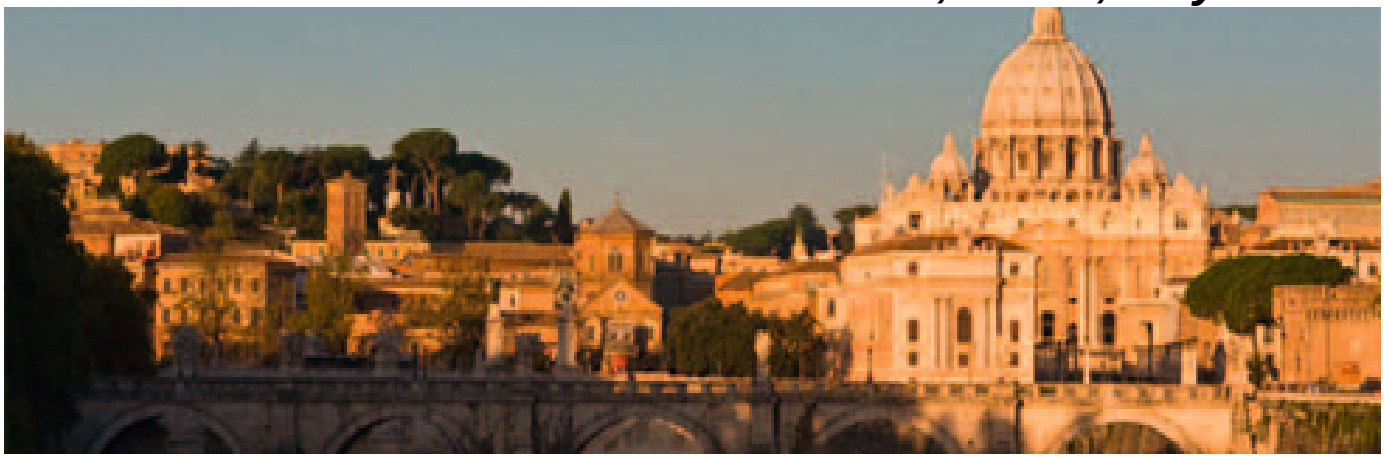
30 November - 2 December 2011, Rome, Italy



Prevention of surgical site infection: the WHO Safe Surgery Checklist and more…

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Infectious Diseases Department
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CENTERS for MEDICARE & MEDICAID SERVICES

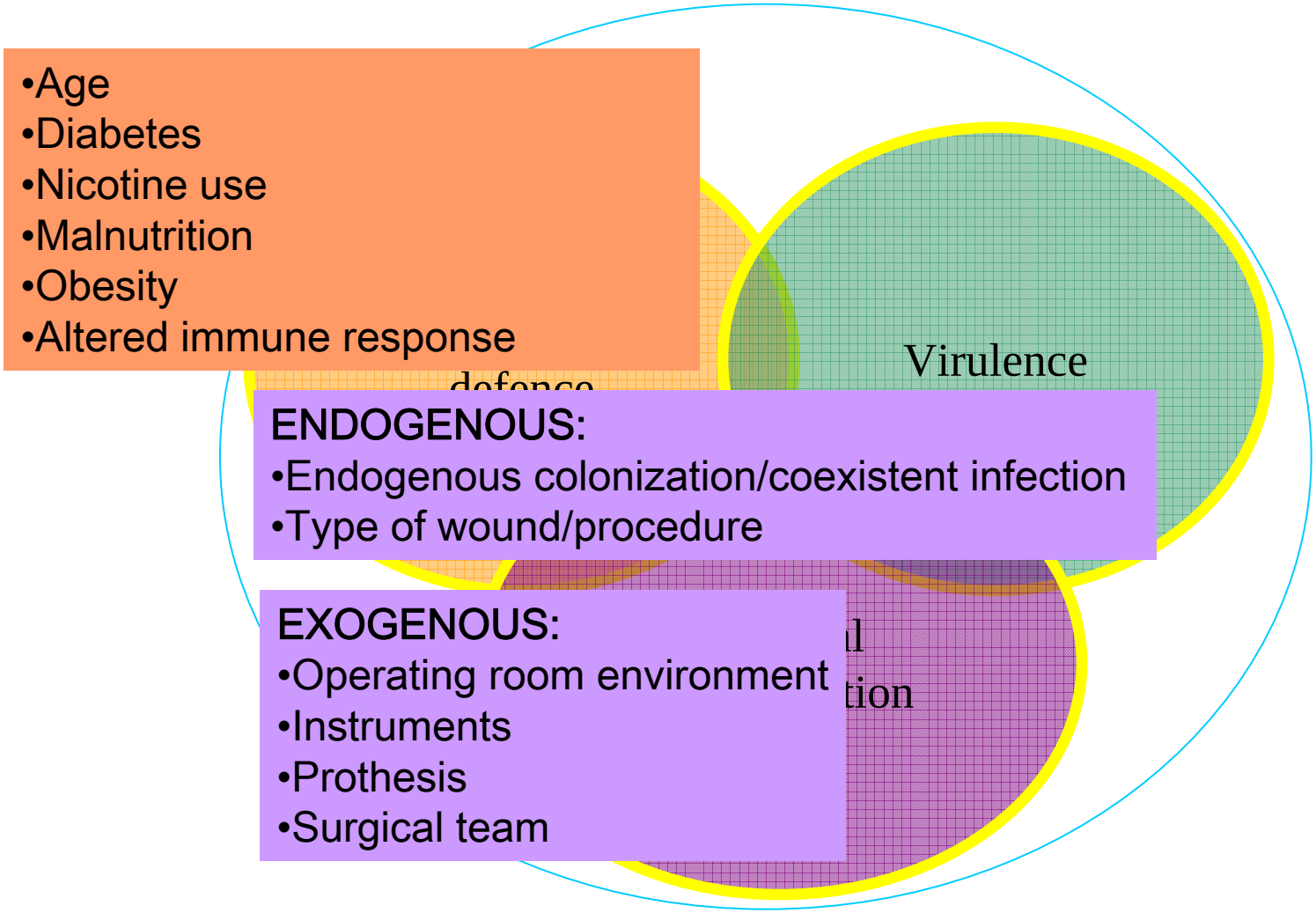
Surgical Site Infection, Mediastinitis, Following Coronary Artery Bypass Graft (CABG)
Surgical Site Infection Following Certain Orthopedic Procedures: • Spine • Neck • Shoulder • Elbow
Surgical Site Infection Following Bariatric Surgery for Obesity: • Laparoscopic Gastric Bypass • Gastroenterostomy • Laparoscopic Gastric Restrictive Surgery

10-70% of nosocomial infections are preventable

Harbarth et al, JHI, 2003

http://www.cms.gov/HospitalAcqCond/downloads/HACFactsheet.pdf

Surgical site infection risk



Opportunities to prevent SSI
the patient

BEFORE SURGERY

✓Prolonged preoperative stay
✓Coexistent infections at a remote body site
✓Endogenous colonization (antiseptic bath, decolonization protocols)
✓Hair removal

DURING SURGERY

✓Antibiotic prophylaxis
✓Endogenous colonization (skin disinfection)
✓Normothermia
✓Supplemental oxygen
✓Glucose level control

AFTER SURGERY

✓Appropriate wound management

Opportunities to prevent SSI
the procedure

Shortened operating time

Proper asepsis measures and
antisepsis of skin and instruments

Meticulous surgical techniques and minimization of
tissue trauma

On the patient
Before surgery

Reducing endogenous colonization

TABLE 4. OVERALL AND *STAPHYLOCOCCUS AUREUS*–SPECIFIC RATES OF NOSOCOMIAL INFECTION AMONG PATIENTS WHO RECEIVED MUPIROCIN AND THOSE WHO RECEIVED PLACEBO.

TYPE OF INFECTION	MUPIROCIN RECIPIENTS			PLACEBO RECIPIENTS		
	TOTAL (N=1933)	*S. AUREUS* CARRIERS (N=444)	NONCARRIERS (N=1489)	TOTAL (N=1931)	*S. AUREUS* CARRIERS (N=447)	NONCARRIERS (N=1484)
	number/total number (percent)					
Nosocomial infection*	218/1933 (11.3)	57/444 (12.8)	161/1489 (10.8)	220/1931 (11.4)	72/447 (16.1)	148/1484 (10.0)
Nosocomial *S. aureus* infection*	45/1884 (2.4)	17/430 (4.0)	28/1454 (1.9)	55/1886 (2.9)	34/439 (7.7)†	21/1447 (1.5)
Surgical-site infection	152/1933 (7.9)	44/444 (9.9)	108/1489 (7.3)	164/1931 (8.5)	52/447 (11.6)	112/1484 (7.5)
S. aureus surgical-site infections‡	43/1892 (2.3)	16/432 (3.7)	27/1460 (1.8)	46/1894 (2.4)	26/439 (5.9)	20/1455 (1.4)

Perl et al., NEJM, 2002

Table 3. Surgical site infection (SSI) rates for 614 patients assessed for SSIs after orthopedic surgery performed with artificial implant material.

Infection	No. (%) of patients: Mupirocin group (n = 315)	No. (%) of patients: Placebo group (n = 299)	RR (95% CI)
SSI	12 (3.8)	14 (4.7)	
Deep	0 (0)	1 (0.3)	
Superficial	12 (3.8)	13 (4.3)	0.81 (0.38–1.73)
Staphylococcus aureus SSI	5 (1.6)	8 (2.7)	0.59 (0.20–1.79)
Endogenous *S. aureus* SSI	1 (0.3)	5 (1.7)	0.19 (0.02–1.62)

Kalmeijter et al., CID, 2002

Characteristics	Control Periods (n = 10 910)	Intervention Periods (n = 10 844)	Incidence Rate Ratio (95% Confidence Interval)
Patients with any type of nosocomial MRSA infection, No. (%)	76 (0.7)	93 (0.9)	
Total incidence per 1000 patient-days	0.91	1.11	1.2 (0.9-1.7)
Ward of infected patients by subspecialty, No.			
Orthopedics	18	27	
Cardiovascular and thoracic surgery	9	6	
Neurosurgery	2	2	
Abdominal surgery	32	38	
Urology	13	12	
Other	2	8	
Total No. of MRSA infections[a]	88	103	
Sites of MRSA infection, No.[a]			
Surgical	60	70	
Urinary tract	10	14	
Respiratory tract	6	2	
Bacteremia	2	4	
Other	10	13	
Rate of surgical site infections due to MRSA/surgical interventions × 100	0.99	1.14	1.2 (0.8-1.7)
Patients with nosocomial MRSA acquisition[b]	132	142	
Incidence of nosocomial MRSA acquisition per 1000 patient-days	1.59	1.69	1.1 (0.8-1.4)

Harbarth et al., JAMA, 2008

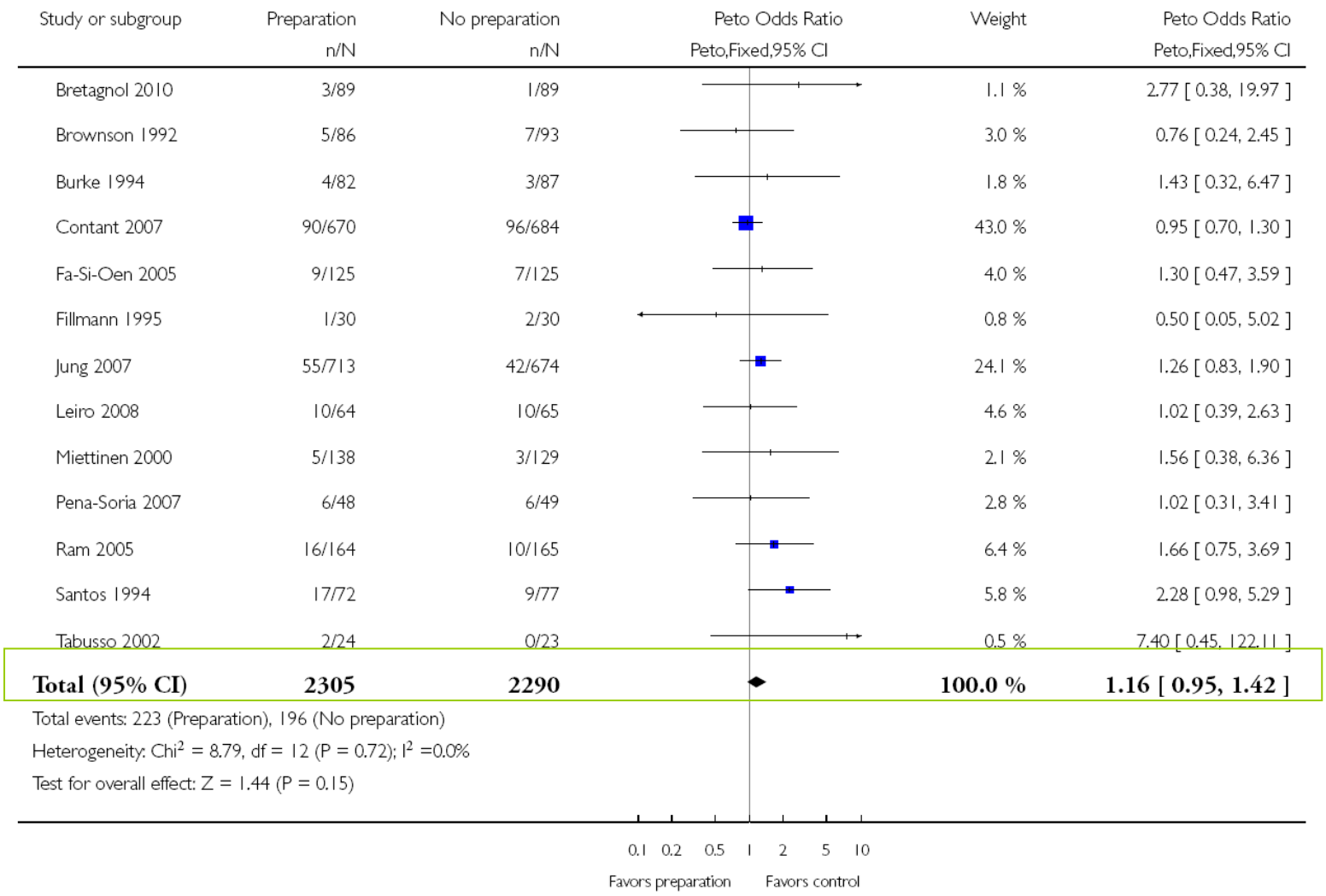
Table 2. Relative Risk of Hospital-Acquired *Staphylococcus aureus* Infection and Characteristics of Infections (Intention-to-Treat Analysis).

Variable	Mupirocin–Chlorhexidine (N=504)	Placebo (N=413)	Relative Risk (95% CI)*
	no. (%)		
S. aureus infection	17 (3.4)	32 (7.7)	0.42 (0.23–0.75)
Source of infection†			
Endogenous	12 (2.4)	25 (6.1)	0.39 (0.20–0.77)
Exogenous	4 (0.8)	6 (1.5)	0.55 (0.16–1.92)
Unknown	1 (0.2)	1 (0.2)	
Localization of infection			
Deep surgical site‡	4 (0.9)	16 (4.4)	0.21 (0.07–0.62)
Superficial surgical site‡	7 (1.6)	13 (3.5)	0.45 (0.18–1.11)

	Mupirocin and Chlorhexidine		Placebo		RR (95% CI)
Cardiothoracic surgery (n=391)	3/220	(1.4%)	15/171	(8.8%)	0.14 (0.04-0.51)
Orthopedics (n=172)	1/85	(1.2%)	4/87	(4.6%)	0.25 (0.03-2.26)
Vascular surgery (n=95)*	7/53	(13.2%)	6/42	(14.3%)	0.91 (0.28-2.96)
Gastrointestinal surgery (n=43)†	2/22	(9.1%)	3/21	(14.3%)	0.60 (0.09-4.01)
General surgery (n=107)‡	3/61	(4.9%)	3/46	(6.5%)	0.74 (0.14-3.85)

Bode et al., NEJM, 2010

Mechanical bowel preparation for elective colorectal surgery (Review)



Guenaga et al., Cochrane Database Syst Rev, last update Dec 2010

Preoperative bathing or showering with skin antiseptics to prevent surgical site infection (Review)

Analysis 3.1. Comparison 3 Chlorhexadine 4% versus no wash, Outcome 1 Surgical site infection.

Review: Preoperative bathing or showering with skin antiseptics to prevent surgical site infection

Comparison: 3 Chlorhexadine 4% versus no wash

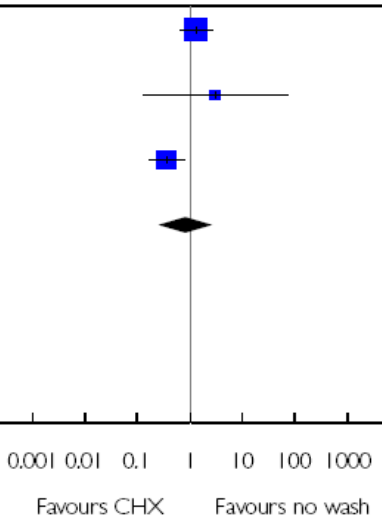
Outcome: 1 Surgical site infection

Study or subgroup	Chlorhexadine 4% n/N	No wash n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
Randall 1983	12/32	9/32		45.4 %	1.33 [0.65, 2.72]
Veiga 2009	1/50	0/50		10.7 %	3.00 [0.13, 71.92]
Wihlborg 1987	9/541	20/437		43.9 %	0.36 [0.17, 0.79]
Total (95% CI)	**623**	**519**		**100.0 %**	**0.82 [0.26, 2.62]**

Total events: 22 (Chlorhexadine 4%), 29 (No wash)

Heterogeneity: $Tau^2 = 0.64$; $Chi^2 = 6.77$, df = 2 (P = 0.03); $I^2 = 70\%$

Test for overall effect: Z = 0.33 (P = 0.74)



Webster et al., Cochrane Database Syst Rev, last update Nov 2010

On the patient
Before surgery

Hair removal

Preoperative hair removal to reduce surgical site infection (Review)

Comparison 1. Clipping compared with no hair removal

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection	1	130	Risk Ratio (M-H, Fixed, 95% CI)	1.0 [0.06, 15.65]

Comparison 2. Shaving compared with no hair removal

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection - body hair	3	445	Risk Ratio (M-H, Fixed, 95% CI)	1.65 [0.85, 3.19]
2 Surgical site infection - scalp hair	1	130	Risk Ratio (M-H, Fixed, 95% CI)	3.0 [0.32, 28.09]
3 Surgical site infection - body hair and scalp hair	4	575	Risk Ratio (M-H, Fixed, 95% CI)	1.75 [0.93, 3.28]

Comparison 3. Cream compared with no hair removal

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection	1	267	Risk Ratio (M-H, Fixed, 95% CI)	1.02 [0.45, 2.31]

Tanner et al., Cochrane Database Syst Rev, last update Aug 2011

Comparison 4. Shaving compared with clipping

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection - scalp hair	1	130	Risk Ratio (M-H, Fixed, 95% CI)	3.0 [0.32, 28.09]
2 Surgical site infection - body hair	2	1213	Risk Ratio (M-H, Fixed, 95% CI)	1.97 [1.08, 3.58]
3 Surgical site infection - body hair and scalp hair	3	1343	Risk Ratio (M-H, Fixed, 95% CI)	2.03 [1.14, 3.61]

Comparison 5. Shaving compared with cream

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Surgical site infection	7	1213	Risk Ratio (M-H, Random, 95% CI)	1.53 [0.73, 3.21]

Tanner et al., Cochrane Database Syst Rev, last update Aug 2011

On the patient
During surgery

Antibiotic prophylaxis

Any time?

WHO Guidelines for Safe Surgery 2009

Safe Surgery Saves Lives

Prophylactic antibiotics should be used routinely in all clean–contaminated surgical cases and considered for use in any clean surgical case.

Is Antibiotic Prophylaxis in Surgery a Generally Effective Intervention?

Testing a Generic Hypothesis Over a Set of Meta-Analyses

Russell J. Bowater, BSc, PhD, Seonaid A. Stirling,† and Richard J. Lilford, PhD, FRCOG, FRCP, FFPH**

1. Antibiotic prophylaxis is an effective intervention for preventing wound infection over a broad range of different surgical procedures as measured by relative reductions in the risk of wound infection.

2. There is a substantial difference in the degree of protection from wound infection given by antibiotic prophylaxis between clean and contaminated surgical procedures or more precisely, that the relative risk of wound infection varies substantially over different levels of surgery cleanliness.

Ann Surg, 2009

Is Antibiotic Prophylaxis in Surgery a Generally Effective Intervention?

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TABLE 3. Meta-Analyses and Types of Surgery for Which a Relative Risk Could be Calculated

Review Number	Type of Surgery		
19	Colorectal surgery, Song and Glenny[21]		
20	Simple appendicitis, Andersen et al[22]		clean-contaminated[§]
21	Complicated appendicitis, Andersen et al[22]	Dirty	Wound

1. Antibiotic prophylaxis is an effective intervention for preventing wound infection over a broad range of different surgical procedures as measured by relative reductions in the risk of wound infection.

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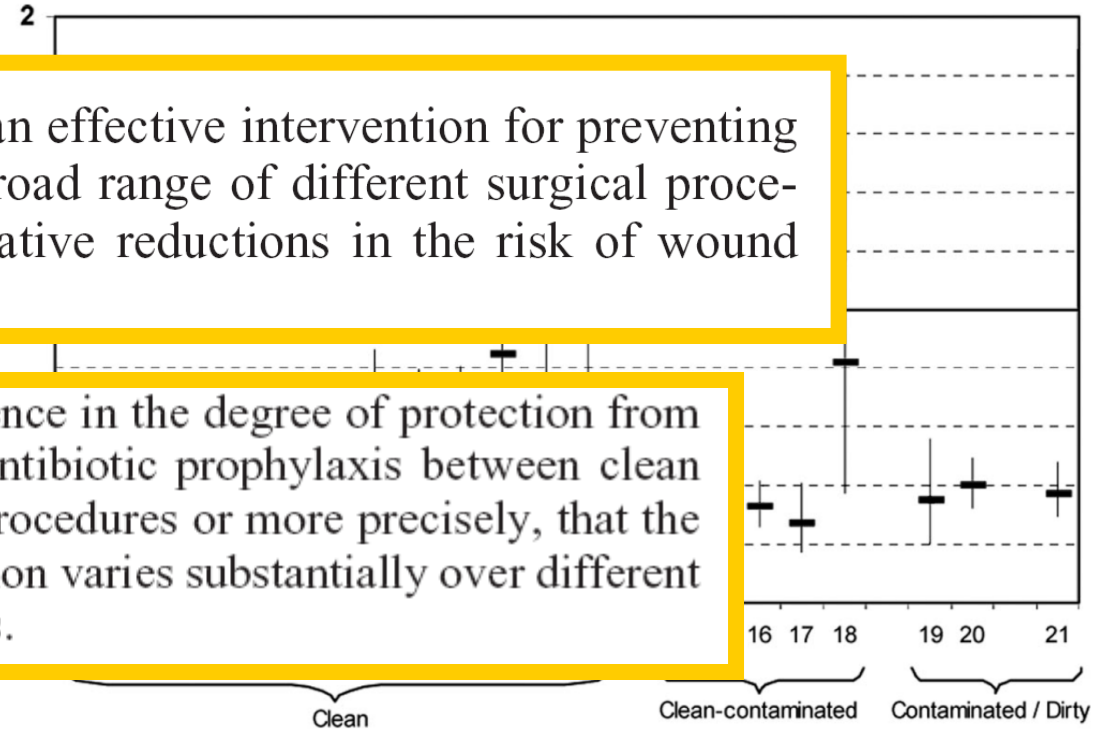
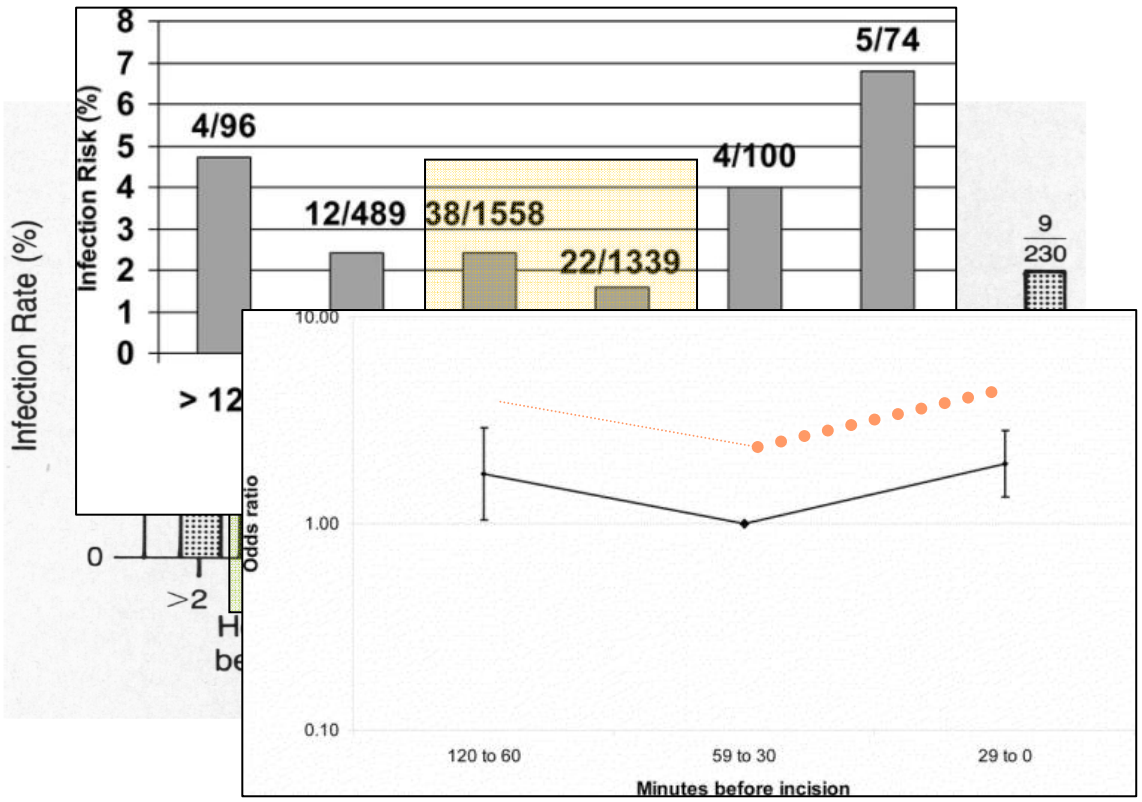
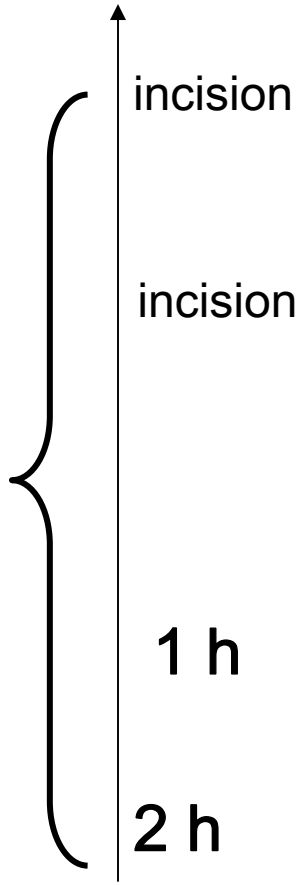


Ann Surg, 2009

When?

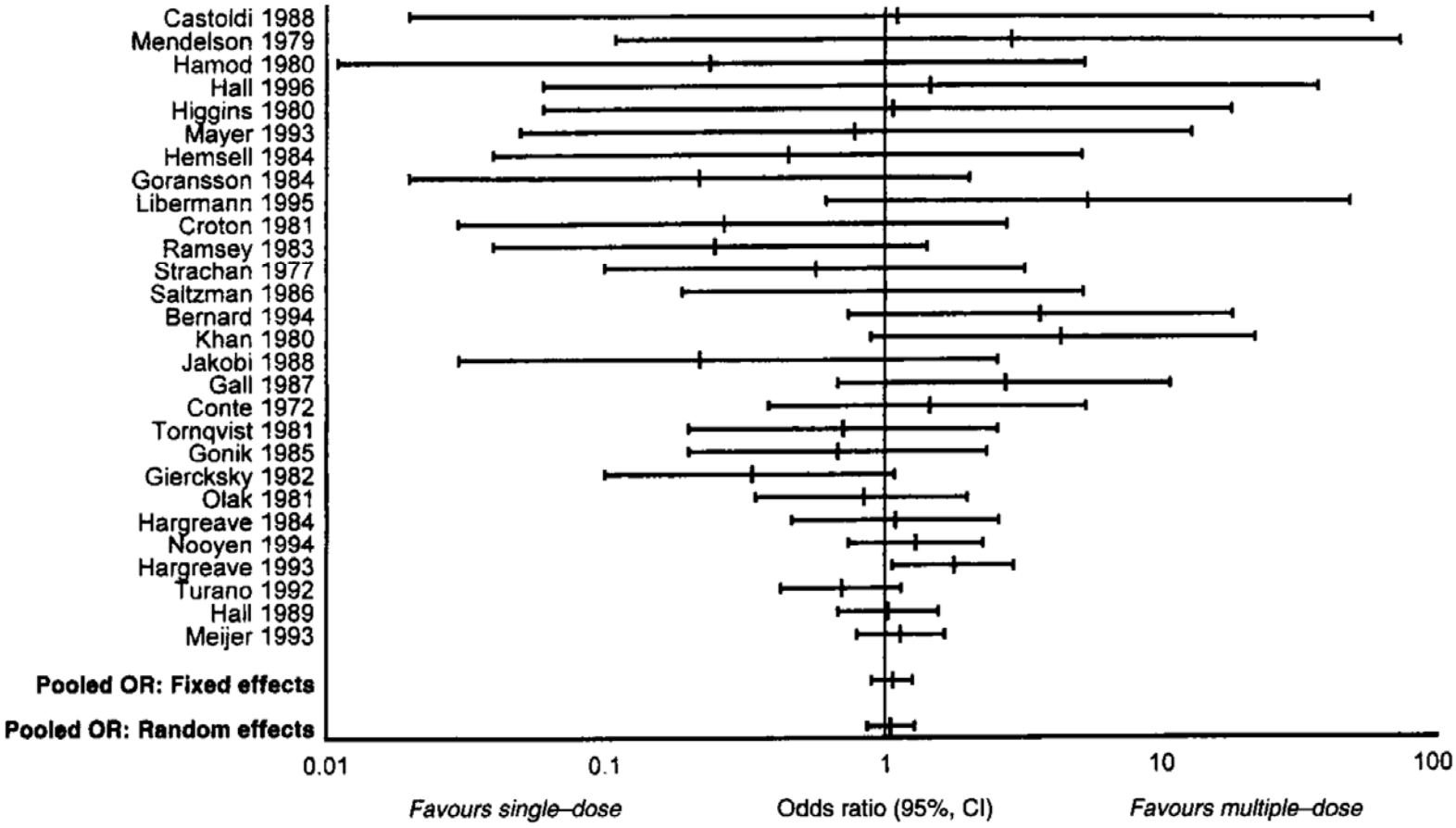


Weber et al., Ann Surg, 2008



Classen et al., NEJM, 1992

Single or multiple doses?



Mc Donald et al., Aust NZ J Surg, 1998

Single or multiple doses?

To keep best serum and tissue level till the end of surgery:

- Repeat administration at 1-2 half life of drug
- Use a drug with long half life

Redosing with prophylactic antibiotics should be considered if the surgical procedure lasts more than 4 hours or if there is evidence of excessive intraoperative bleeding. (When vancomycin is used as the prophylactic agent, there is no need for redosing in operations lasting less than 10 hours.)

Antibiotic	***Half-life (hours)***	***Antibiotic***	***Half-life (hours)***
Cefazolin	1.8	**Aminoglycosides**	2
Vancomycin	3-9	**Metronidazole**	8
Cefoxitin	0.6-1	**Clindamycin**	2.4-3
Cefotetan	3.4-6	**Ciprofloxacin**	3-5

How long?

WHO Guidelines for Safe Surgery 2009

Safe Surgery Saves Lives

Antibiotics used for prophylaxis should be discontinued within 24 hours of the procedure.

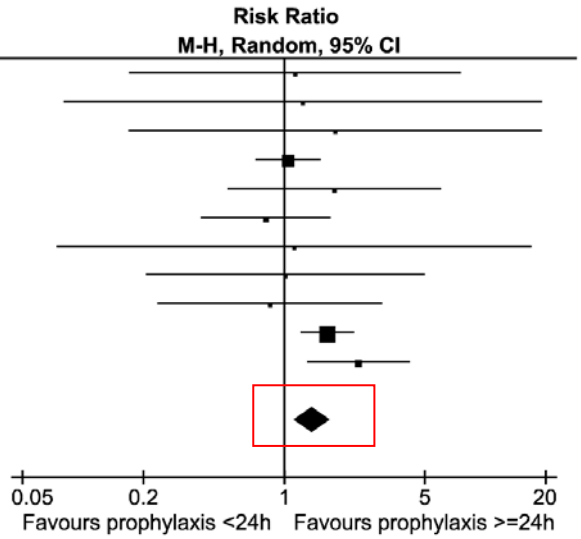
How long?

Antibiotic prophylaxis in cardiac surgery and sternal SSI

Study or Subgroup	Short-term group Events	Total	Longer-term group Events	Total	Weight	Risk Ratio M-H, Random, 95% CI	Year
Conte 1972	2	30	2	34	1.1%	1.13 [0.17, 7.56]	1972
Austin 1980	1	38	1	47	0.5%	1.24 [0.08, 19.13]	1980
Beam 1984	2	48	1	43	0.7%	1.79 [0.17, 19.07]	1984
Hall 1993	51	515	49	516	29.0%	1.04 [0.72, 1.51]	1993
Nooyen 1994	7	419	4	425	2.7%	1.78 [0.52, 6.02]	1994
Sisto 1994	12	274	15	277	7.3%	0.81 [0.39, 1.70]	1994
Niederhäuser 1997	1	25	1	28	0.5%	1.12 [0.07, 16.98]	1997
Kriaras1997	3	501	3	508	1.6%	1.01 [0.21, 5.00]	1997
Salminen 1999	4	97	5	103	2.4%	0.85 [0.23, 3.07]	1999
Saginur 2000	102	1518	62	1509	42.5%	1.64 [1.20, 2.22]	2000
Tamayo 2008	35	419	15	419	11.6%	2.33 [1.29, 4.21]	2008
Total (95% CI)		**3884**		**3909**	**100.0%**	**1.38 [1.13, 1.69]**	
Total events	220		158				

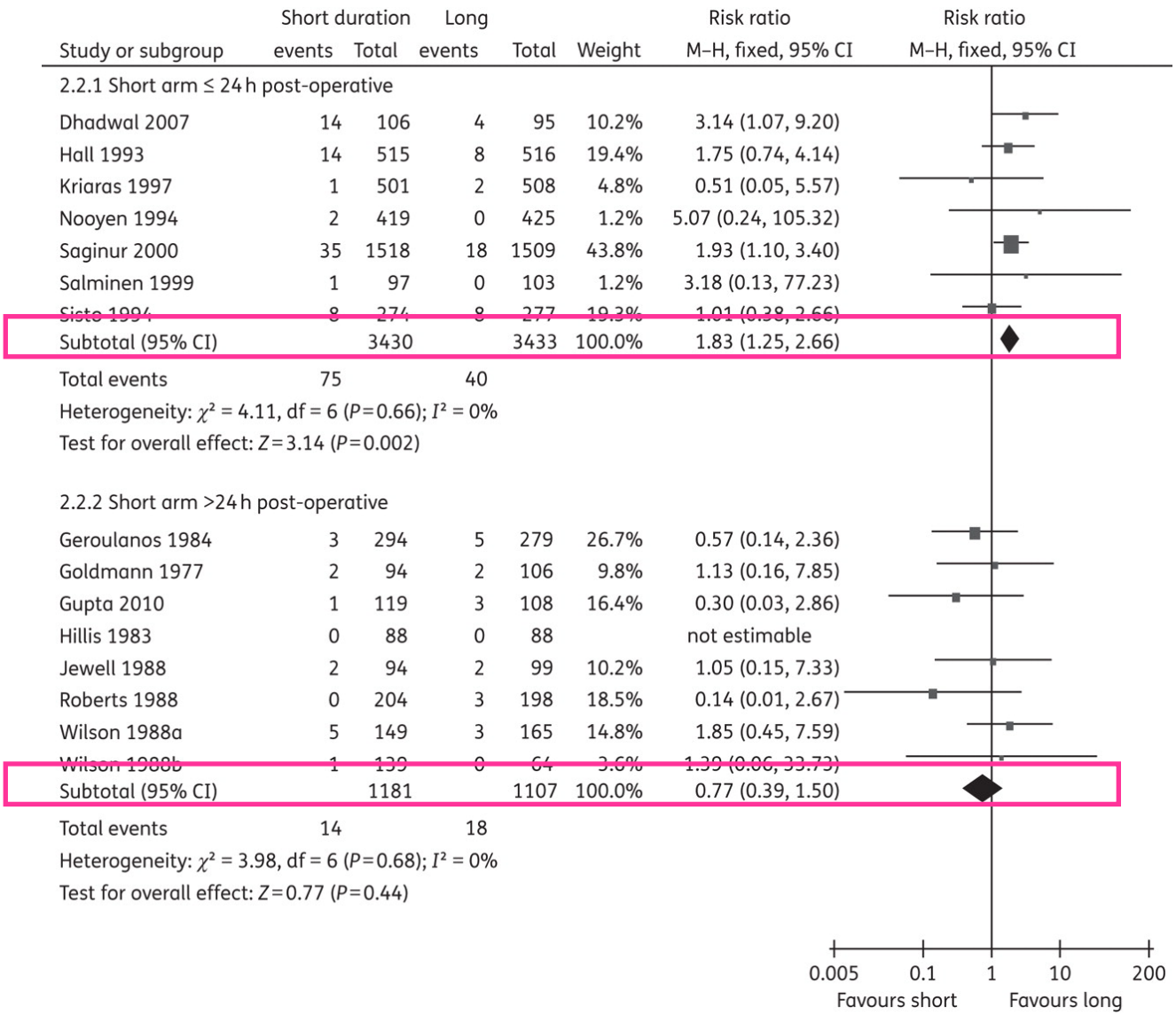
Heterogeneity: $\tau^2 = 0.00$; $\chi^2 = 9.38$, $df = 10$ ($P = 0.50$); $I^2 = 0\%$

Test for overall effect: $Z = 3.16$ ($P = 0.002$)



Mertz et al., Ann Surg, 2011

Deep sternal wound infection in trials comparing short prophylaxis duration versus longer duration, stratified by duration of prophylaxis in the short arm.



Study or subgroup	Short duration events	Total	Long events	Total	Weight	Risk ratio M–H, fixed, 95% CI
2.2.1 Short arm ≤ 24 h post-operative						
Dhadwal 2007	14	106	4	95	10.2%	3.14 (1.07, 9.20)
Hall 1993	14	515	8	516	19.4%	1.75 (0.74, 4.14)
Kriaras 1997	1	501	2	508	4.8%	0.51 (0.05, 5.57)
Nooyen 1994	2	419	0	425	1.2%	5.07 (0.24, 105.32)
Saginur 2000	35	1518	18	1509	43.8%	1.93 (1.10, 3.40)
Salminen 1999	1	97	0	103	1.2%	3.18 (0.13, 77.23)
Siste 1994	8	274	8	277	19.3%	1.01 (0.38, 2.66)
Subtotal (95% CI)		3430		3433	100.0%	1.83 (1.25, 2.66)
Total events	75		40			
Heterogeneity: $\chi^2 = 4.11$, df = 6 ($P = 0.66$); $I^2 = 0\%$						
Test for overall effect: $Z = 3.14$ ($P = 0.002$)						
2.2.2 Short arm >24 h post-operative						
Geroulanos 1984	3	294	5	279	26.7%	0.57 (0.14, 2.36)
Goldmann 1977	2	94	2	106	9.8%	1.13 (0.16, 7.85)
Gupta 2010	1	119	3	108	16.4%	0.30 (0.03, 2.86)
Hillis 1983	0	88	0	88		not estimable
Jewell 1988	2	94	2	99	10.2%	1.05 (0.15, 7.33)
Roberts 1988	0	204	3	198	18.5%	0.14 (0.01, 2.67)
Wilson 1988a	5	149	3	165	14.8%	1.85 (0.45, 7.59)
Wilson 1988b	1	139	0	64	3.6%	1.39 (0.06, 33.73)
Subtotal (95% CI)		1181		1107	100.0%	0.77 (0.39, 1.50)
Total events	14		18			
Heterogeneity: $\chi^2 = 3.98$, df = 6 ($P = 0.68$); $I^2 = 0\%$						
Test for overall effect: $Z = 0.77$ ($P = 0.44$)						

Lador et al., JAC, 2011

On the patient
During surgery

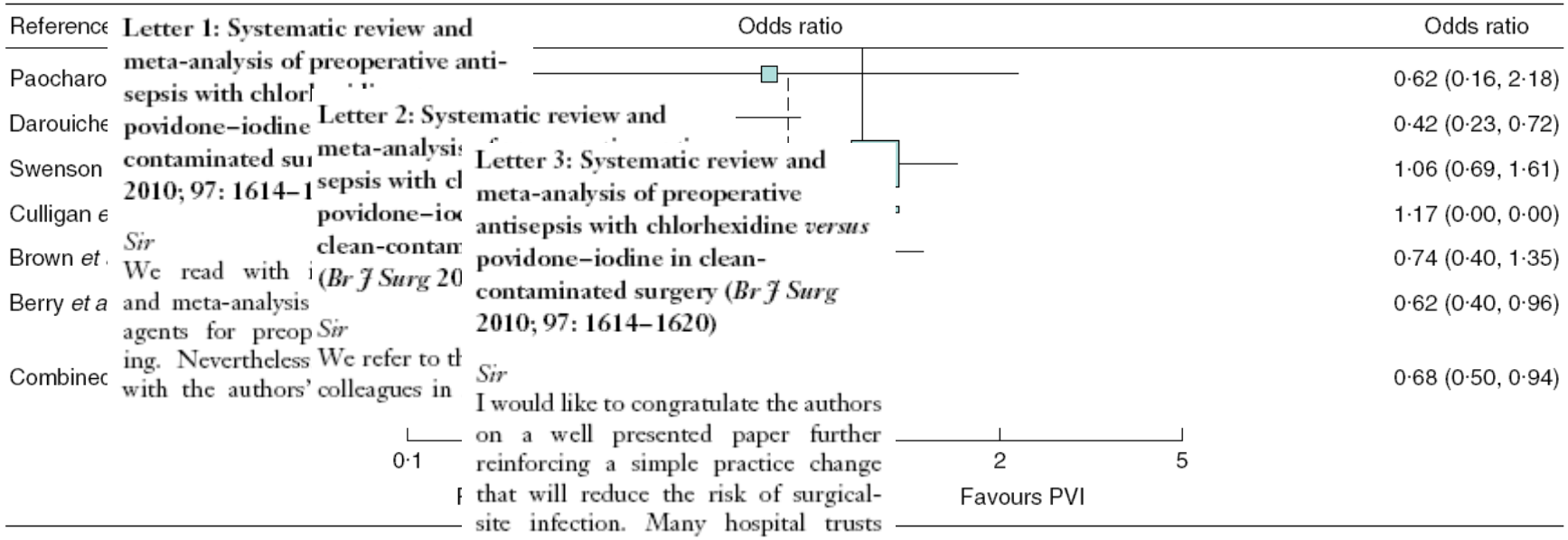
Skin disinfection

WHO Guidelines for Safe Surgery 2009

Safe Surgery Saves Lives

The skin of all surgical patients should be prepared with an appropriate antiseptic agent before surgery. The antimicrobial agent should be selected on the basis of its ability to decrease the microbial count of the skin rapidly and its persistent efficacy throughout the operation.

Systematic review and meta-analysis of preoperative antisepsis with chlorhexidine *versus* povidone–iodine in clean-contaminated surgery



Authors' reply: *"Our data clearly demonstrate that this agent is inferior to an alternative. Whether this alternative contains one antiseptic or two is somewhat academic."*

Noorani et al., Br J Surg, 2010

On the patient
During surgery

Normothermia

Measures to maintain core normothermia should be taken throughout the perioperative period.

TABLE 1. Evidence Supporting Hypothermia as a Risk Factor for Surgical Site Infection (SSI)

Year	Patient population	Study type	Definition of hypothermia	Definition of SSI	Outcome
1996	200 elective colorectal resection patients (18–80 yo)	Double-blind randomized controlled trial	Core temperature maintained at 34.5°C	Production of pus, positive culture result, and ASEPSIS[a] score of >20	Hypothermic patients had higher rate of SSI (19% vs 6%; $P = .009$), longer hospital stay (2.6 days; $P = .01$), and required more blood transfusions ($P = .054$) than normothermic patients
1999	1,575 surgery patients (average ages ranged from 14.7 to 74 yo)	Meta-analysis	Varied	Varied	There was a 64% and 55% increased rate of SSIs and mortality, respectively, in hypothermic patients ($P < .05$ for each); estimated cost savings of $545.40–$1,696.80 per patient when normothermia was preserved
2001	79 pediatric cardiothoracic surgery patients (average age: case patients, 0.38 yo; control patients, 1.73 yo)	Retrospective case-control study	Lowest core temperature reported; mean ± SD, 22.1°C ± 7.3°C	Modified CDC NNIS case definition of infection	Hypothermia was associated with increased risk of SSIs; average core temperature (±SD) was 22.1°C ± 7.3°C for case patients with SSIs and 28.0°C ± 6.0°C for control patients ($P <$ .001)
2001	261 cholecystectomy patients (15–60 yo)	Prospective cohort study	Tympanic temperature of <36°C on readmission to recovery	Masked surgeon's diagnosis and positive culture result	11.5% of hypothermic patients and 2% of normothermic patients developed SSIs ($P =$ .004); mild perioperative hypothermia was identified as an independent risk factor for SSI (RR, 6.3; $P = .01$)
2001	416 clean breast, varicose vein, or hernia surgery patients (13–48 yo)	Randomized controlled trial	Patients receiving no temperature control measures	Masked physician review, purulent discharge/painful erythema lasting ≥5 days treated with antibiotics within 6 weeks of surgery	SSIs were identified in 14% of nonwarmed patients and 5% of all warmed patients ($P =$ .001); systemic and locally warmed patients had 57.7% and 73.7% reductions in the RR of SSI, respectively

Beltramini et al., ICHE, 2011

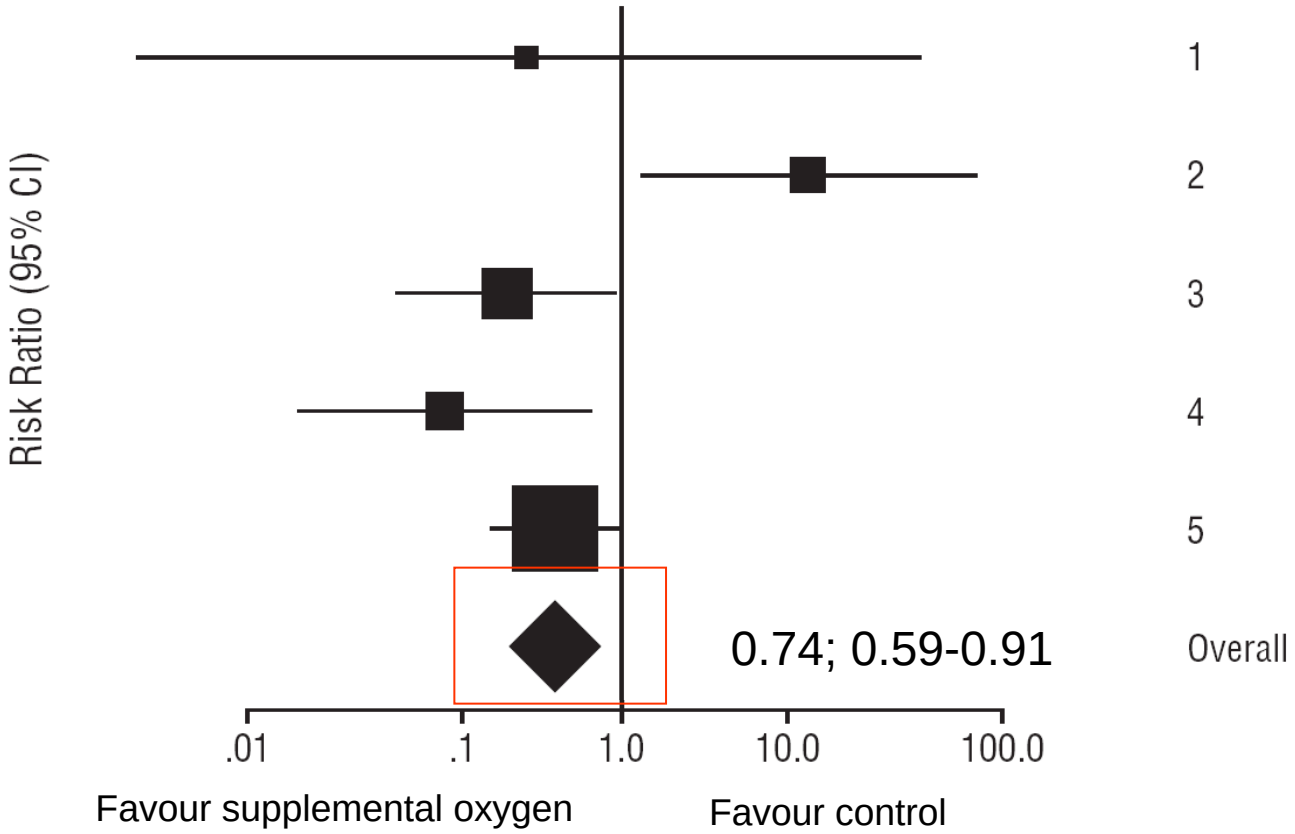
TABLE 2. Summary of Studies Investigating Mechanisms to Prevent Surgery-Induced Hypothermia

Year	Intraoperative warming mechanism	Patient population	Outcome
1991	Cloth "split sheet" surgical drape,[a] Convertors paper split sheet,[b] Thermadrape,[c] Bair Hugger,[d] prewarmed cotton hospital blanket, plastic hamper bag	5 healthy volunteers	Similar reduction in heat loss from 100 ± 3 to 69 ± 6 W across methods; Thermadrape, unheated Bair Hugger, and paper surgical drape (nonsignificantly) most effective
1993	Prewarmed (50°C) cotton hospital blankets	6 healthy volunteers	33% and 51% reductions in heat loss with 1 vs 3 blankets, respectively; short-lived (10 minutes) 9–16 W extra reduction in heat loss with prewarmed blankets
1993	Bair Hugger or full-length Aquamatic[e] circulating-water mattress (40°C); fluids warmed to 37°C for all patients	36 maxillofacial surgery (including 20 infants), 53 hip arthroplasty,[f] and 10 pediatric osteotomy patients	Core temperatures in maxillofacial surgery patients rose 3.4°C (adults) and 1.3°C (infants) higher in the forced-air group vs the circulating water group (in which core temperatures steadily dropped), a trend seen in all surgical subpopulations
1994	Metallized plastic sheet,[g] Bair Hugger	45 patients undergoing hip arthroplasty	Bair Hugger group maintained core temperature; metallized plastic sheet group had reduced core temperature by 1.0°C (compared with 1.5°C in control patients)
2003	Single cotton sheets flanking a WarmTouch 5200 forced-air warming blanket[h] set at 42°C–46°C beginning 60 minutes before anesthesia	30 female patients undergoing elective abdominal surgery	Prewarmed patients maintained core temperatures and MSTs significantly ($P < .05$) higher than control patients; patients warmed solely intraoperatively maintained significantly higher MSTs ($P < .05$) and nonsignificantly higher core temperatures than control patients
2004	Operating lamp warming a CO_2-rich, humid microenvironment around surgical site	In vitro; blood agar to simulate wound tissue	Humidified, warmed CO_2 kept the surface temperature nearly 2°C warmer than control and reduced evaporation at the site
2008	Intravenous fluids warmed to 41°C using the Hotline system[i]	40 off-pump coronary artery bypass surgery patients	Significant ($P < .05$) difference in mean rectal temperatures 4 hours after anesthesia in Hotline system group vs control group[j]

Beltramini et al., ICHE, 2011

On the patient
During surgery

Supplemental oxygen



Qadan et al., Arch Surg, 2009

Effect of High Perioperative Oxygen Fraction on Surgical Site Infection and Pulmonary Complications After Abdominal Surgery

The PROXI Randomized Clinical Trial

Table 3. Clinical Outcomes for Patients Scheduled for Laparotomy (N = 1386)

Outcome	No. (%) 80% Oxygen (n = 685)	No. (%) 30% Oxygen (n = 701)	Univariate OR (95% CI)	*P* Value	Adjusted OR (95% CI)[a]	*P* Value
Surgical site infection	131 (19.1)	141 (20.1)	0.94 (0.72 to 1.22)	.64	0.91 (0.69 to 1.20)	.51
Infection location						
Superficial	75 (57.3)	76 (53.9)				
Deep	20 (15.3)	26 (18.4)				
Organ/space	36 (27.5)	39 (27.7)				

Meyhoff et al., JAMA, 2009

Surgical Site Infection in Colorectal Surgery: A Review of the Nonpharmacologic Tools of Prevention

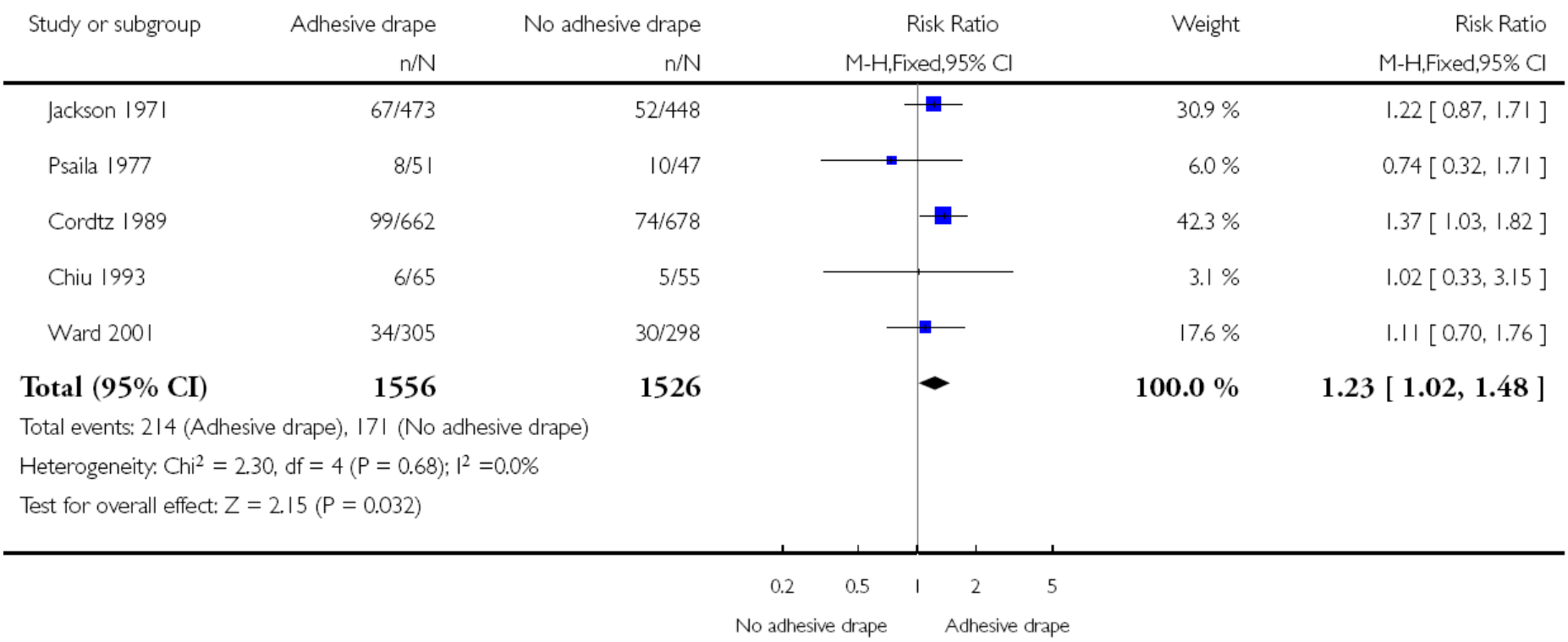
"*When the results of the PROXI study are combined with those from the previous 5 studies, the analysis shows* ***no statistical benefit*** *for hyperoxia in preventing surgical site infection in the colorectal population*."

Murray et al., J Am Coll Surg, 2010

On the patient
During and after surgery

Appropriate wound management

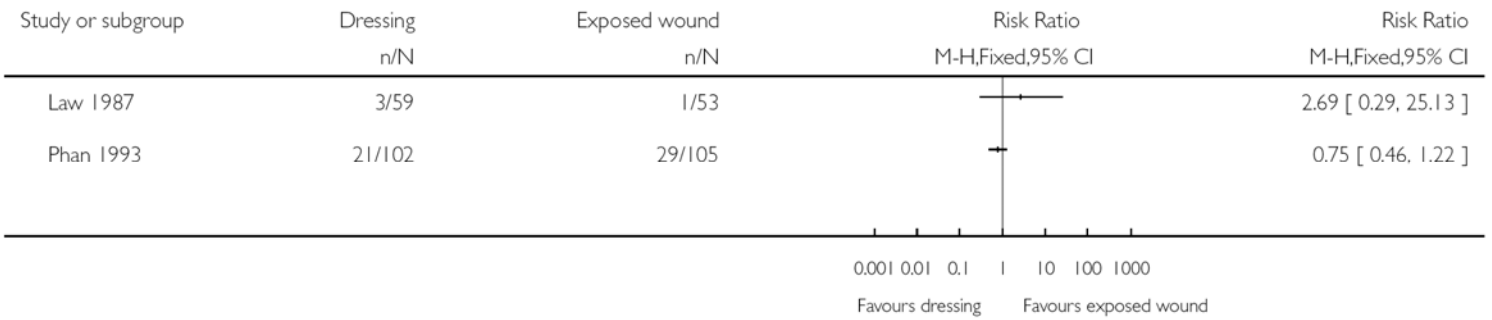
Use of plastic adhesive drapes during surgery for preventing surgical site infection (Review)



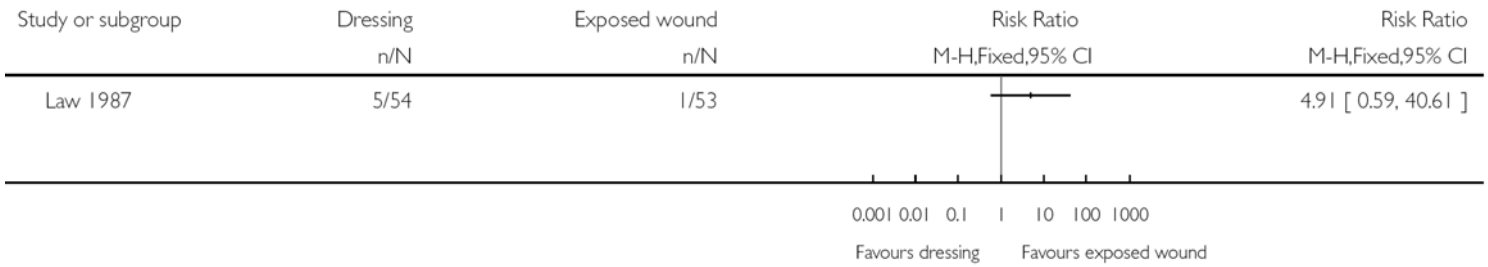
Webster et al., Cochrane Database Syst Rev, last update Nov 2010

Dressings for the prevention of surgical site infection (Review)

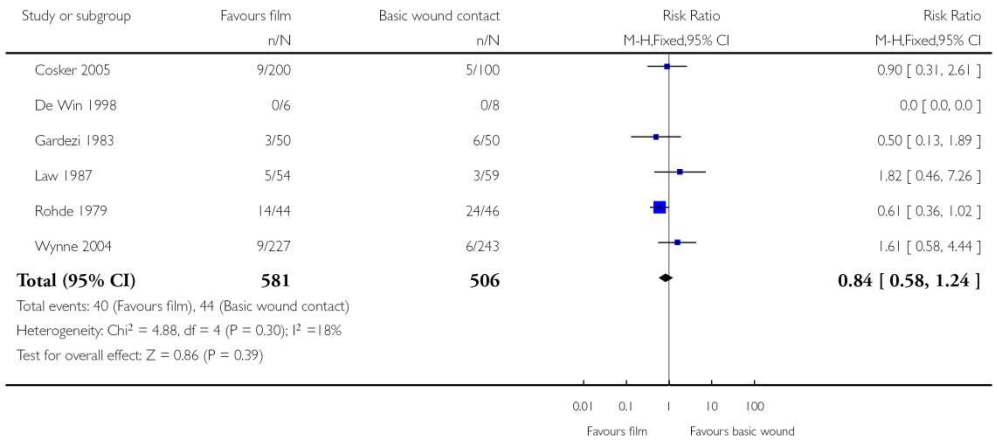
Basic wound contact dressings compared with exposed wounds



Advanced dressings compared with exposed wounds



Basic wound contact compared with film dressings



Dumville et al., Cochrane Database Syste Rev, last update July 2011

On the patient
During and after surgery

Blood glucose level

Peri-operative glycaemic control regimens for preventing surgical site infections in adults (Review)

	Strict arm		Conventional arm		Respect to surgery	Efficacy on SSI
	Glucose (mg/dl)	Insulin	Glucose (mg/dl)	Insulin		
1	80-120	ev	180-220	ev	POST-OPERATIVE	Significant difference
2	80-100	ev	<200	ev	INTRA-OPERATIVE	No difference
3	125-200	ev	<200	sc	INTRA AND POST-OPERATIVE	Significant difference (SSI+pneumonia)
4	80-120	ev	80-220	ev	INTRA AND POST-OPERATIVE	No difference
5	150-200	ev	150-200	sc	POST-OPERATIVE	No difference

Kao et al., Cochrane Database Syste Rev, last update March 2009

On the procedure

Proper asepsis measures and antisepsis of skin and instruments

WHO Guidelines for Safe Surgery 2009

Safe Surgery Saves Lives

Highly recommended:

- Surgical hand antisepsis should be assured with an antimicrobial soap. The hands and forearms should be scrubbed for 2–5 minutes. If the hands are physically clean, an alcohol-based hand antiseptic agent can be used for antisepsis.
- The operating team should cover their hair and wear sterile gowns and sterile gloves during the operation.

Recommended:

- The operating team should wear masks during the operation.

Surgical hand antisepsis to reduce surgical site infection (Review)

Table 2. Surgical Site Infection (SSI) Rates and Differences Between Hand-Scrubbing and Hand-Rubbing*

Altemeier Class of Contamination	No. SSI/No. Operations (%)		SSI Rate Difference (Hand-Scrubbing–Hand-Rubbing), % (95% Confidence Interval)	χ^2 Test of Equivalence (*P* Value)
	Hand-Scrubbing Protocol	Hand-Rubbing Protocol		
Clean	29/1485 (1.95)	32/1520 (2.11)	–0.15 (–1.16 to 0.85)	16.0 (<.001)
Clean-contaminated	24/650 (3.69)	23/732 (3.14)	0.55 (–1.36 to 2.46)	1.9 (.09)
All	53/2135 (2.48)	55/2252 (2.44)	0.04 (–0.88 to 0.96)	19.5 (<.001)

*The 95% confidence interval of the SSI rate difference was calculated according to Wallenstein[16] and the χ^2 test was the lowest χ^2 value of the Dunnett and Gent[17] continuity-corrected double 1-sided test for equivalence at –2% and +2%.

Parienti et al., JAMA, 2002

Tanner et al., Cochrane Database Syst Rev, last update June 2007

Disposable surgical face masks for preventing surgical wound infection in clean surgery (Review)

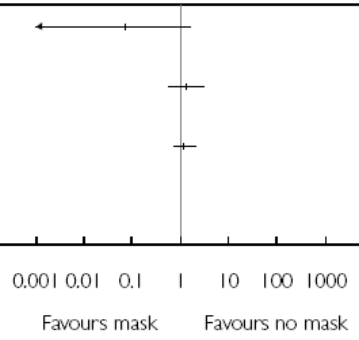
Analysis 1.1. Comparison 1 Masks versus no masks, Outcome 1 Wound infection.

Review: Disposable surgical face masks for preventing surgical wound infection in clean surgery

Comparison: 1 Masks versus no masks

Outcome: 1 Wound infection

Study or subgroup	Mask n/N	No mask n/N	Odds Ratio M-H,Fixed,95% CI	Odds Ratio M-H,Fixed,95% CI
Chamberlain 1984	0/14	3/10		0.07 [0.00, 1.63]
Tunevall 1991	13/706	10/723		1.34 [0.58, 3.07]
Webster 2010	33/313	31/340		1.17 [0.70, 1.97]



Lipp and Edwards, Cochrane Database Syst Rev, last update Sept 2009

WHO Guidelines for Safe Surgery 2009

Safe Surgery Saves Lives

Highly recommended:

Every facility should have a routine sterilization process that includes means for verifying the sterility of all surgical instruments, devices and materials. Indicators should be used to determine sterility and checked before equipment is introduced onto the sterile field. Before induction of anaesthesia, the nurse or other person responsible for preparing the surgical trays should confirm the sterility of the instruments by evaluating the sterility indicators and should communicate any problems to the surgeon and anaesthetist.

Surgical Safety Checklist

World Health Organization | Patient Safety
A World Alliance for Safer Health Care

Before induction of anaesthesia

(with at least nurse and anaesthetist)

Has the patient confirmed his/her identity, site, procedure, and consent?
- ☐ Yes

Is the site marked?
- ☐ Yes
- ☐ Not applicable

Is the anaesthesia machine and medication check complete?
- ☐ Yes

Is the pulse oximeter on the patient and functioning?
- ☐ Yes

Does the patient have a:

Known allergy?
- ☐ No
- ☐ Yes

Difficult airway or aspiration risk?
- ☐ No
- ☐ Yes, and equipment/assistance available

Risk of >500ml blood loss (7ml/kg in children)?
- ☐ No
- ☐ Yes, and two IVs/central access and fluids planned

Before skin incision

(with nurse, anaesthetist and surgeon)

- ☐ **Confirm all team members have introduced themselves by name and role.**
- ☐ **Confirm the patient's name, procedure, and where the incision will be made.**

Has antibiotic prophylaxis been given within the last 60 minutes?
- ☐ Yes
- ☐ Not applicable

Anticipated Critical Events

To Surgeon:
- ☐ What are the critical or non-routine steps?
- ☐ How long will the case take?
- ☐ What is the anticipated blood loss?

To Anaesthetist:
- ☐ Are there any patient-specific concerns?

To Nursing Team:
- ☐ Has sterility (including indicator results) been confirmed?
- ☐ Are there equipment issues or any concerns?

Is essential imaging displayed?
- ☐ Yes
- ☐ Not applicable

Before patient leaves operating room

(with nurse, anaesthetist and surgeon)

Nurse Verbally Confirms:
- ☐ The name of the procedure
- ☐ Completion of instrument, sponge and needle counts
- ☐ Specimen labelling (read specimen labels aloud, including patient name)
- ☐ Whether there are any equipment problems to be addressed

To Surgeon, Anaesthetist and Nurse:
- ☐ What are the key concerns for recovery and management of this patient?

The NEW ENGLAND JOURNAL of MEDICINE

SPECIAL A

Table 5. Outcomes before and after Checklist Implementation, According to Site.*

Site No.	No. of Patients Enrolled		Surgical-Site Infection		Unplanned Return to the Operating Room		Pneumonia		Death		Any Complication	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
							percent					
1	524	598	**4.0**	**2.0**	**4.6**	**1.8**	0.8	1.2	**1.0**	**0.0**	**11.6**	**7.0**
2	357	351	2.0	1.7	0.6	1.1	3.6	3.7	1.1	0.3	7.8	6.3
3	497	486	5.8	4.3	4.6	2.7	1.6	1.7	0.8	1.4	13.5	9.7
4	520	545	3.1	2.6	2.5	2.2	0.6	0.9	1.0	0.6	7.5	5.5
5	370	330	**20.5**	**3.6**	1.4	1.8	0.3	0.0	**1.4**	**0.0**	**21.4**	**5.5**
6	496	476	4.0	4.0	3.0	3.2	2.0	1.9	3.6	1.7	10.1	9.7
7	525	585	**9.5**	**5.8**	**1.3**	**0.2**	1.0	1.7	2.1	1.7	**12.4**	**8.0**
8	444	584	4.1	2.4	0.5	1.2	0.0	0.0	1.4	0.3	6.1	3.6
Total	3733	3955	**6.2**	**3.4**	**2.4**	**1.8**	1.1	1.3	**1.5**	**0.8**	**11.0**	**7.0**
P value			<0.001		0.047		0.46		0.003		<0.001	

Primary endpoint: **rate of complications** after non cardiac surgery

A bundle of care to reduce colorectal surgical infections: an Australian experience

Bundle of care for patients undergoing colorectal surgery

Bundle component	Comments
Temperature maintained ≥36 °C peri-operatively and for 1 h postoperatively	Recommendations included documentation of temperature, use of warmed blankets pre- and postoperatively, use of Bair Huggers and warmed fluids intra-operatively
Fraction of inspired oxygen delivered maintained ≥0.8 intra-operatively; adequate oxygenation for 4 h postoperatively	Adequate postoperative oxygenation was
Systolic blood pressure maintained ≥90 mmHg intra- and postoperatively	
Blood sugar level maintained ≤10 mmol pre- and intra-operatively	Documentation of pre- and intra-operative blood sugar level was requested from February 2009
Appropriate antibiotic prophylaxis given	Appropriate choice, timing and second dose for prolonged procedures (>3 h)

The infection rate fell from 15% [95% CI 10.4-20.2] before the project to 7% (95% CI 3.4-12.6) 12 months after the project.

Bull et al., J Hosp Infect, 2011

Evaluating an Evidence-Based Bundle for Preventing Surgical Site Infection

A Randomized Trial

- Standard arm
  - mechanical bowel preparation
  - concentration of inspired oxygen after endotracheal intubation (target fraction of inspired oxygen,30%),
  - Intravenous fluid delivered at the discretion of the anesthesiologist,
  - no wound edge protectors.

- Extended arm
  - no mechanical bowel preparation
  - ating
  - ced
  - air unit
  - increased concentration of inspired oxygen (80%) until 2 hours after surgery.
  - restriction of intraoperative, intravenous fluid administration
  - Placement of a plastic wound edge protection device in the incision

Allocation to the extended arm conferred a 2.49-fold (95% confidence interval, 1.36-4.56; *P*=.003) increased risk of developing a SSI.

Anthony et al., Arch Surg, 2011

What are the most effective IC measures to reduce the rate of surgical site infection?

No more excuses!

- decolonization of *S.aureus* carriers (not specifically MRSA), especially before cardiac surgery;
- when it is necessary to remove hair, clipping instead of shaving;
- antibiotic prophylaxis
  - routinely in all clean–contaminated, and most of clean surgery,
  - within 1 h of incision,
  - as single preoperative infusion or at least discuntinued within 24 h (longer up to 48h for cardiac surgery);
- chlorexidine (+alcohol) for skin antisepsis in clean-contaminated surgery;
- perioperative tissue normothermia;
- proper surgical hand antisepsis (rubbing equivalent to scrubbing), wearing sterile attire.

Less convincing evidence…

- preoperative showering with an antiseptic,
- mechanical bowel preparation prior to colorectal surgery,
- supplemental oxygen,
- peri-operative glycemic control,
- surgical drapes and wound dressing,
- surgical masks.

Careful use of bundle