Surgical Wound Infections

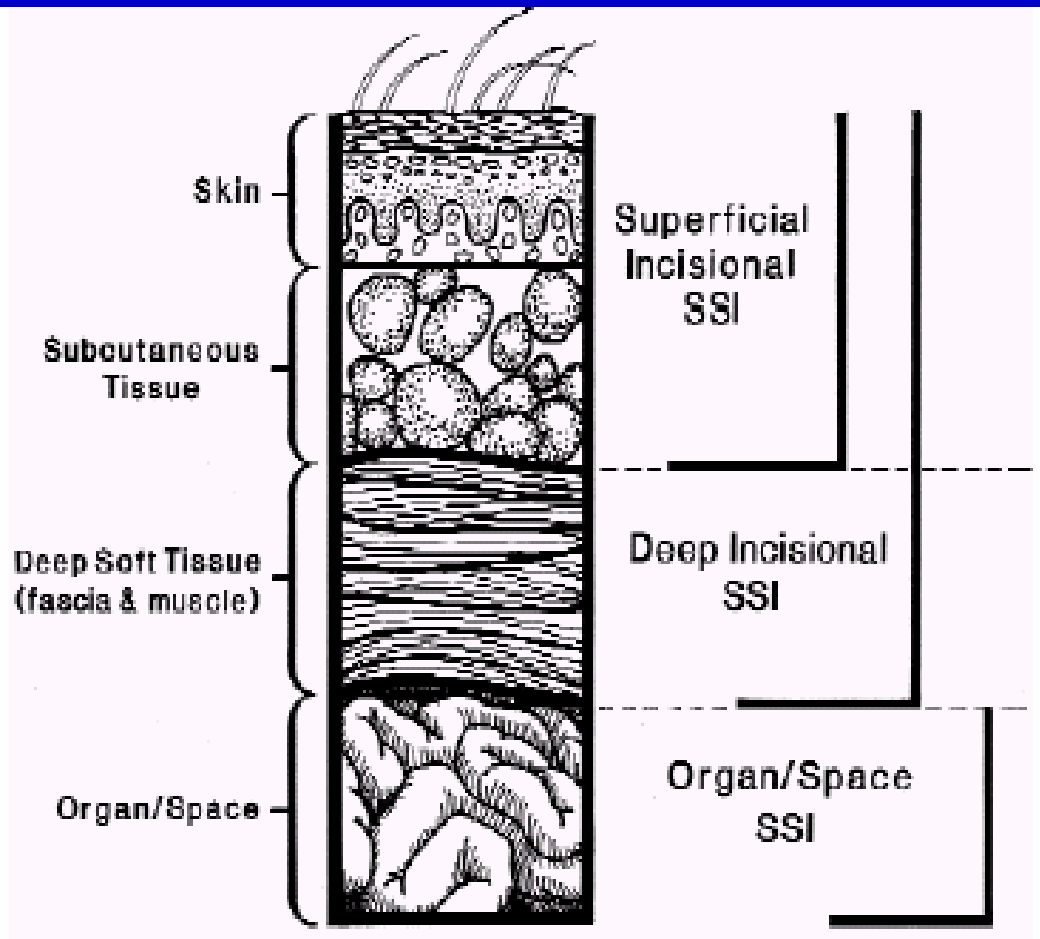

Figure. Cross-section of abdominal wall depicting CDC classifications of surgical site infection.[22]

Why?

Based on NNIS system reports, SWIs are the third most frequently reported nosocomial infection, accounting for *14% to 16% of all nosocomial infections* among hospitalized patients. ***Emori TG, Gaynes RP. Clin Microbiol Rev 1993;6(4):428-42.***

A 1992 analysis showed that each SWI resulted in *7.3 additional postoperative hospital days*.

Poulsen KB et al. Estimated costs of postoperative wound infections. A case control study of marginal hospital and social security costs. Epidemiol Infect 1994;113(2):283-95.

PSU Surgical Wound Infections: How Many?

PSU Hospital Surgical Site Infection Rates (infections/100 operations) and standardized infection ratio. *Na-narong M et al. AJIC 2003;31:274*

Operative procedures	n	Infection	Rate	SIR
Craniotomy	341	19	5.6	4.1
Laminectomy	126	3	2.4	2.0
Vascular	160	5	3.1	2.1
Appendectomy	335	11	3.3	1.3
Cholecystectomy	202	3	1.5	1.6
Herniorrhaphy	169	6	3.6	3.8
Small-bowel	152	25	16.4	2.2

Operative procedures	n	Infection	Rate	SIR
Gastric	101	7	6.9	1.4
Colon	102	6	5.9	1.0
Other genitourinary	161	6	3.7	6.7
Open reduction fracture	280	10	3.6	3.7
Limb amputation	107	12	11.2	3.0
Other musculoskeletal	745	18	2.4	3.6
Mastectomy	151	5	3.3	1.6
Other integumentary system	323	5	1.5	1.2
Miscellaneous	699	51	7.3	2.6
Other operation	283	0	0.0	0.0
Total	4437	192	4.3	2.3

Procedure	ปีงบฯ 2550 SIR(เท่า)	ปีงบฯ 2551 SIR(เท่า)
Open Heart surgery	#	0.84
Appendectomy	0.66	#
Cholecystectomy	1.86	5.99
Colectomy	0.79	0.84
Craniotomy	1.44	5.52
Herniorrhaphy	0.56	#
Mastectomy	0.33	0.54
Total	**0.84**	**1.97**

Which Organisms?

Sites of infection and pathogens	No. of isolations	Infected sites, %
Surgical site infection (n = 192)		
Staphylococcus aureus	54	28.1
Escherichia coli	32	16.7
Pseudomonas aeruginosa	23	12.0

Ref.:Montha Na Narong, Somchit Thongpiyapoom, Nonglak Thaikul,,

Silom Jamulitrat, and Nongyao Kasatpibal AJIC 2003;31:274

WHO?

SWI Risk Factors

By using logistic regression modeling, four of 10 variables collected in the SENIC Project were found to be independently associated with SWI risk.

(1) an abdominal operation,

(2) an operation lasting >2 hours,

(3) a surgical site with a wound classification of either contaminated or dirty/infected, and

4) A patient having >3 discharge diagnoses.

Ref.:Haley RW *et al.* Identifying patients at high risk of surgical wound infection.. Am J Epidemiol 1985;121:206-15.

Table 4. The association between selected variables and surgical site infections derived from multivariate analysis

Variables	Odds ratio	95% CI	*P* value
Male sex	1.182	0.862–1.620	.30
Emergency operation	1.382	0.986–1.938	.06
Preoperative hospital stay (days)	1.005	0.993–1.016	.38
Duration of antibiotic prophylaxis (days)	1.032	0.995–1.071	.09
Duration of operation (minutes)	1.003	1.002–1.004	<.001
ASA class			
I	1	Reference	-
II	2.000	1.324–3.021	.001
III	3.445	2.108–5.631	<.001
IV	4.404	1.785–10.86	.001
V	5.908	0.472–73.88	.168
Degree of wound contamination			
Clean	1	Reference	-
Clean-contaminated	2.059	1.382–3.069	<.001
Contaminated	5.432	3.560–8.289	<.001
Dirty/infected	9.391	5.458–16.15	<.001

Ref.:Montha Na Narong, Somchit Thongpiyapoom, Nonglak Thaikul,,, Silom Jamulitrat, and NongyaoKasatpibalAJIC 2003;31:274

Surgical Wound Infections:Factors

1.Patients

2.Surgical Team

3.Operating Room & Equipment

Surgical Wound Infections:Factors

1.Patients

2.Surgical Team

3.Operating Room & Equipment

Diabetes Mellitus

The contribution of diabetes to SSI risk is controversial, although increased glucose levels (>200 mg/dL) in the immediate postoperative period (48 hours) were associated with increased SWI risk.

"Adequately control serum blood glucose levels inall diabetic patients and particularly avoid hyperglycemia perioperatively." CDC Category IB Suggestion.

Cigarrette Smoking

Nicotine use delays primary wound healing and may increase the risk of SSI. ***In a large prospective study, current cigarette smoking was an independent risk factor for sternal and/or mediastinal SSI following cardiac surgery***.

Nagachinta T et al. Risk factors for surgical-wound infection following cardiac surgery. J Infect Dis 1987; 156: 967-73.

Cigarrette Smoking

Encourage tobacco cessation. At minimum, ***instruct patients to abstain for at least 30 days before elective operation*** from smoking cigarettes.

CDC: Guideline for Prevention of Surgical Site Infection, 1999. AJIC 1999;27:97

Preoperative Hospital Stay

Keep preoperative hospital stay as short as possible **while allowing for adequate preoperative preparation of the patient.**

CDC's Category II Suggestion.AJIC 1999;27;97

Nasal *Staphylococcus aureus* colonization?

A recent multivariate analysis demonstrated that *S. aureus* nasal carriage was the most powerful independent risk factor for SSI following cardiothoracic operations.

Kluytmans JA et al. Nasal carriage of Staphylococcus aureus as a major risk factor for wound infections after cardiac surgery. J Infect Dis 1995;171:216-9.

Decolonization of nasal *Staphylococcus aureus*?

In one study, SSI rates for 752 mupirocin-treated patients were compared with those previously observed for an untreated group of 928 historical control patients, and the significant SSI rate reduction was attributed to the mupirocin treatment.

Ref.: Kluytmans JA, et al. Reduction of surgical-site infections in cardiothoracic surgery by elimination of nasal carriage of Staphylococcus aureus. Infect Control Hosp Epidemiol 1996;17:780-5.

INTRANASAL MUPIROCIN TO PREVENT POSTOPERATIVE *STAPH. AUREUS* INFECTIONS:*Perl TM et al. NEJM 2002;346:1871-7*

Randomized, double-blind, placebo-controlled trial to determine whether intranasal Rx with mupirocin (BID.x 5 days before surgery) reduces the rate of *S. aureus*infections at surgical sites and prevents other nosocomial infections.

INTRANASAL MUPIROCIN TO PREVENT POSTOPERATIVE *STAPH. AUREUS* INFECTIONS:*Perl TM et al. NEJM 2002;346:1871-7*

Results:Overall, nasal carriage of *S. aureus* was eliminated in 83.4 %of patients who received mupirocin, as compared with 27.4 % of patients who received placebo (P<0.001)

The rate of S. aureus infection at surgical sites was 2.3 %among mupirocin recipients and 2.4 % among placebo recipients.(P=NS)

INTRANASAL MUPIROCIN TO PREVENT POSTOPERATIVE *STAPH. AUREUS* INFECTIONS:*Perl TM et al. NEJM 2002;346:1871-7*

Results: *Among the patients with nasal carriage of S. aureus,4.0 %of those who received mupirocin had nosocomial S. aureus infections, as compared with 7.7 %of those who received placebo (odds ratio for infection, 0.49; 95 percent confidence interval, 0.25 to 0.92; P=0.02).*

Only 6 of 1021 *S. aureus* isolates *(0.6 %),* obtained from six patients, were resistant to mupirocin during the four-year study period.

Decolonization of nasal *Staphylococcus aureus*?

No recommendation to preoperatively apply mupirocin to nares to prevent SSI. Unresolved issue

CDC: Guideline for Prevention of Surgical Site Infection, 1999. AJIC 1999;27:97

Preoperative antiseptic showering?

A study of >700 patients who received preoperative antiseptic showers showed that chlorhexidine reduced bacterial colony counts ninefold. However,, they have not definitively been shown to reduce SSI rates.

Rotter MLet al. A comparison of the effects of preoperative whole-bodybathing with detergent alone and with detergent containingchlorhexidine gluconate on the frequency of wound infectionsafter clean surgery. The European Working Party on Control of Hospital Infections. J Hosp Infect 1988;11:310-20.

Preoperative antiseptic showering?

Require patients to shower or bathe with an antiseptic agent on at least the night before the operative day.

CDC's Category IB Suggestion. Guideline for Prevention of Surgical Site Infection, 1999. AJIC 1999;27:97

Preoperative hair removal?

Type of hair removal	Surgical infection rate
Shaving	5.6%
Depilation	0.6%
No hair removal	0.6%

Seropian R, Reynolds BM. Wound infections after preoperative depilatory versus razor preparation. Am J Surg 1971;121:251-4.

Nonshaved cranial neurosurgery.

Ratanalert S.et al. Surg Neurol. 1999;51(4):458-63

	No.	Surgical infection rate
Shaved	**136**	**5.9%**
Non shaved	**89**	**3.3% (P= NS)**

Preoperative Skin Shaving Practices in Songklanagarind Hospital.

Ward	Frequency of shaving
Orthopedic	Never shave for at least 10 years
Obstetric and gynecology	Routinely performed
Surgery and ENT	Diversity of practices

Source : Silom Jamulitrat et al.

Type of surgery	Number	Shave performed	Percentage
Digestive system surgery	43	28	65.1%
Cardiovascular surgery	18	15	83.3%
Integumentary surgery	15	9	60.0%
Cranial surgery	9	5	55.6%

Source : Silom Jamulitrat et al.

Musculoskeletal surgery	**9**	**5**	**55.6%**
Thyroid surgery	**7**	**2**	**28.6%**
Urinary system surgery	**6**	**6**	**100.0%**
Salivary gland surgery	**3**	**1**	**33.3%**

Source : Silom Jamulitrat et al.

Preoperative hair removal?

Do not remove hair preoperatively unless the hair at or around the incision site will interfere with the operation.If hair is removed, remove immediately before the operation, preferably with electric clippers. *CDC'sCategory IA Suggestion. Guideline for Prevention of Surgical Site Infection, 1999. AJIC 1999;27:97*

Distribution of time interval between skin shaving and operation performed, PSU Hospital.

Time interval	Number	Percentage
no record	60	81.1%
≤ 2 hr	2	2.7%
between 2 and 12 hours	2	2.7%
more than 12 hr	10	13.5%
total	74	100.0%

Source : Silom Jamulitrat et al.

Preoperative Antibiotic

Quantitatively, it has been shown that if a surgical site is contaminated with $>10^5$ microorganisms per gram of tissue, the risk of SSI is markedly increased. Preoperative antibiotic prophylaxis is not an attempt to sterilize tissues, but a critically timed adjunct used to reduce the microbial burden of intraoperative contamination to a level that cannot overwhelm host defenses. ***It is indicated for all operations that entail entry into a hollow viscus (clean contaminated wound) and is sometimes indicated for clean operations when any prosthetic material or a prosthetic joint will be inserted, and (2) for any operation in which an incisional or organ/space SSI would pose catastrophic risk.***

Preoperative Antibiotic: When?

Basic "rules of thumb" guide decisions about antibiotic dose sizes and timing. For example, it is believed that a full therapeutic dose of cefazolin (1-2 g) should be given to adult patients *no more than 30 minutes before the skin is incised.* *CDC.Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97*

BMC Infectious Diseases

BioMed Central

Research article

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Risk of surgical site infection and efficacy of antibiotic prophylaxis: a cohort study of appendectomy patients in Thailand

Nongyao Kasatpibal*[1,2], Mette Nørgaard[1], Henrik Toft Sørensen[1], Henrik Carl Schønheyder[3], Silom Jamulitrat[4] and Virasakdi Chongsuvivatwong[5]

BMC Infectious Diseases 2006, 6:111

2139 appendectomies in 8 hospitals. (Chiangkham, Saraburi,Bhumibol Adulyadej, Phuket,Naradhiwas, Rayong,Chumphon, and Udonthani Hospitals)

Characteristics	Number	%	Infection	Rate*
Combination Metronidazole and Gentamicin	1266	64.2	13	1.0
Single dose combination	766	38.8	8	1.0
Combination within 1 day	130	6.6	1	0.8
Combination > 1 day	370	18.8	4	1.1

The Society of Thoracic Surgeons Practice Guideline Series: Antibiotic Prophylaxis in Cardiac Surgery, Part I: Duration*

Fred H. Edwards, MD, Richard M. Engelman, MD, Peter Houck, MD, MPH, David M. Shahian, MD, and Charles R. Bridges, MD, ScD

Ann Thorac Surg 2006;81:397–404

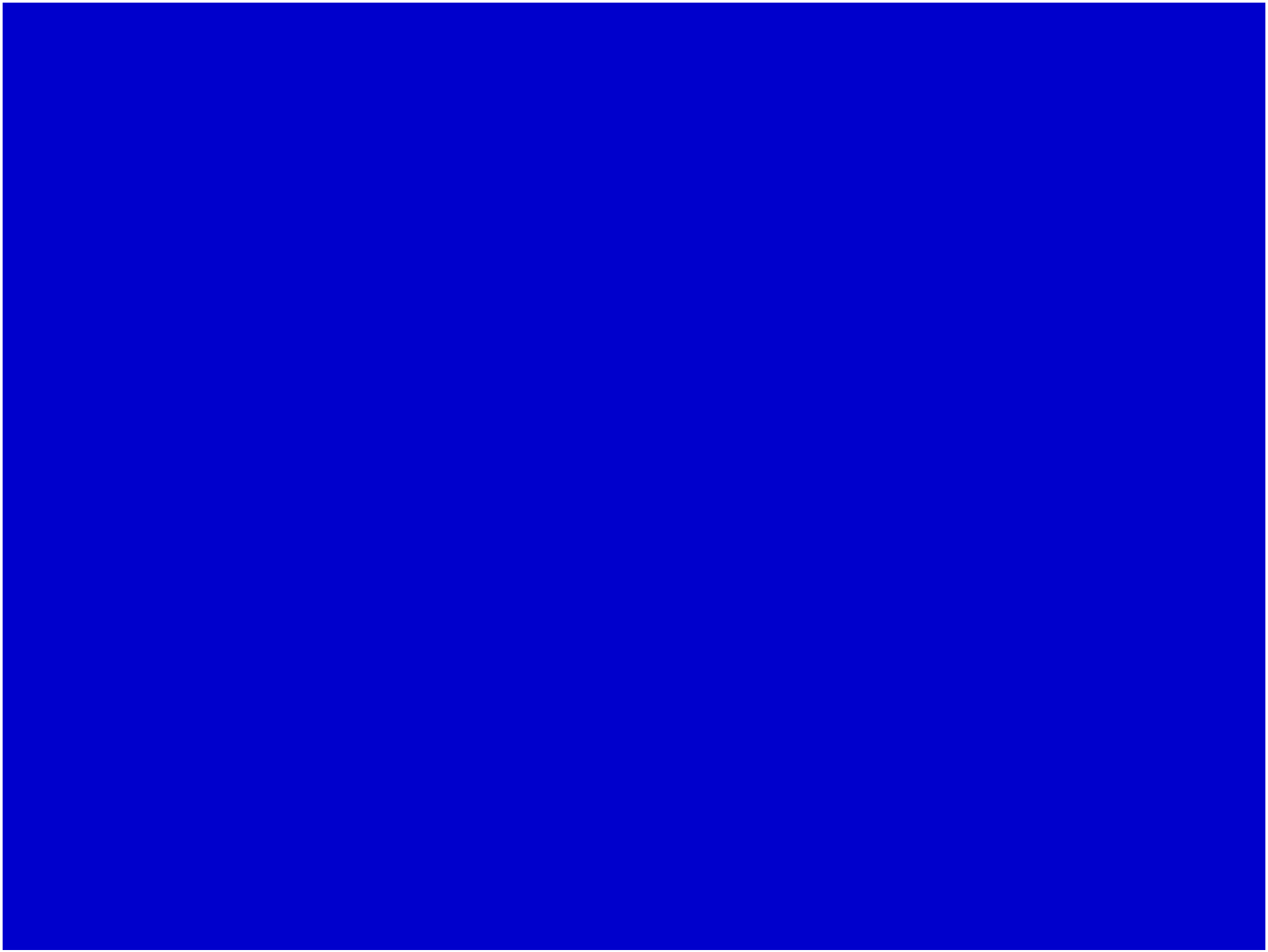
					Single-Dose		Multiple-Dose			
Author	Country	Date	Number	RCT	Agent	Surgical Site Infections (%)[a]	Agent	Surgical Site Infections (%)[a]	Duration	Significant Difference in SSI
Bucknell and colleagues [43]	Australia	2000	353	No	Cephazolin	1.0	Cephazolin	0.7	48 Hours	No
Saginur and colleagues [38]	Canada	2000	3027	Yes	Teicoplanin	2.0	Cefazolin	1.2	48 Hours	Yes
Salminen and colleagues [37]	Finland	1999	200	No	Ceftriaxone	4	Vancomycin	5	48 Hours	No
Kriaras and colleagues [36]	Italy	1997	1009	Yes	Cefuroxime	0.6	Amoxycillin	1.0	4 Days	No
Nooyen and colleagues [42]	Netherlands	1994	844	Yes	Cefuroxime	1.9	Cefuroxime	0.9	72 Hours	No
Sisto and colleagues [39]	Finland	1994	551	Yes	Ceftriaxone	2.9	Cefuroxime	2.9	48 Hours	No
Hall and colleagues [40]	Australia	1993	1031	No	Ceftriaxone	2.7	Flucloxacillin gentamycin	1.6	48 Hours	No
Beam and colleagues [41]	United States	1984	94	Yes	Ceftriaxone	4.1	Cefazolin	2.2	48 Hours	No

Harbarth and colleagues, in an observational study of 2,641 patients undergoing coronaryartery bypass grafting (CABG). found that antibiotic prophylaxis for > 48 hours had a 1.6 times higher probability of harboring resistant organisms compared with those having a regimen of < 48 hours.

Harbarth Set al.. Prolonged antibiotic prophylaxis after cardiovascular surgery and its effects on surgical site infections and antimicrobial resistance. Circulation 2000;101:2916 –21.

Summary Conclusions

There is evidence indicating that antibiotic prophylaxis of 48-hours duration is effective. There is some evidence that single-dose prophylaxis or 24-hour prophylaxis may be as effective as 48-hour prophylaxis, but additional studies are necessary. There is no evidence that prophylaxis administered for >48 hours is more effective than a 48-hour regimen.



Case 431905

Case : หญิงไทยอายุ **80** ปีมาโรงพยาบาลด้วยอาการซึมลงมา **1** วัน

Underlying diseases: DM, HT, CVA, CRF(Cr~3) & Fracture at Rt hip--> status bed ridden ช่วยเหลือตัวเองได้บ้าง

1 วันก่อน **PTA** มีไข้ต่ำ ๆ ซึมลง กินอาหารไม่ได้

PE:BT 38.5 C RR 24/min BP 190/100mmHg HR100/min

HEENT : mildly pale

Heart : no gallop, SEM gr II/VI at AVA MVA

Lung : Clear. Abdomen: Normal

Neurol : E4V2M5 ลืมตาไม่สื่อความหมาย ทำตามคำสั่งไม่ได้

pupil 3 mm BRTL LT side movement > RT side

DTR 1 + all BBK <-> <->

no stiffness of neck

CBC: Hct29% WBC 9,200 PMN 81 Lymph 10 Mono 4

Plt.count 253,000

Glucose H 391 mg%

Creatinine H 2.59 mg %

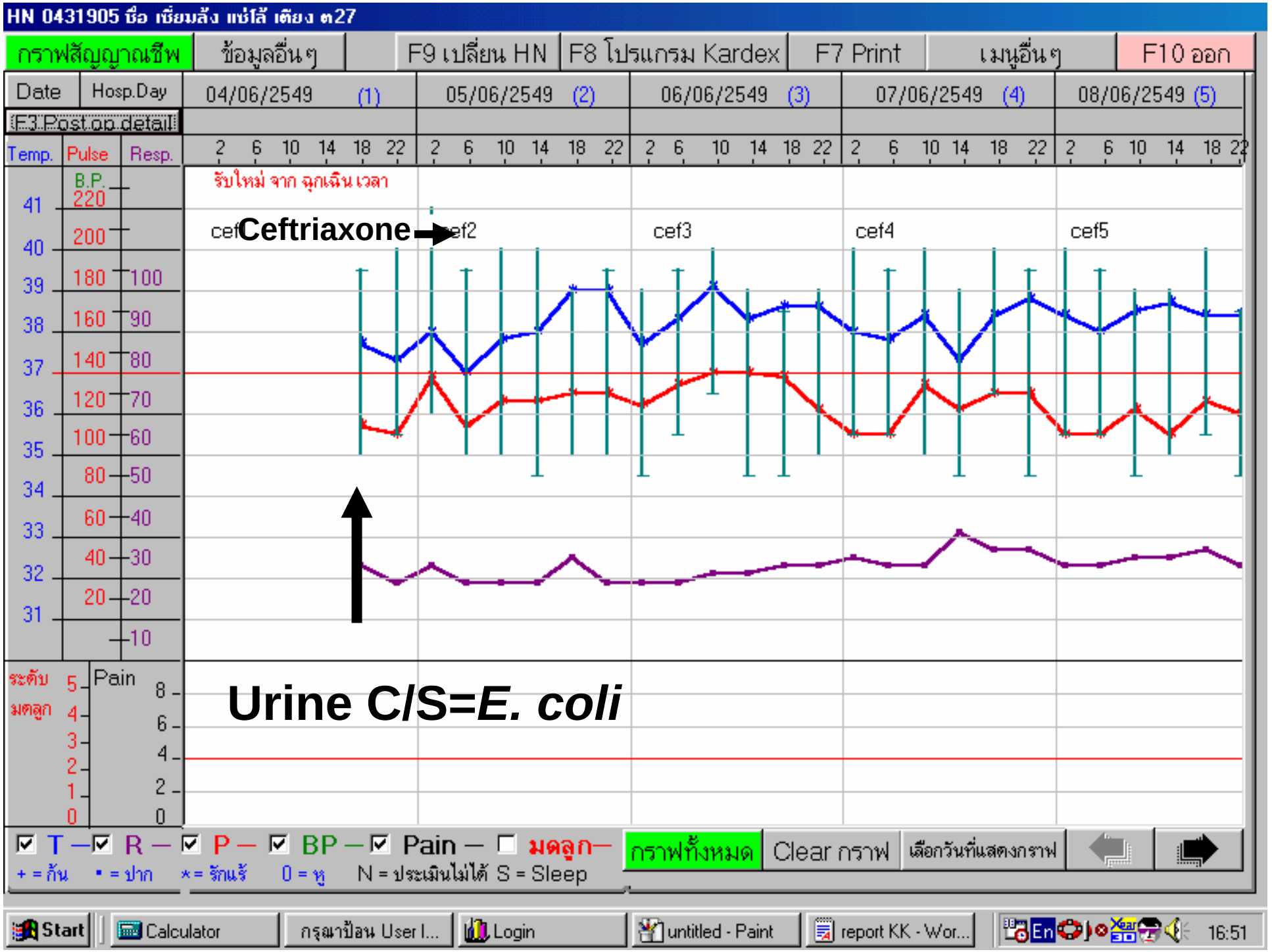
Na+ 141 mmol/L

K+ 3.89 mmol/L

Cl- 107 mmol/L

Total CO2 20 mmol/L

Urinalysis: Numerous WBCs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Pain
มดลูก
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• = ปาก
× = รักแร้
0 = หู
N = ประเมินไม่ได้ S = Sleep
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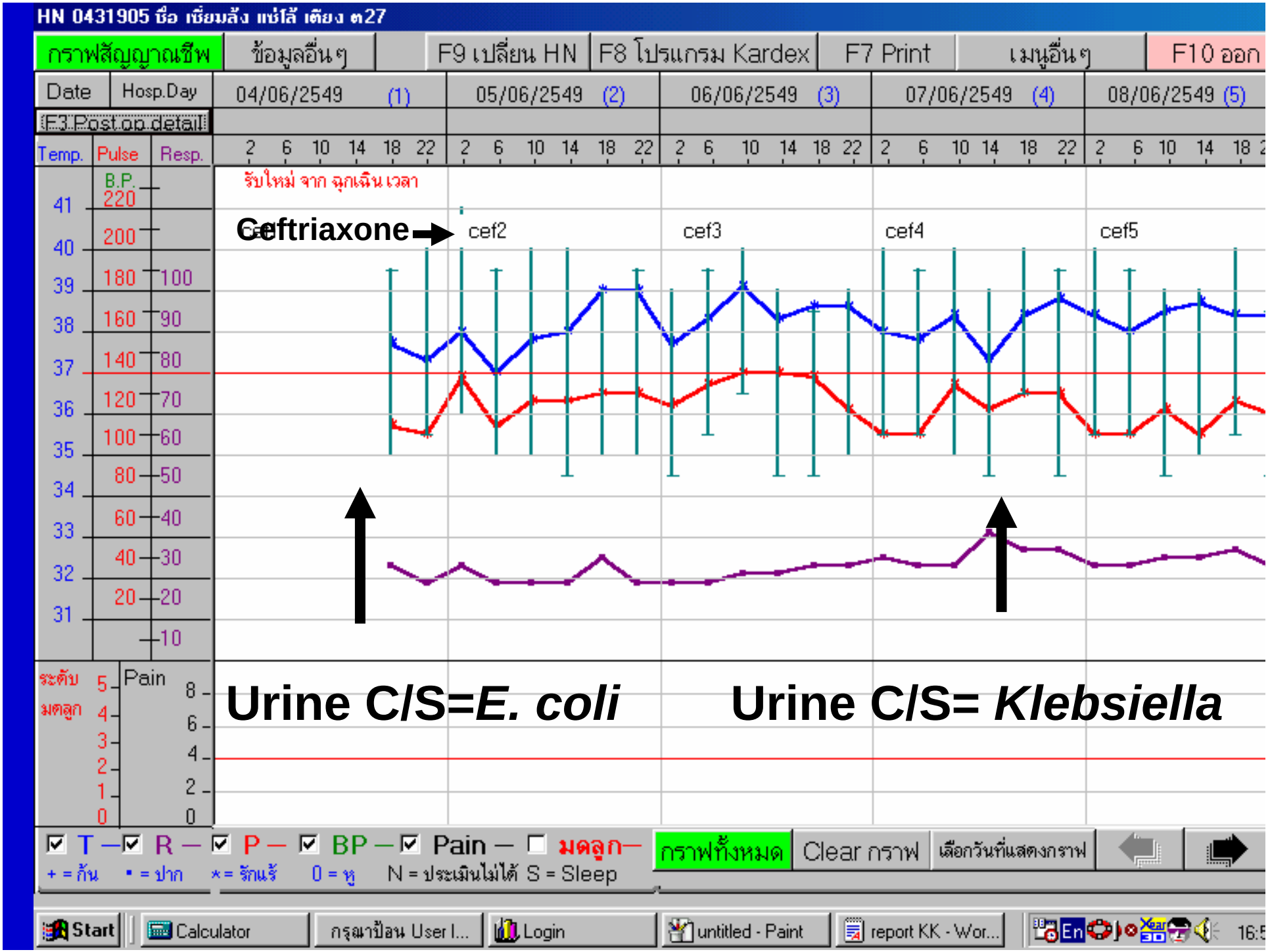
Blood cultures: No growth

Urine culture: *E.Coli* > 100,000 CFU/ml

Amikac S	Ampici R
Cefota S	Cefoxi S
Ceftaz S	Ceftri S
Cefuro S	Cephal IS
Cotrim S	Gentam S
Imipen S	Norflo S
Merope S	Cefipi S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Ceftriaxone
cef2
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cef5
ระดับมดลูก
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Urine C/S=E. coli
Urine C/S= Klebsiella
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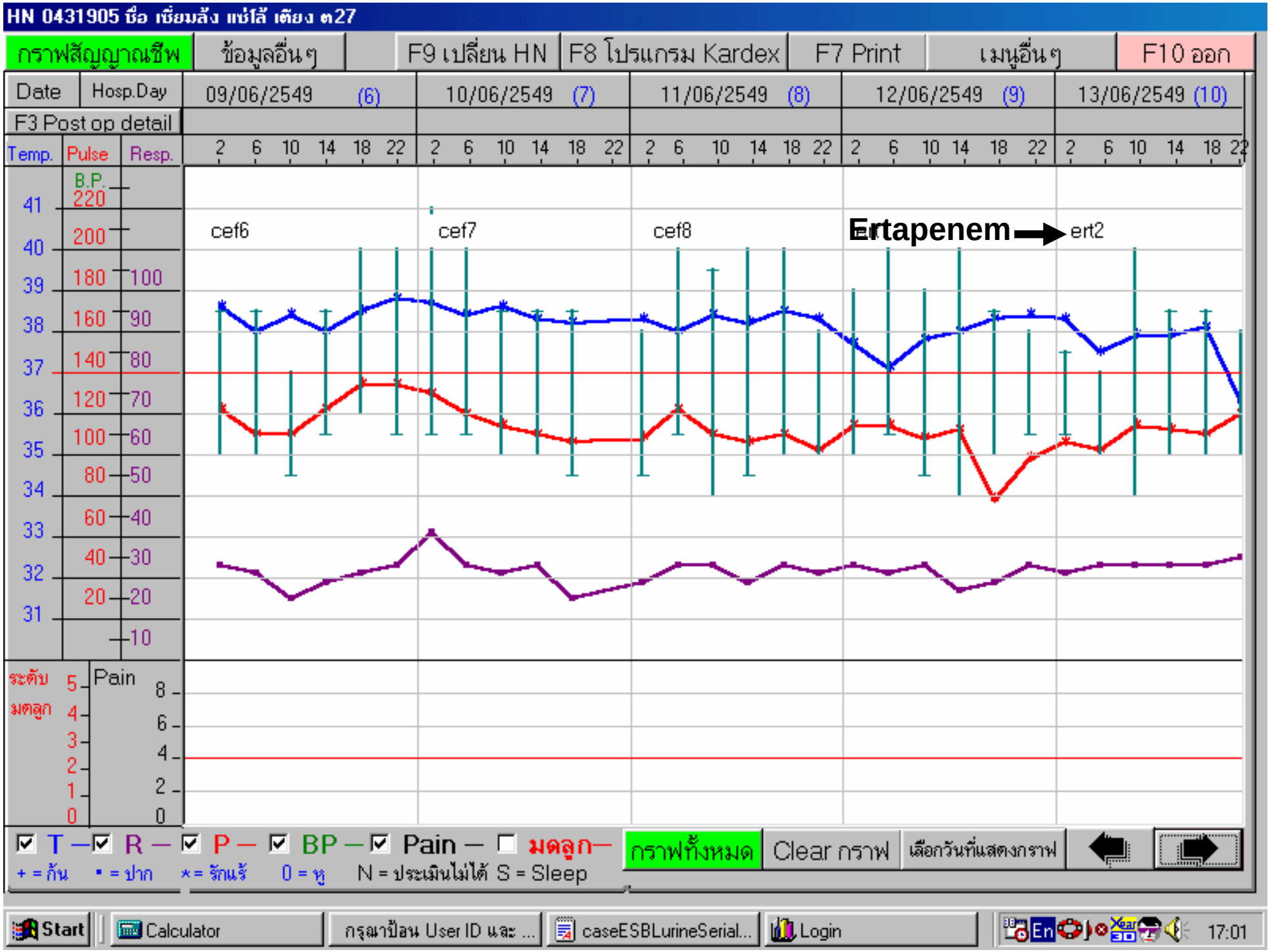
Urine Culture: *K. pneumoniae*> 100,000 CFU/ml

Amikac	S	Ampici	R
Cephal	R	Cefuro	R
Cefota	R	Cefoxi	S
Ceftri	R	Ceftaz	R
Cotrim	R	Gentam	S
Imipen	S	Norflo	R
Sulper	S	Merope	S
Cefipi	IS		

ESBL

Extended-spectrum beta-lactamases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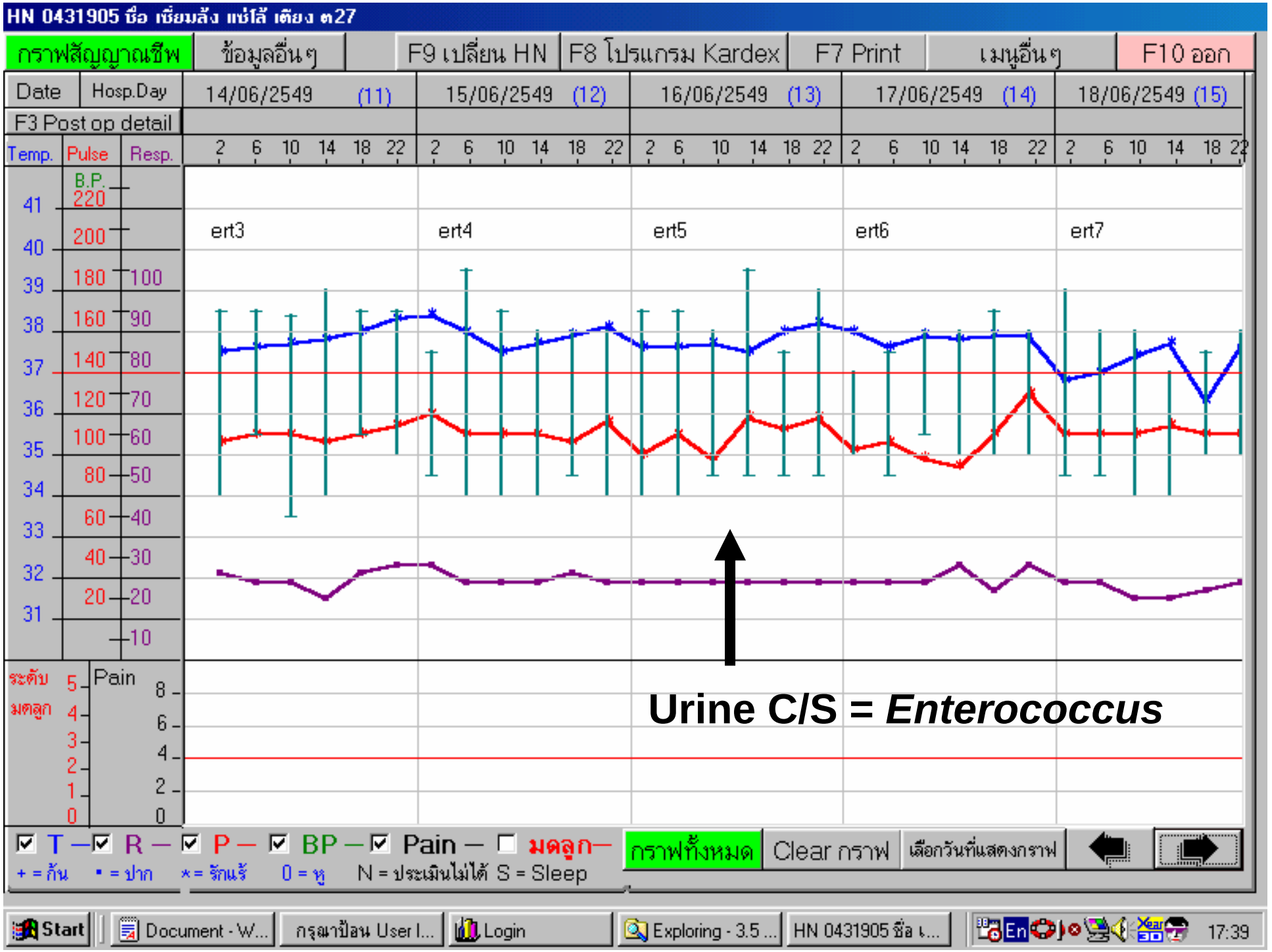
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(CATH) Urine Culture = *Enterococci* 3,000 CFU/ml

Ampici	R	Fosfom	S
Gentam	S	Imipen	R
Penici	R	Vancom	S

Hypothermia: Risk for SWI?

Hypothermia (<36º C) in surgical patients may result from general anesthesia, exposure to cold, or intentional cooling during cardiac operations. It increases incisional SSI risk by causing vasoconstriction, decreased delivery of oxygen to the wound space, and subsequent impairment of neutrophil function. ***One study of colorectal operations, hypothermia was associated with an increased SSI risk.***

Kurz A, Sessler DI, Lenhardt R. Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization. N Engl J Med 1996;334(19):1209-15.

Hypothermia: Risk for SWI?

Two hundred patients undergoing colorectal surgery were randomly assigned to routine intraoperative thermal care (the hypothermia group) or additional warming (the normothermia group). *A forced-air cover (Augustine Medical, Eden Prairie, Minn.) was positioned over the upper body of every patient, but it was set to deliver air at the ambient temperature in the hypothermia group and at 40 °C in the normothermia group.* The temperatures were not controlled postoperatively.

Kurz A, Sessler DI, Lenhardt R. Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization. N Engl J Med 1996;334(19):1209-15.

Table 2. Postoperative Findings in the Two Study Groups.*

VARIABLE	NORMOTHERMIA (N = 104)	HYPOTHERMIA (N = 96)	P VALUE
All patients			
Infection — no. of patients (%)	6 (6)	18 (19)	0.009
ASEPSIS score	7±10	13±16	0.002
Collagen deposition — μg/cm	328±135	254±114	0.04
Days to first solid food	5.6±2.5	6.5±2.0	0.006
Days to suture removal	9.8±2.9	10.9±1.9	0.002
Days of hospitalization	12.1±4.4	14.7±6.5	0.001
Uninfected patients			
No. of patients	98	78	
Days to first solid food	5.2±1.6	6.1±1.6	<0.001
Days to suture removal	9.6±2.6	10.6±1.6	0.003
Days of hospitalization	11.8±4.1	13.5±4.5	0.01

*Plus–minus values are means ±SD.

Table 1. Major consequences of mild perioperative hypothermia in humans.

Authors [reference]	Consequence	Total no. of subjects	ΔT_{core}, °C	Normothermia[a]	Hypothermia[a]	*P*
Frank et al. [21]	Morbid cardiac events	300	1.3	1%	6%	<.05
	Postoperative ventricular tachycardia	300	1.3	2%	8%	<.05
Schmied et al. [22]	Intraoperative blood loss	60	1.6	1.7 ± 0.3 L	2.2 ± 0.5 L	<.001
	Allogeneic transfusion requirement	60	1.6	1 U	8 U	<.05
Heier et al. [25]	Duration of vecuronium	20	2.0	28 ± 4 min	62 ± 8 min	<.001
Lenhardt et al. [26]	Duration of postanesthetic recovery	150	1.9	53 ± 36 min	94 ± 65 min	<.001
Kurz et al. [30]	Surgical wound infection	200	1.9	6%	19%	<.01
	Duration of hospitalization	200	1.9	12.1 ± 4.4 days	14.7 ± 6.5 days	<.01
Carli et al [31]	Urinary excretion of nitrogen	12	1.5	982 m*M*/day	1798 m*M*/day	<.05
Leslie et al. [32]	Duration of atracurium	6	3.0	44 ± 4 min	68 ± 7 min	<.05
Just et al. [33]	Postoperative shivering	14	2.3	141 ± 9 mL/min/m^2	269 ± 60 mL/min/m^2	<.001
Frank et al. [34]	Adrenergic activation	74	1.5	330 ± 30 pg/mL	480 ± 70 pg/mL	<.05
Kurz et al. [35]	Thermal discomfort	74	2.6	50 ± 10 mm VAS	18 ± 9 mm VAS	<.001

Does hypothermia improve outcomes of neurological patients with fever ??

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Mild Intraoperative Hypothermia during Surgery for Intracranial Aneurysm

Michael M. Todd, M.D., Bradley J. Hindman, M.D., William R. Clarke, Ph.D., and James C. Torner, Ph.D., for the Intraoperative Hypothermia for Aneurysm Surgery Trial (IHAST) Investigators*

N Engl J Med 2005;352:135-45.

A total of 1001 patients with SAH and a preoperative WFNS score of I, II, or III ("good-grade patients"),

Randomly assigned to intraoperative hypothermia (target temperature, 33° C, or normothermia (target temperature, 36.5° C).

Outcome	Hypothermia Group		Normothermia Group		P Value†	Odds Ratio (95% CI)‡
	No. Analyzed	No. with Score (%)	No. Analyzed	No. with Score (%)		
Score for Glasgow Outcome Scale	499		501			
1 (Minor or no disability)§		329 (66)		314 (63)	0.32	1.14 (0.88–1.48)
2 (Moderate disability)		105 (21)		108 (22)		
3 (Severe disability)		35 (7)		47 (9)		
4 (Vegetative state)		1 (<1)		0		
5 (Death)¶		29 (6)		32 (6)		
Rankin score	499		501			
Score 0 or 1 (mild or no neurologic disability)		333 (67)		318 (63)	0.32	1.14 (0.88–1.49)

Table 4. Selected Adverse Events and Procedures.*

Event	Hypothermia Group (N=499)	Normothermia Group (N=502)	P Value
	percent		
Infection			
Incision or bone-flap infection	2	2	0.81
Meningitis or ventriculitis	6	4	0.31
Bacteremia	5	3	0.05
Pneumonia	7	7	0.90
Urinary tract infection	15	18	0.31

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Hypothermia Therapy after Traumatic Brain Injury in Children

James S. Hutchison, M.D., Roxanne E. Ward, B.A., Jacques Lacroix, M.D., Paul C. Hébert, M.D., M.H.Sc., Marcia A. Barnes, Ph.D., Desmond J. Bohn, M.B., Peter B. Dirks, M.D., Steve Doucette, M.Sc., Dean Fergusson, Ph.D., Ronald Gottesman, M.D., Ari R. Joffe, M.D., Haresh M. Kirpalani, M.B., M.Sc., Philippe G. Meyer, M.D., Kevin P. Morris, M.D., David Moher, Ph.D., Ram N. Singh, M.D., and Peter W. Skippen, M.D., for the Hypothermia Pediatric Head Injury Trial Investigators and the Canadian Critical Care Trials Group*

N Engl J Med 2008;358:2447-56.

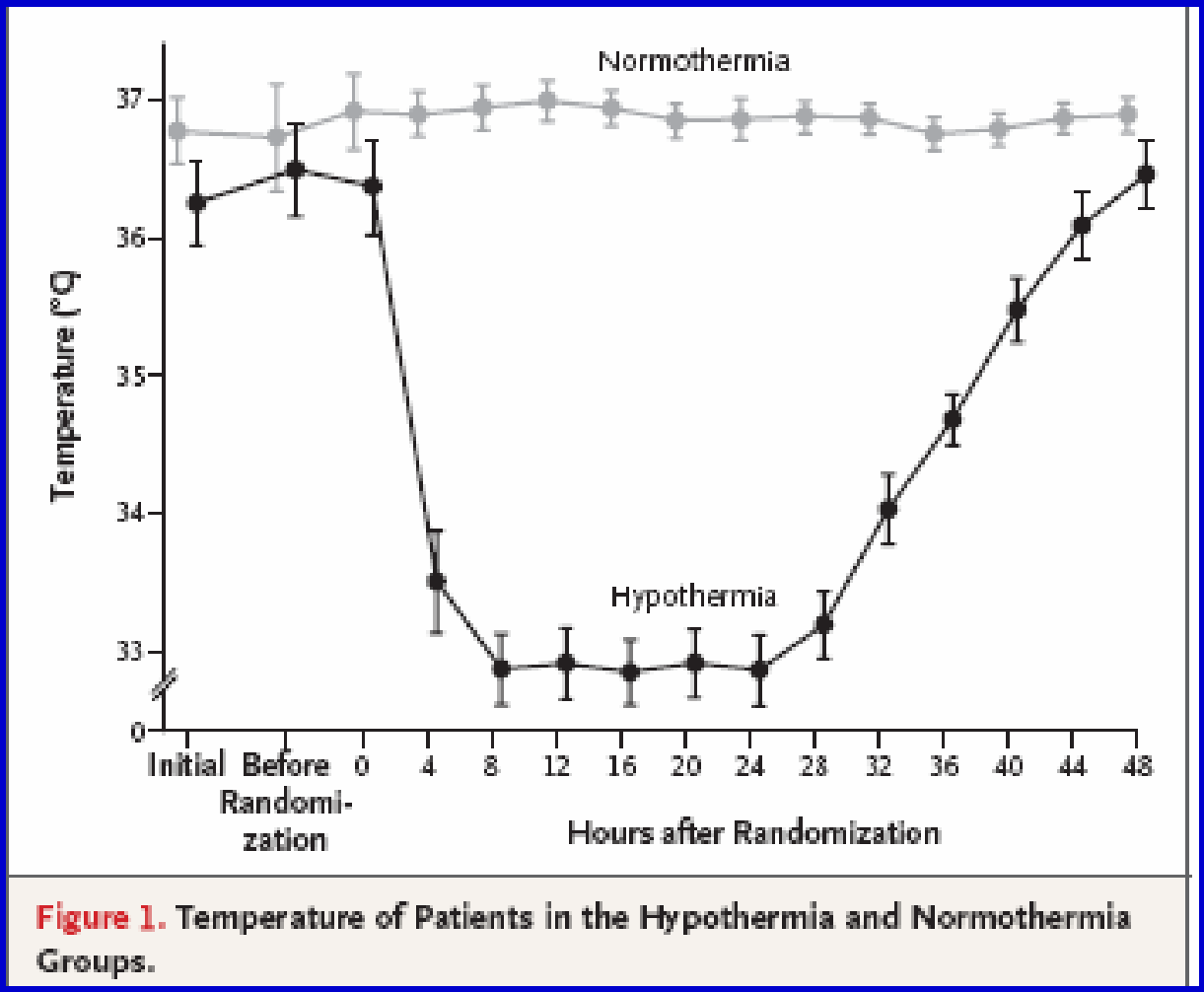


Figure 1. Temperature of Patients in the Hypothermia and Normothermia Groups.

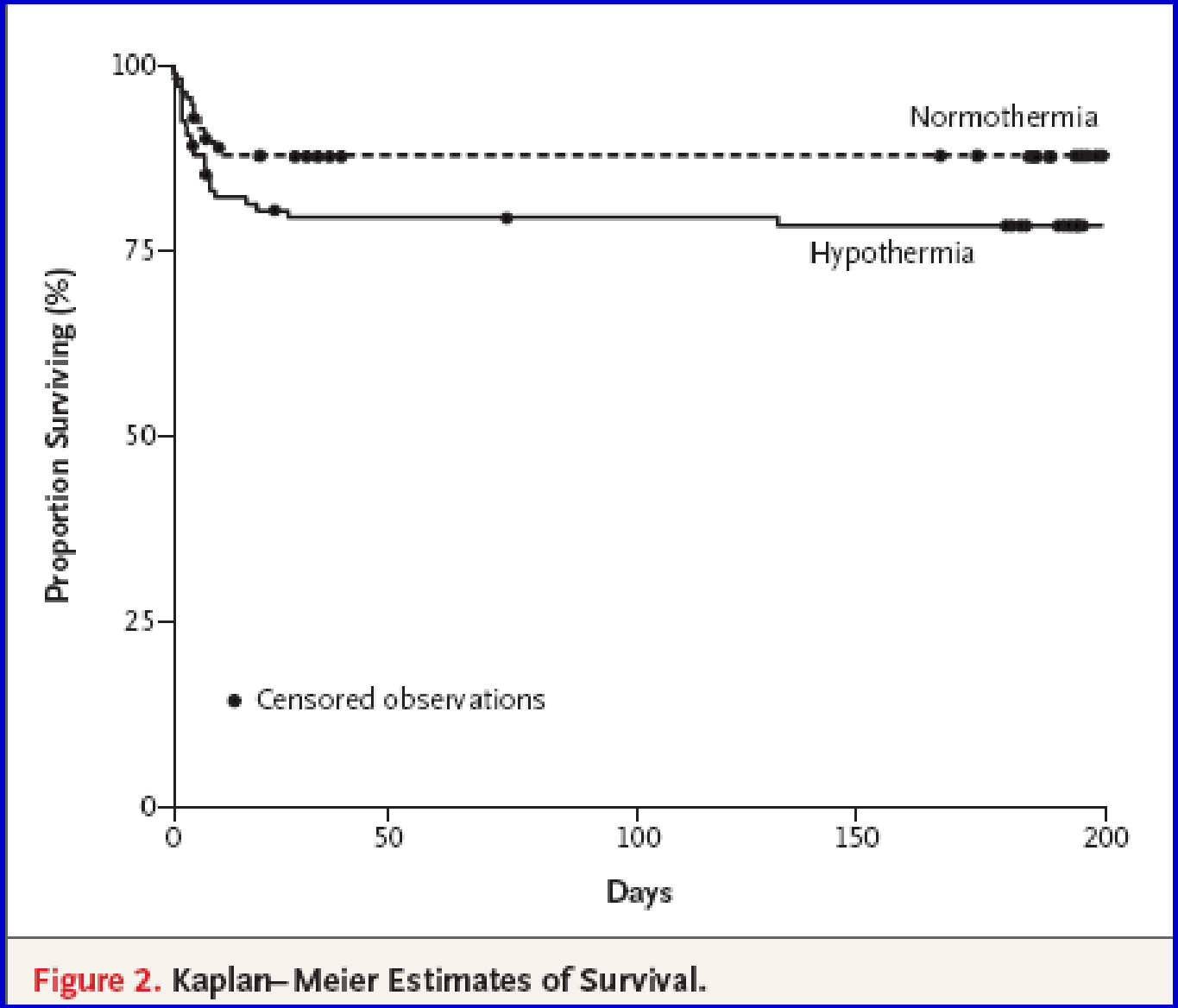


Figure 2. Kaplan–Meier Estimates of Survival.

SUPPLEMENTAL PERIOPERATIVE OXYGEN TO REDUCE THE INCIDENCE OF SURGICAL-WOUND INFECTION:

(Greif R *et al.* N Engl J Med 2000;342:161-7.)

500 patients undergoing colorectal resection were randomly assigned to receive 30 % or 80 % inspired oxygen during the operation and for two hours afterward.

SUPPLEMENTAL PERIOPERATIVE OXYGEN TO REDUCE THE INCIDENCE OF SURGICAL-WOUND INFECTION

ROBERT GREIF, M.D., OZAN AKÇA, M.D., ERNST-PETER HORN, M.D., ANDREA KURZ, M.D., AND DANIEL I. SESSLER, M.D., FOR THE OUTCOMES RESEARCH GROUP*

ABSTRACT

Background Destruction by oxidation, or oxidative killing, is the most important defense against surgical pathogens and depends on the partial pressure of oxygen in contaminated tissue. An easy method of improving oxygen tension in adequately perfused tissue is to increase the concentration of inspired oxygen. We therefore tested the hypothesis that the supplemental administration of oxygen during the perioperative period decreases the incidence of wound infection.

Methods We randomly assigned 500 patients undergoing colorectal resection to receive 30 percent or 80 percent inspired oxygen during the operation and for two hours afterward. Anesthetic treatment was standardized, and all patients received prophylactic antibiotic therapy. With use of a double-blind protocol, wounds were evaluated daily until the patient was discharged and then at a clinic visit two weeks after surgery. We considered wounds with culture-positive pus to be infected. The timing of suture removal and the date of discharge were determined by the surgeon, who did not know the patient's treatment-group assignment.

Results Arterial oxygen saturation was normal in both groups; however, the arterial and subcutaneous partial pressure of oxygen was significantly higher in the patients given 80 percent oxygen than in those given 30 percent oxygen. Among the 250 patients who received 80 percent oxygen, 13 (5.2 percent; 95 percent confidence interval, 2.4 to 8.0 percent) had surgical-wound infections, as compared with 28 of the 250 patients given 30 percent oxygen (11.2 percent; 95 percent confidence interval, 7.3 to 15.1 percent; P=0.01). The absolute difference between groups was 6.0 percent (95 percent confidence interval, 1.2 to 10.8 percent). The duration of hospitalization was similar in the two groups.

Conclusions The perioperative administration of supplemental oxygen is a practical method of reducing the incidence of surgical-wound infections. (N Engl J Med 2000;342:161-7.)

stitute a critical period during which wound infections are established.[4] Therefore, perioperative factors influence the incidence of infections, even though infections are typically not detected until some days after surgery. The factors that influence the incidence of surgical-wound infection include the site and complexity of surgery,[1] the patient's underlying illness, the use or nonuse of prophylactic antibiotics,[5-7] the patient's temperature during surgery,[2] the presence or absence of hypovolemia,[8,9] the degree to which pain is controlled postoperatively,[10] and the oxygen tension in tissue.[11]

Bactericidal activity of neutrophils is mediated by oxidative killing, a critical defense against surgical pathogens.[12] Oxidative killing is dependent on the production of bactericidal superoxide radicals from molecular oxygen. The rate of this reaction, which is catalyzed by the NADPH-linked oxygenase, is dependent on the partial pressure of oxygen in the tissue. In the case of neutrophils, oxidative killing depends on a partial pressure of oxygen in the range from 0 to more than 300 mm Hg.[13]

All wounds disrupt the local vascular supply as a result of injury and thrombosis of vessels, which cause wounds to be hypoxic as compared with normal tissue.[14] The oxygen tension of wounds is often less than 30 mm Hg.[14] Resistance to infection therefore depends on the partial pressure of oxygen in the wound[11] and can thus potentially be improved by increasing arterial oxygen tension beyond that required to saturate blood. We tested the hypothesis that the supplemental administration of oxygen during the perioperative period decreases the incidence of postoperative wound infections in patients undergoing elective colorectal resection.

METHODS

We studied 500 patients who were 18 to 80 years of age and who were undergoing elective open colorectal resection, in most

TABLE 2. OUTCOMES IN THE TWO STUDY GROUPS.*

CHARACTERISTIC	PATIENTS WHO RECEIVED 30% OXYGEN (N=250)	PATIENTS WHO RECEIVED 80% OXYGEN (N=250)	P VALUE
Infection — no. (%)	28 (11.2)	13 (5.2)	0.01
ASEPSIS score†	5±9	3±7	0.01
Collagen deposition — ng/mm‡	267±109	258±118	0.38
Protein deposition — μg/mm‡	163±74	153±91	0.31
First solid food — days after surgery	4.4±1.6	4.5±1.8	0.27
Staples removed — days after surgery	10.4±1.5	10.3±1.4	0.21
Duration of hospitalization after surgery — days	11.9±4.0	12.2±6.1	0.26

Results Arterial oxygen saturation was normal in both groups; however, the arterial and subcutaneous partial pressure of oxygen was significantly higher in the patients given 80 percent oxygen than in those given 30 percent oxygen. Among the 250 patients who received 80 percent oxygen, 13 (5.2 percent; 95 percent confidence interval, 2.4 to 8.0 percent) had surgical-wound infections, as compared with 28 of the 250 patients given 30 percent oxygen (11.2 percent; 95 percent confidence interval, 7.3 to 15.1 percent; P=0.01). The absolute difference between groups was 6.0 percent (95 percent confidence interval, 1.2 to 10.8 percent). The duration of hospitalization was similar in the two groups.

Conclusions The perioperative administration of supplemental oxygen is a practical method of reducing the incidence of surgical-wound infections. (N Engl J Med 2000;342:161-7.)

Surgical Site Infection and the Routine Use of Perioperative Hyperoxia in a General Surgical Population
A Randomized Controlled Trial

Kane O. Pryor, MD; Thomas J. Fahey III, MD; Cynthia A. Lien, MD; Peter A. Goldstein, MD

JAMA. 2004;291:79-87.

Results: In an intention-to-treat analysis, the incidence of infection was significantly higher in the group receiving FIO_2 of 0.80 than in the group with FIO_2 of 0.35 (25.0% vs 11.3%; *P* = .02). FIO_2 remained a significant predictor of SSI (*P* = .03) in multivariate regression analysis. Patients who developed SSI had a significantly longer length of hospitalization after surgery (mean [SD], 13.3 [9.9] vs 6.0 [4.2] days; *P*<.001).

Conclusions: The routine use of high perioperative FIO_2 in a general surgical population does not reduce the overall incidence of SSI and may have predominantly deleterious effects.

Surgical Wound Infections:Factors

1.Patients

2.Surgical Team

3.Operating Room & Equipment

Numbers of Staffs

Outbreaks of SSIs caused by group A beta-hemolytic streptococci have been traced to transmission of the organism from colonized operating room personnel to patients.Therefore, *efforts should be made to minimize personnel traffic during operations.*

CDC. Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

Infected or colonized surgical personnel

Surgical personnel who have active infections or are colonized with certain microorganisms have been linked to outbreaks or clusters of SSIs.

"Exclude from duty, surgical personnel who have draining skin lesions until infection has been ruled out or personnel have received adequate therapy and infection has resolved."

CDC's Category IB Suggestion. Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

Infection Rates: Surgical Handscrub vs. Handrub

Class of Contamination	No. SSI/No. Operations (%) Handscrub	Handrub	χ^2 Test of Equivalence (p-value)
Clean	29/1485 (1.9)	32/1520 (2.1)	16.0 (<0.001)
Clean-Contaminated	24/650 (3.7)	23/732 (3.1)	1.9 (0.09)
All	53/2135 (2.5)	55/2252 (2.4)	19.5 (<0.001)

Parienti et al. *JAMA* 2002: 288(6);722-27.

Surgical Hand Scrub: Duration?

Scrubbing for at least *2 minutes is as effective as the traditional 10-minute scrub* in reducing hand bacterial colony counts.

Wheelock SM, Lookinland S. Effect of surgical hand scrub time on subsequent bacterial growth. AORN J 1997; 65: 1087-92, 1094-8.

Hand-Rubbing With an Aqueous Alcoholic Solution vs Traditional Surgical Hand-Scrubbing and 30-Day Surgical Site Infection Rates :

Parienti JJ et al.: JAMA 2002;288:722-727

Six surgical services in France used 2 hand-cleansing methods alternately every other month (75% aqueous alcoholic solution* vs. 4% povidone iodine or 4% chlorhexidine gluconate)and 30-day surgical site infection rates among *4387 consecutive patients who underwent clean and clean-contaminated surgery* between January 1, 2000, and May 1, 2001 were compared.

*

Hand-Rubbing With an Aqueous Alcoholic Solution vs Traditional Surgical Hand-Scrubbing and 30-Day Surgical Site Infection Rates :

Parienti JJ et al.: JAMA 2002;288:722-727

-Prior to the first procedure of the day,wash hands with ordinary soap for 1 min. (including a subungual space cleaning with brush).

-Then fully cover hands and forearms with at least 5cc.(=> 4 pump strokes) of alcohol solution and apply it twice over 2.5 min. for a total of 5 min. (rub hands with alcohol solution for 30 sec. when changing gloves).”

Hand-Rubbing With an Aqueous Alcoholic Solution vs Traditional Surgical Hand-Scrubbing and 30-Day Surgical Site Infection Rates :

Parienti JJ et al.: JAMA 2002;288:722-727

Results:Surgical site infection rates were *55 of 2252 (2.44%) in the hand-rubbing protocol and 53 of 2135 (2.48%)* in the hand-scrubbing protocol, for a *difference of 0.04% (95% CI= -0.88% to 0.96%).*

Surgical Attire: Risk for SWI?

Few controlled clinical studies have evaluated the relationship between the use of surgical attire and SSI risk. Nevertheless, the use of barriers seems prudent to protect surgical team members from exposure to blood and bloodborne pathogens.

Scrub suits:

OSHA regulations require that “if a garment(s) is penetrated by blood or other potentiallyinfectious materials, the garment(s) shall be remove dimmediately or as soon as feasible.”

No recommendations on restricting use of scrub suits to the operating suite, or for covering scrub suits when out of the operating suite. <u>Unresolved issue</u>

CDC. Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

Surgical Mask

Many studies have raised questions about the efficacy and cost-benefit of surgical masks in reducing SSI risk.

Wear a surgical mask that fully covers the mouth and nose *when entering the operating room if an operation is about to begin or already under way, or if sterile instruments are exposed. Wear the mask throughout the operation*.

CDC. Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

Surgical Cap

Wear a cap or hood to fully cover hair on the head and face when entering the operating room.

CDC. Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

Shoes

The use of shoe covers has never been shown to decrease SSI risk or to decrease bacteria counts on the operating room floor. Shoe covers may, however, protect surgical team members from exposure to blood and other body fluids during an operation.

CDC. Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

Surgical Wound Infections:Factors

1.Patients

2.Surgical Team

3.Operating Room & Equipment

Operating Room: Risk Factors for SWI?

-Ventilation: Airborne transmission?

-Environmental Surfaces: Floors? Operating table? Wall?

-Eqipments?

Operating Room Ventilation: CDC Suggestion

Introduce all air at the ceiling, and exhaust near the floor. Filter all air, recirculated and fresh, through the appropriate filters. Maintain a minimum of 15 air changes per hour, of which at least 3 should be fresh air.

CDC:Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

Table 8 Parameters for Operating Room Ventilation, American Institute of Architects, 1996

Temperature	68-73°F, depending on normal ambient temperatures
Relative humidity	30%-60%
Air movement	From "clean to less clean" areas
Air changes	Minimum 15 total air changes per hour Minimum 3 air changes of outdoor air per hour

Surgical Wound Infection: Airborne?

ปกติแล้วอากาศในห้องผ่าตัดก็มีเชื้อน้อยมาก เช่น มีการศึกษาที่เบอร์มิงแฮม ประเทศอังกฤษ โดยการดูดอากาศของห้องผ่าตัด **10** แห่ง มาเพาะเชื้อ **Staphylococcus aureus** พบว่ามีเชื้อนี้เฉลี่ยเพียง **0.03 colony forming unit** ต่ออากาศ **1** ลูกบาศก์ฟุตเท่านั้น และพบว่าถึงแม้ว่าจะติดตั้งระบบระบายอากาศที่ดีทำให้จำนวนเชื้อลดน้อยลง แต่อัตราการติดเชื้อแผลผ่าตัดไม่ได้ลดลงเลย

Ref.:Ayliffe GAJ : Role of the environment of the operation suite in surgical wound infection. Rev Infect Dis 1991 ; 13 (Suppl 10) $ 800-804

Surgical Wound Infection: Airborne?

มีการศึกษาแสดงว่า การผ่าตัดในห้องโรงพยาบาล โดยทีมผ่าตัดชุดเดียวกันและผ่าตัดคนไข้โรคกลุ่มเดียวกันด้วยเทคนิคเหมือนกัน ปรากฏว่า*การติดเชื้อแผลผ่าตัดไม่ได้แปรตามจำนวนเชื้อแบคทีเรียในอากาศ นอกจากนี้จำนวนแบคทีเรียที่นับได้จากการวาง* ***plate* *ที่พื้นก็ไม่แปรผันตามจำนวนแบคทีเรียในอากาศด้วย***

Ref.:Seropian R, Benedict RM : The importance of airborne contamination as a factor in postoperative wound infection. Arch Surg 1969 ; 98 : 654-658

Operating Room:Ultraclean Air?

(Laminar Air Flow)

Lidwell et al. compared the effects of ultraclean airalone, antimicrobial prophylaxis alone, and ultraclean air in combination with antimicrobial prophylaxis on the rate of deep SSIs.

Ref.:Lidwell OM et al. Ultraclean air and antibiotics for prevention of postoperative infection. A multicenter study of 8,052 joint replacemnet operations. Acta Orthop Scand 1987;58:4-13.

Operating Room:Ultraclean Air?

The SSI rate following operations in which ultraclean air alone was used decreased from 3.4% to 1.6%, whereas the rate for those who received only antimicrobial prophylaxis decreased from 3.4% to 0.8%. When both interventions were used incombination, the SSI rate decreased from 3.4% to 0.7%..

Ref.:Lidwell OM et al. Ultraclean air and antibiotics for prevention of postoperative infection. A multicenter study of 8,052 joint replacemnet operations. Acta Orthop Scand 1987;58:4-13.

ควรวางจานเพาะเชื้อในห้องผ่าตัดหรือไม่ ?

ปกติแล้วอากาศในห้องผ่าตัดก็มีเชื้อน้อยมาก เช่น มีการศึกษาที่เบอร์มิงแฮม ประเทศอังกฤษ โดยการดูดอากาศของห้องผ่าตัด **10** แห่งมาเพาะเชื้อ **Staphylococcus aureus** พบว่ามีเชื้อนี้เฉลี่ยเพียง **0.03 colony forming unit** ต่ออากาศ **1** ลูกบาศก์ฟุตเท่านั้น และพบว่าถึงแม้ว่าจะติดตั้งระบบระบายอากาศที่ดีทำให้จำนวนเชื้อลดน้อยลง แต่อัตราการติดเชื้อแผลผ่าตัดไม่ได้ลดลงเลย

Ref.:Ayliffe GAJ : Role of the environment of the operation suite in surgical wound infection. Rev Infect Dis 1991 ; 13 (Suppl 10) $ 800-804

มีการศึกษาแสดงว่า การผ่าตัดในห้องโรงพยาบาล โดยทีมผ่าตัดชุดเดียวกันและผ่าตัดคนไข้โรคกลุ่มเดียวกันด้วยเทคนิคเหมือนกัน ปรากฏว่า*การติดเชื้อแผลผ่าตัดไม่ได้แปรตามจำนวนเชื้อแบคทีเรียในอากาศ นอกจากนี้จำนวนแบคทีเรียที่นับได้จากการวาง* ***plate* *ที่พื้นก็ไม่แปรผันตามจำนวนแบคทีเรียในอากาศด้วย***

Ref.:Seropian R, Benedict RM : The importance of airborne contamination as a factor in postoperative wound infection. Arch Surg 1969 ; 98 : 654-658

***Medical Research Council* ของอังกฤษ, *CDC* ของอเมริกา, สมาคมโรงพยาบาลของอเมริกา(*AmericanHospitalAssociation*) และแม้กระทั่ง *American College of Surgeons* ก็แนะนำให้เลิกวางจานเพาะเชื้อดังกล่าวในห้องผ่าตัดตั้งแต่ปี ค.ศ. *1968, 1970, 1974* และ *1976* ตามลำดับ**

Ref.:Committee on Hospital infection, Medical Research Council, Great Britain. Aseptic methods in the operating suite. Lancet 1968 ; 1 : 705-709 ; 763-766, 831-839

American Hospital Association. Statement on microbiologic sampling in the hospital. Hospitals 1974 ; 48 : 125-126

American College of Surgeons. Manual on control of infection in surgical patients. J.B.Lippincott Co., Philadelphia 1976

Operating Room: Risk Factors for SWI?

-Ventilation: Airborne transmission?

-Environmental Surfaces: Floors? Operating table? Wall?

-Eqipments?

Operating Room: Fogging with Formalin?

Dr Beeby ที่ประเทศอังกฤษพบว่า ความเข้มข้นของฟอร์มาลินที่ใช้และความชื้น **(humidity)** มีผลต่อการฆ่าเชื้ออย่างมาก โดยที่ต้องใช้ความชื้นสูงถึงร้อยละ **86** ถึงจะฆ่าเชื้อได้หมด ความชื้นขนาดร้อยละ **53** ฆ่าเชื้อไม่หมด และความชื้นที่ร้อยละ **32** แทบจะไม่ฆ่าเชื้อเลย การศึกษานี้พบว่า การอบห้องด้วยฟอร์มาลิน โดยวิธี **permanganate** แบบที่ใช้กันอยู่ทั่วไป ไม่สามารถทำความชื้นได้สูงพอ และความเข้มข้นของฟอร์มาลินในอากาศก็ไม่ได้มาตรฐาน

Ref.:Beeby MM *et al.*: Experiments on terminal disinfection of cubicles with formaldehyde. J Hyg (Camb.) 1967 ; 65 : 115-130

ปรกติมาตรฐานห้องผ่าตัดมีพัดลมดูดอากาศในห้องจะสามารถแลกเปลี่ยนลมขนาดปริมาตรเท่ากับห้องได้อย่างน้อย15ครั้งต่อชั่วโมง แม้กระทั่ง*ห้องแยกธรรมดา ก็มีการแลกเปลี่ยนลมได้เท่าปริมาตรห้องอย่างน้อย 6 ครั้งต่อชั่วโมงอยู่แล้ว มีการศึกษาซึ่งแสดงว่าร้อยละ 90 ของ airborne particle สามารถถูกดูดออกไปภายใน 2 air exchanges เท่านั้น.*

Ref.:Centers for Disease Control : Disinfectant fogging, an ineffective measure. NNIS Report1971 (third quarter) Washington DC US Government Printing Office 1972 – DHEW Publication No.CDC 72-8149

National Institute for Occupational Safety and Health (NIOSH) ได้กล่าวเตือนว่าฟอร์มาลินเป็น **potential carcinogen** และตั้งมาตรฐานว่าคนเราไม่ควรได้รับสารฟอร์มาลินเข้มข้นเกิน **3 ppm.** เกินกว่าระยะเวลา **8** ชั่วโมงต่อวัน. **(National Institute for Occupational Safety and Health : Formaldehye : Evidence ofcarcinogenicity – NIOSGH Current Intelligence Bulletin 34 DHEW(NIOSH) Publication No 31-111 Apr 1981)**

CDC ได้วิเคราะห์ว่าการฆ่าเชื้อด้วยฟอร์มาลินได้ผลไม่ดี และไม่ cost effective *และแนะนำตั้งแต่ปี ค.ศ. 1972 ว่าไม่ควรทำ* (Category I Suggestion)

Ref.: CDC. Disinfectant fogging, an ineffective measure. NNIS Report 1971 (third quarter) Washington DC US Government Printing Office 1972 – DHEW Publication No CDC 72-8419

American Hospital Association : Infection control in the hospital. Chicago 1979 :114-115

“Disinfectant fogging for control of microbial contamination of air or surfaces is not only ineffective for infection control, it is time-consuming and potentially toxic.” ***Daschner FD.***

Operating Room: Risk Factors for SWI?

-Ventilation: Airborne transmission?

-Environmental Surfaces: Floors? Operating table? Wall?

-Eqipments?

Operating Room: UV?

แสง **UV** มีระยะ **penetration** สั้นมาก ; **intensity** ที่ระยะ **8-9** นิ้ว จะลดลงไปถึง **25%** และถ้าผ่านน้ำแล้ว **intensity** จะลดลงเหลือ **38%** ที่ระยะห่างเพียง **2** นิ้วฟุต เท่านั้น ดังนั้นถ้าไม่อยู่ใกล้แสง **UV** จริง ๆ มันจะไม่ถูกฆ่า

-ถ้ามีฝุ่นหรือคราบความชื้นจับอยู่ที่หลอดเพียงไม่มาก **penetration** ของแสง **UV** ก็จะลดลงมากเช่นกัน, **relative humidity** ของห้องต้องต่ำกว่า **60%** ; ถ้าเกิน **80-90%** จะไม่ได้ผลในการฆ่าเชื้อ

Operating Room: UV?

ถ้าจะใช้หลอด **UV** *จะต้องมีการดูแลสม่ำเสมอมาก เพราะว่าหลอดเสื่อมปล่อยแสง UV ไม่ได้ **wavelength** เท่าที่ต้องการ โดยที่สีของแสงไม่เปลี่ยนก็ได้*

UV ก็คือทำให้แสบตา *ทำให้เกิด **burns** และอาจทำให้เกิดแผลที่ **cornea** **(keratitis) 4-12** ชั่วโมง* หลังจากถูกแสงได้ ในประเทศไทยก็มีรายงานการเกิดแสบตาและผิวหนังอักเสบพร้อมกัน **81** คน ในวันเดียว เนื่องจากถูกแสง **UV .**

Ref.:Sensakovich JW, Smith LG : Nosocomial ultraviolet kerato conjunctivitis. Infect Control 1982 ; 475-476

Kittisrivorapoj S *et al.* Conjunctivitis in employees of a fish canning factory. An abstract of a presentation at the annual National Epidemiology Conference, Bangkok 1992 : 24-26

Operating Room: UV?

มี*การศึกษาเปรียบเทียบการใช้แสง UV ในห้องผ่าตัด*เปรียบเทียบกับการที่ไม่ใช้เป็น **double-blind, randomized study** ในโรงพยาบาลมหาวิทยาลัย 5 แห่ง พบว่า*ผู้ป่วยที่ถูกผ่าตัด จำนวน 14,854 ราย ปรากฏว่าไม่พบความแตกต่างในอัตราของการติดเชื้อ* ยกเว้นว่าผู้ป่วยพวกที่ใส่ **prosthesis** เช่น **heart valve** หรือ **hip prosthesis** พวกที่เป็น **ultra clean surgery** เหล่านี้ มีการติดเชื้อลดลงอย่างมีนัยสำคัญถ้าใช้ UV ในห้องผ่าตัด **(3.8% vs 2.5%)**

Ref.: National Research Council : Post operative wound infections - the influence of ultraviolet irradiation of the operating room and of various factors. Ann Surg 1964 ; 160 (Suppl 2) 1-125

Operating Room: UV?

Intraoperative UV radiation has not beenshown to decrease overall SSI risk. *Do not use UV radiation in the operating room to prevent SSI.* *Category IB Suggestion.*

CDC. Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

Operating Room: Risk Factors for SWI?

- Ventilation: Airborne transmission?

- Environmental Surfaces: Floors? Operating table? Wall?

- Eqipments?

Operating Room: Environmental Surfaces

การศึกษาของ **Weber** ที่ **Ann Arbor, Michigan** โดยทำการเปรียบเทียบการถู*พื้นห้องผ่าตัด*ด้วยยาฆ่าเชื้อหลังการผ่าตัดทุกรายกับการถูด้วยยาฆ่าเชื้อเฉพาะหลังการผ่าตัดผู้ป่วยที่เป็น **contaminated** หรือ **septic cases** พบว่า *การถูพื้นแบบแรกสามารถลดจำนวนเชื้อบนพื้นได้อย่างมีนัยสำคัญ แต่ไม่สามารถลดจำนวนการติดเชื้อที่แผลผ่าตัดได้เลย (ติดตามดูผู้ป่วย 2,020 ราย)* **Ref.:Weber DO *et al.* Influence of operating room surface contamination on surgical wounds : A prospective study. Arch Surg 1976 ; 111 : 484-487**

Operating Room: Environmental Surfaces

There are no data to support routine disinfecting of environmental surfaces or equipment between operations in the absence of contamination or visible soiling. When visible soiling of surfaces or equipment occurs during an operation, an Environmental Protection Agency (EPA)-approved hospital disinfectant should be used to decontaminate the affected areas before the next operation. *Category IB suggestion.*

CDC. Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

Operating Room: “Dirty” Case

There are no data to support special cleaning procedures

or closing of an operating room after a contaminated

or dirty operation has been performed.

CDC. Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

“Each air change will, assuming perfect mixing, reduce airborne contamination to 37% of its former level. A theatre should have an air change rate of around 20 air changes per hour (one air change every 3 min).Assuming 12min between the `dirty' patient leaving the theatre and the `clean' patient's wound being exposed to the theatre air, there should be under 2% of the former airborne contaminants which will then rapidly decrease further. If theatre ventilation is effective, air should not be a source of infection transmission between sequential patients.”

Woodhead K et al.Behaviours and rituals in the operating Theatre. Journal of Hospital Infection (2002) 51: 241□255

Air change / hour (ACH) and time required for removal efficiencies of 99% and 99.9%.

ACH	99%	99.9%
6/hr.	46 min.	69 min.
12/hr.	23 min.	35 min.
15/hr.	18 min.	28 min.

(CDC Guidelines for Environmental Infection Control in Health-Care Facilities . MMWR 2003;52(RR10):1-42)

Operating Room: Risk Factors for SWI?

- Ventilation: Airborne transmission?

- Environmental Surfaces: Floors? Operating table? Wall?

- Eqipments?

Operating Room: Equipments

Do not use flash sterilization for reasons of convenience,as an alternative to purchasing additional instrument sets, or to save time.

CDC. Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

Surgical Wound Dressing

1. ***Wash hands before and after dressing changes and any contact with the surgical site. Category IB***

2. No recommendation to cover an incision closed primarily beyond 48 hours, nor on the appropriate time to shower or bathe with an uncovered incision. *Unresolved Issue*

CDC. Guideline for Prevention of Surgical Site Infection, 1999.AJIC 1999;27:97

PROCEDURE dressing (Apr-Jun 2008	nurse				PN			
	before		after		before		after	
	ล้าง	ไม่ล้าง	ล้าง	ไม่ล้าง	ล้าง	ไม่ล้าง	ล้าง	ไม่ล้าง
ICU ศัลยกรรม	8	3	11	0	1	0	1	0
ศัลยกรรมชาย 1	3	0	3	0	33	0	33	0
ศัลยกรรมชาย 2	4	0	4	0	15	11	20	6
ศัลยกรรมหญิง	6	0	6	0	2	0	2	0
อุบัติเหตุ	21	4	24	1	-	-	-	-
ศัลยกรรมประสาท	33	1	34	0	-	-	-	-

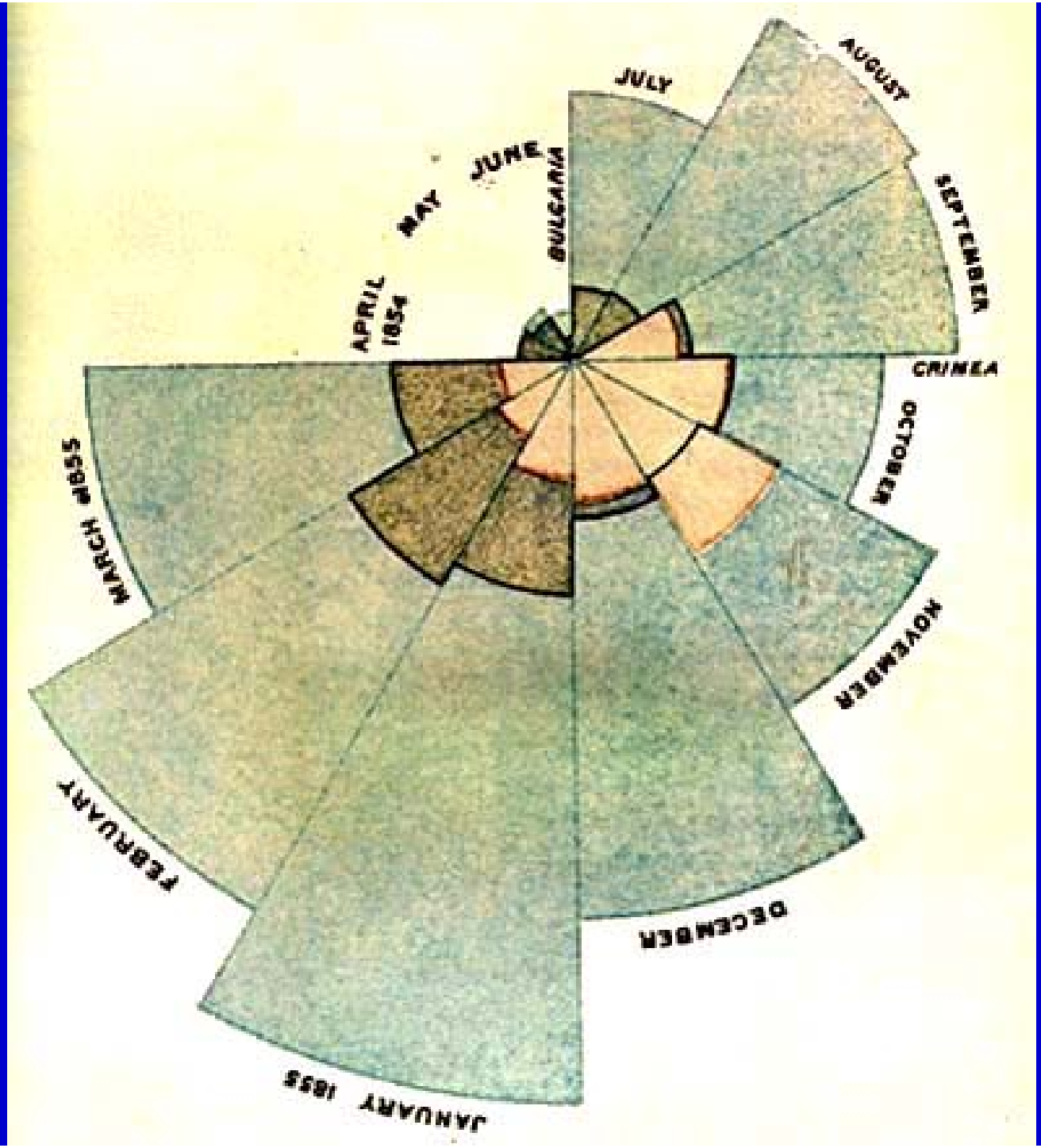
Wound dressing (Apr-Jun 2008

	doctor				นศพ.			
	before		after		before		after	
	ล้าง	ไม่ล้าง	ล้าง	ไม่ล้าง	ล้าง	ไม่ล้าง	ล้าง	ไม่ล้าง
ICU ศัลยกรรม	13	9	21	1	15	4	15	4
ศัลยกรรมชาย 1	**9**	**11**	**20**	**0**	**16**	**7**	**23**	**0**
ศัลยกรรมชาย 2	**15**	**14**	**28**	**1**	**13**	**3**	**16**	**0**
ศัลยกรรมหญิง	**17**	**18**	**30**	**5**	**14**	**9**	**22**	**1**
อุบัติเหตุ	**11**	**13**	**22**	**2**	**17**	**5**	**21**	**1**
ศัลยกรรมประสาท	**1**	**7**	**8**	**0**	**3**	**6**	**9**	**0**

Sites of infection and pathogens	No. of isolations	Infected sites, %
Surgical site infection (n = 192)		
Staphylococcus aureus	54	28.1
Escherichia coli	32	16.7
Pseudomonas aeruginosa	23	12.0

Ref.:Montha Na Narong, Somchit Thongpiyapoom, Nonglak Thaikul,,

Silom Jamulitrat, and Nongyao Kasatpibal AJIC 2003;31:274


JULY
AUGUST
SEPTEMBER
CRIMEA
OCTOBER
NOVEMBER
DECEMBER
JANUARY 1855
FEBRUARY
MARCH 1855
APRIL 1854
MAY
JUNE
BULGARIA