (O) -한다[1,3]. (X)

2) 표지

(1) 표지에는 다음의 사항을 순서대로 기록한다.

① 논문제목, 저자(소속, 성명), 국문 및 영문 간추린 제목, 연락처(책임저자 성명, 국문 및 영문 연락주소, 전화, 팩스번호, 이메일, 저자식별번호[ORCID]). (단, 저자의 최종학위는 기입하지 않는다. 저자와 저자 사이는 쉼표(,)로 표기하고 마지막 저자 앞에 and를 추가하며 and 앞에 쉼표(,)를 두지 않는다.)

표지에는 모든 저자의 저자식별 번호(ORCID)를 제시해야 한다. ORCID ID가 없는 경우, ORCID홈페이지(http://www.orcid.org)에서 등록할 수 있다.

② 제목: 국문 40자, 영문 20단어 이하로 간결하게 작성한다. 영문제목의 경우 명사와 형용사는 첫 자를 대문자로 표기한다.

③ 줄임제목(running title): 논문제목의 주제를 살려 영문 10단어 이내로 작성한다.

④ 소속이 다른 저자들이 포함된 경우에는 연구가 주로 이루어진 기관을 먼저 기록한다. 그 이외의 기관은 해당저자 이름의 바로 뒤에 어깨번호(1, 2, 3, 4, …)를 하고, 해당 소속기관의 맨 뒤에 같은 어깨번호로 표기한다.

⑤ 연구비 지원(fund): 연구비수혜, 경제적 지원 여부(financial support)를 밝힌다.

⑥ 이해관계: 만일 논문과 관계된 어떠한 이해 충돌 관계가

있다면 저자는 이를 논문에 밝혀야 한다.

3) 초록

영문을 원칙으로 하며 250단어 이내로 하며, 연구의 목적(Objectives), 방법(Methods), 결과(Results), 결론(Conclusion)으로 구분하여 반드시 줄을 바꾸어 기술한다. 이 형식은 원저에 한하며 그 외의 경우 '원저 이외의 원고'란을 참고한다.

4) 중심단어

영문초록이 끝나는 하단에 5개 이내의 중심단어를 영어로 별도로 기재하며, Index Medicus의 MeSH (Medical Subject Headings, http://www.ncbi.nlm.nih.gov/sites/entrez?db=mesh)에 등재된 용어를 사용하는 것을 원칙으로 하되 MeSH에 적절한 해당용어가 없는 경우 일반적인 의학용어로 표기한다.

(예) Key Words: Textiloma; Retained foreign object; Gossypioma

5) 본문

(1) 서론: 연구의 배경 및 목적을 명확히 기술한다.

(2) 대상 및 방법: 대상은 동일한 군으로 이루어져야 하며, 방법이 본 연구에 적당한 이유와 그 기준이 명기되어 있어야 한다.

(3) 결과: 연구목적에 합당한 결과만 객관적으로 기술한다. 표(Table)를 사용할 경우 논문에 표의 내용을 중복 설명하지 않고 중요한 경향과 요점을 기술한다.

(4) 고찰: 결과가 연구목적이나 가설과 일치하는지를 기술하고, 새롭고 중요한 관찰을 강조한다. 다른 연구자의 결과와 비교하여 저자의 결과의 당위성 및 정확성을 기술하고, 본 연구와 무관한 교과서식 사실들을 나열하지 않는다.

6) 지원 내역(Funding)

연구 수행에 각종 연구비 지원을 받은 경우, 연구비 지원 내역을 기술한다.

7) 감사의 글(Acknowledgements)

감사의 글에는 저자로 포함하기에는 연구나 저술에 대한 기여도가 낮은 연구자에게 감사의 표시를 할 수 있다.

8) 저자 기여도(Author Contributions)

각 저자의 이름은 다음 범주에 최소 한 번 이상 표시되어야 한다; Conceptualization, Data acquisition, Formal analysis, Funding, Supervision, Writing—original draft, Writing—review & editing. 교신저자는 논문 제출 시 이러한 정보를 작성해야 할 책임이 있으며, 모든 저자는 원고를 제출하기 전에 각자의 기여에 대해 검토 및 토론 과정을 거쳐 동의해야 한다.

9) 참고문헌

(1) 본문에서 반드시 인용되어야 하며 인용되는 순서대로 참고문헌 란에 기재한다 .

(2) 모든 참고문헌(국내문헌, 일본문헌 포함)은 반드시 영어로 기재하여야 한다.

(3) 저자명의 기입방법은 성 뒤에 이름 첫 글자를 대문자로 쓴다. 저자가 6인 이내면 모두 기재하고, 7인 이상은 6인 이후 "et al."로 끝맺을 수 있다.

(4) 참고문헌은 원저는 30개 이내, 증례는 15개 이내로 제한한다.

(5) 본문에서 참고문헌 인용방법

① 참고문헌은 순서대로 번호를 위첨자로 붙이며, 번호는 저자의 성 뒤에 기재하여야 하고 저자의 성이 없는 경우는 문장의 마침표나 쉼표 뒤에 기재한다.

(예) Kim[1]은--. --이다.[2-5] --하며,[6]

② 저자가 2명 이하일 때는 저자의 성을 다 쓰며, 3명 이상일 때 에는 첫 저자의 성에 "등"을 붙인다.

(예) Kim과 Woo[3]는--, Park 등[4]은--, Nogueras와 Williams[3]는--, Goldberg 등[4]은--

(6) 학술지명의 표기는 Index Medicus의 공인된 약자를 사용한다.

10) 참고문헌의 표기양식

(1) 학술지 : 저자명. 제목. 잡지명 발표년도;권:시작쪽-끝쪽.

(예 1) Jung CL, Cho SE, Hong KS. Clinical significance of minor elevation of cardiac troponin I. Korean J Lab Med 2008;28:339-345.

(예 2) Vagefi PA, Razo O, Deshpande V, McGrath DJ, Lauwers GY, Thayer SP, et al. Evolving patterns in the detection and outcomes of pancreatic neuroendocrine neoplasms: the Massachusetts General Hospital experience from 1977 to 2005. Arch Surg 2007;142:347-354.

(2) 단행본 : 저자명. 제목. 판. 발행지: 발행사; 년도.

Townsend CM, Beauchamp RD, Evers BM, Mattox K. Sabiston textbook of surgery. 17th ed. Philadelphia: Saunders; 2004.

(3) 단행본 내의 장(chapter)을 인용할 경우 : 저자명. 장(Chapter)제목. In: 편집인. 제목. 판. 발행지: 발행사; 년도. pp. 시작쪽-끝쪽.

Dozois RR. Disorders of the anal canal. In: Sabiston DC, Lyerly HK, editors. Textbook of surgery: the biological basis of modern surgical practice. 15th ed. Philadelphia: W.B. Saunders; 1997. pp.1032-1044.

(4) 웹사이트(website 상의 정보)

ASA physical status classification system [Internet]. Park Ridge (IL): American Society of Anesthesiologists; 1995 Jan 1 [updated 2010 Jun 8; cited 2010 Oct 10]. Available from: http://www.asahq.org/clinical/physicalstatus.htm

(5) 기타 명시되지 않은 문헌의 인용법은 International

Committee of Medical Journal Editors, Uniform Requirements for manuscripts submitted to biomedical journals (JAMA 1997;277:927-34)에 따른다.

11) 표(Table)

본문에서 인용된 순서대로 문장의 첫머리 또는 끝에 기재한다.
(예) ---있다(Table 1).

(1) 특별한 사유가 없는 한 10개 이내로 작성한다.

(2) 영문과 아라비아숫자로 기록하고 내용이 논문 안에서 반복되지 않도록 한다.

(3) 제목은 명료하게 절 혹은 구의 형태로 기술하고 마침표를 찍지 않는다. 명사와 형용사는 첫 자를 대문자로 한다.

(4) 본문에서 인용되는 순서대로 번호를 붙인다.

(5) 약어 사용 시 해당표의 하단에 풀어서 설명한다.

(6) 특정항목을 설명하기 위해 부가설명표시를 사용할 때에는 ^{a,b,c,d,e}의 순으로 하며 이를 하단 각주(footnote)에 설명한다.

(7) 이미 출간된 논문의 표와 동일한 것은 사용할 수 없다.

12) 그림 및 사진

(1) 그림은 도표(graph), 도화(line drawing), 사진(photograph)을 포함하며, 모든 그림은 본문에서 인용된 순서대로 번호를 기입하여 Fig. 첨부파일 란에 인용순서대로 입력하여 접수한다.

(2) 그림의 사이즈와 해상도는 논문이 인쇄되었을 때 그림의 질적 수준과 직접적인 관련이 있기 때문에, 투고규정을 잘 지키도록 한다. 특히 그림의 사이즈가 작지 않도록 주의한다. 규격은 사진의 규정을 적용하되 해상도는 300 dpi, 300만 화소 이상을 권장하며 2 MB 크기 이하의 ppt, jpg, gif, pdf 파일로 접수한다.

(3) 제목은 절로, 설명은 완전한 문장의 형태로 현재시제의 영문으로 기술한다.

(4) 도화(line drawing)는 원본이어야 한다. 타 논문의 그림을 인용할 때는 원칙적으로 원저자의 동의를 얻도록 한다.

(5) 동일 번호에서 여러 장의 사진 또는 그림이 있는 경우, 아라비아 숫자 이후에 A, B, C 글자를 기입하여 표시한다.
(예) Fig. 1A --, Fig. 1B --

(6) 현미경 사진인 경우 염색방법 및 배율을 기록한다.
(예) H&E stain, ×400

(7) 컬러 그림(현미경 사진 포함)을 접수하는 경우 접수한 대로 인쇄하는 것을 원칙으로 하며 이 때 발생하는 추가인쇄비는 저자가 부담한다.

(8) 그림에 대한 설명은 그림의 하단에 간단한 제목과 함께 내용을 이해할 수 있도록 명료하게 기록해야 한다.

6. 원저 이외의 원고

1) 종설(review article)

종설은 특정 제목에 초점을 맞춘 고찰로서 간행정보위원회에서 위촉하여 게재한다. 종설 형식은 원저를 따르되 내용에 따라 자유롭게 기술한다.

2) 증례 보고(case report)

증례 보고는 단순히 드물다는 이유로 게재하는 것이 아니라 학술적으로 충분히 가치가 있다고 판단되는 경우에 한하여 게재되며, 게재 불가 판정을 받을 확률이 높다는 점을 유념해야 한다.

(1) 표지: 원저의 규정에 따른다.

(2) 초록: 영문초록 150단어 이내로 작성하고, 색인단어를 5개 이내로 기입한다.

(3) 서론: "서론"이라는 제목 없이 증례 보고의 목적과 연관이 있는 내용만을 명확히 기술하여야 한다.

(4) 증례 보고: 간결하고 증례와 직접 관련이 있는 사항만 국한하여 기술한다.

(5) 고찰: 증례가 강조하고 있는 특성부분에 초점을 맞추며 장황한 문헌고찰은 피한다.

(6) 참고문헌: 15개 이하로 한다.

3) 편집인에게 보내는 글(letter to the editor)

최근 게재된 논문과 관련된 독창적인 의견이나 비평, 또는 논란이 되고 있는 특정 주제에 대한 의견을 투고할 수 있다. 형식은 초록이나 참고문헌 없이 본문으로 한다.

4) 단신(brief communication)

흥미로운 임상증례에 대한 보고로 표지, 본문, 참고문헌으로 구성된다. 본문은 환자의 임상양상과 흥미로운 사진, 검사 소견을 포함하며 최종 진단을 포함하여 투고한다.

7. 편집과 교정

저자가 완성하여 제출한 원고를 편집하면서 편집 상의 수정을 할 수 있다. 편집한 원고는 인쇄하기 전에 저자에게 교정을 한 번 의뢰하며, 저자는 교정 의뢰를 받는 즉시 교정하여 제출한다. 게재판정 후 최종교정본을 48시간 이내에 보내지 않으면 발간이 연기될 수 있다.

8. 저작권 및 논문게재료

1) 저작권: 타 학술지에 이미 발표되었던 내용과 동일한 원고는 본지에 게재할 수 없으나 사용언어가 다른 논문이거나 양측 잡지의 편집인의 승인이 있는 경우는 이중 게재를 허가한다. 이때는 이 사실을 공지란에 기재한다. 게재승인으로 논문의 내용에 관한 모든 저작권은 대한수술감염학회로 이양된다.

2) 논문게재료: 게재확정시 소정의 게재료(100,000원, US $120)를 대한수술감염학회에 납부한다.

3) 별책인쇄료: 필요한 수량의 금액을 인쇄소에 저자가 납부한다.

4) 기타 원고에 관한 문의는 간행정보위원장에게 한다.

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저자(Author)

국문 _____ 영문 _____ 서명 _____

국문 _____ 영문 _____ 서명 _____

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국문 _____ 영문 _____ 서명 _____

국문 _____ 영문 _____ 서명 _____

년 월 일 대표저자 _____ (인)

*공동저자가 더 있는 경우에는 위 양식을 복사하여 사용하십시오.

Author Checklist

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1. Category of Article

☐ Original article ☐ Review ☐ Case report ☐ Letter to editor ☐ Images of interest

2. 원고형식

☐ 이 논문은 12 포인트 크기에 좌측 정렬하여 2열 간격으로 작성되었으며 사방 2.5 cm의 여백을 두고 투고 규정에 맞게 작성되었습니다.
☐ 원고는 표지, 초록, 본문, 참고문헌, 표, 그림, 사진 순서로 각각 별도의 페이지로 작성되었습니다.
☐ 원고는 표지와 표지를 제외한 나머지 부분으로 나누어 두 개의 파일로 작성하였습니다.
☐ 표지를 제외한 원고 파일에 저자를 식별할 수 있는 정보는 모두 제거하였습니다.

3. 표지

☐ 논문 제목, 모든 저자명(국문 및 영문)을 기재하고, 소속이 다른 저자들이 포함된 경우에는 주 연구기관을 먼저 기록하고, 그 외의 기관은 해당저자명 뒤와 소속기관 앞에 괄호 없는 어깨기호를 붙이고 기호 순으로 기재하였습니다.
☐ 표지의 하단에 책임저자의 성명, 소속, 주소 및 연락처(전화, 팩스, E-mail)를 기재하며 기타 연구비 수혜 및 학술대회 발표 등을 기재하였습니다.

4. 초록

☐ 원고의 유형별 글자 수 투고규정을 준수하였습니다.
☐ 중심단어(Key words): 영문초록이 끝나는 하단에 Index Medicus에 공인된 단어 및 약자를 사용하였습니다.

5. 본문

☐ 인용한 참고문헌은 인용순서에 따라 본문과 동일한 크기의 아라비아 숫자를 괄호 안에 표기하였습니다.

6. 참고문헌

☐ 본문에 인용된 순서대로 투고규정에 맞게 기재하였습니다.
☐ 참고문헌의 개수는 규정을 준수하였습니다.
☐ 학술지명의 표기는 Index Medicus에 공인된 단어 및 약자를 사용하였습니다.

7. 표(Table)와 그림 및 사진(Fig.)

☐ 각각 별도의 페이지에 본문에 인용된 순서대로 작성하였습니다.
☐ 표의 제목 및 설명은 투고 규정을 준수하였습니다.
☐ 이미지는 300 dpi이상의 해상도로 작성하였습니다.
☐ 사진은 별도의 파일로 작성되었습니다.

8. 이 논문이나 유사한 논문이 전체나 부분적으로 다른 저널에 투고 혹은 출판되었거나 출판 예정인 논문입니까?

☐ 예 ☐ 아니오

'예' 라면 설명을 하여 주십시오.

( )

9. 모든 저자들이 논문의 내용을 알고 있고 제출에 동의하였으며 저자목록에 등록되어 있습니까?

☐ 예 ☐ 아니오

년 월 일

책임저자 서명: _____