surgical care bundles for the reduction of surgical site infection: it all starts in the operating room

Wisconsin November 2015

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University of Newcastle upon Tyne

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University of Huddersfield
and by exposing his microbes to non-lethal quantities of the drug make them resistant.... .....the time may come when penicillin may be bought by anyone in the shops. Then there is a danger that the ignorant man may easily underdose himself

Alexander Fleming
Healthcare Associated Infections

- urinary tract infection (CAUTI)
- respiratory tract infection (VAP HAP)
- *Clostridium difficile* infection (CDI)
- surgical site (and prosthetic) infection
- bacteraemias, cSSTIs, CLABSIs

Resistant/emergent organisms ("superbugs")

- ESBLs, NDM
- GRE
- MRSA
- MRCNS
what are the costs of HCAIs?

- in the EU €5-10 billion each year
- added costs are three times more
- an average of 6.5 additional days in hospital
- 1 in 10 hospitalised patients acquires a skin infection

must reduce antibiotic use
new organisms - new antibiotics
...then we run out!

antibiotic introduced.....

.....antibiotic resistance observed
Concern over lack of antibiotics

Hello media!!
managers and politicians
stop devolution of power to them from doctors /ICNs?
(driven by the media)

• clean your hands
• bare below the elbows
• deep clean hospitals  (bring back Matron)
• targets: waiting lists  (difficult in UK)
• search and destroy (difficult in UK)
• stop taking samples
• intravascular catheter care (High Impact Intervention)
• good antibiotic stewardship (local formularies)
quarterly MRSA bacteraemia
(England: 2001-12)
Infection Control lectures are usually considered to be ‘therapeutic’ for staff with sleep deprivation disorders
quarterly *C. difficile*
(England 2004-2011)

surveillance “carrot and stick”
epidemiology of SSI

- 2.5-5% of all operations
- third most common HCAI (now the commonest?)
- most common nosocomial infection among surgical patients (30 -40%)
- 7.3 additional postoperative days at an additional cost of $3,152 per patient (US)
- 9.8 additional postoperative days at an additional cost of €2,000 per patient (Europe)
- one third of postoperative deaths are attributable, at least in part, to SSIs

HCAIs point prevalence study…

why are SSIs NOT falling?
when should antibiotics be given for surgical infections?

- cellulitis
- lymphangitis
- bacteraemia
- SIRS and MODS, MOF and DEATH
- definite pathogens (β-haemolytic streptococcus)
- large numbers (critical colonisation-infection)
- host defences (immunosuppression, diabetes)

antibiotic stewardship
definitions are critical

categories of surgical wounds
(prosthetic surgery?)

clean

clean contaminated

contaminated

dirty
classification of surgical site infection......real patients!

- Superficial
- Deep
- Organ space

CDC definition
(most commonly used)

30 days (1 year prosthetics)
purulent discharge or abscess
isolated organisms
1+ Celsian signs
wound separation or need for drainage
ASEPSIS

Additional treatment

Serous discharge

Erythema

Purulent exudate

Separation of deep tissues

Isolation of bacteria

Stay in hospital >14 days

Wilson et al. Lancet 1986; i: 311-313
prevalence of SSI in hospitals

- Long Bone Fracture
- Laminectomy
- Hip Prothesis
- Abd. Hysterectomy
- Colorectal Surgery
- Small Bowel Surgery
- Vascular Surgery
- CABG

Published data could be an under estimate because of poor post-discharge surveillance.
cost of SSI per incident

Mean additional Cost attributable to SSI
controversy in clean surgical wounds

accurate audit
(rates vary between 1.4% to over 15%)

post-discharge surveillance MUST go to 30 days (1 year)

independent unbiased blinded trained direct observer

scoring systems/diaries

mandatory reporting:

who undertakes it? who pays? primary care?

Leaper et al. IWJ
2004; 1: 247-273

Melling et al. Lancet
2001; 358: 876-880
methods of surveillance
(all need full engagement)

• in patient
  i. notes review
  ii. swab microbiology reports
  iii. temperature charts

• readmission data (only serious and may go elsewhere)

• post-discharge
  i. out-patients review
  ii. questionnaires or telephone follow up
  iii. patient diaries (PROMs)
  iv. research data
  v. specialist appointment data

independent unbiased blinded trained direct observer
let's change perspective for a bit ... 

how can the team prevent surgical site infection?
guidelines for compliance and to prevent SSIs

Surgical site infection prevention and treatment of surgical site infection

Perioperative actions

Hair removal
- Use a clipper with a disposable head.
- Shaving with a razor is not recommended.

Prophylactic antimicrobial
- Appropriate antimicrobial administered within 60 minutes prior to incision.

Normothermia
- Maintaining a body temperature above 36°C in the perioperative period has been shown to reduce infection rates.

Glucose control
- Maintaining a glucose level <11mmol/L has been shown to reduce wound infection in diabetic patients.

Surgical Safety Checklist (First Edition)

Before induction of anaesthesia

- Name and test the patient
- Site and consent
- Intravenous access
- Medication

Time out

- Confirm all team members have introduced themselves by name and role
- Surgical, anaesthesia, professional, and nurse verbally confirm patient site and procedure
- Confirm critical details
- Surgery review: what is the critical, unanticipated step, critical event, anticipated blood loss?
- Anaesthesia team review: is there any contraindication, concerns?
- Nursing team review: is there stability (including monitoring results) been confirmed? Are there equipment issues or any concerns?
- Has antibiotic prophylaxis been given within the last 60 minutes?
- Check essential imaging exploited?
- Check essential imaging exploited

Before skin incision

- Confirm all team members have introduced themselves by name and role
- Check the name of the procedure recorded
- Check instruments, sponges, and needles (counts are correct or not applied)
- Check the specimen is labelled (including patient name)
- Check there are any equipment problems to be addressed

Before patient leaves operating room

- Check essential imaging exploited?
- Check essential imaging exploited
- Check essential imaging exploited
- Check essential imaging exploited

The checklist is not intended to be comprehensive. Additions and modifications to suit local practice are encouraged.

mostly level I evidence
hair removal

traditional, improve view and access
perceived reduction infection rate
razors damage skin, sweat glands
abrasions potentially increase SSIs

• do not use hair removal routinely to reduce the risk of SSI
• if hair has to be removed, use electric clippers with a single-use head on the day of surgery
antibiotic prophylaxis

give antibiotic prophylaxis to patients before:
  • clean surgery involving the placement of a prosthesis or implant
  • clean-contaminated surgery
  • contaminated surgery
  • but not:
  • clean surgery without a prosthesis

empirical choice depending on surgery -decisive period
use local antibiotic formulary
IV at induction of anaesthesia
repeat ONLY with excess blood loss, long operation or prosthetic surgery
any longer is therapy
relation between timing of prophylaxis and SSI rate

causes of hypothermia (<36°C) in the operating theatre

- cold environment 21°C 55% RH
- exposure (particularly open abdomen)
- cold intravenous fluids
- cold anaesthetic gases
- vasodilatation (or inhibited vasoconstriction)
- anaesthetic agents
- increased BMR with increased oxygen requirements
- poor oxygen delivery with hypoxia and acidosis

Kumar et al IWJ 2005; 2: 193-204
complications of hypothermia

- shivering increases O$_2$ demand by 4-5X
- shift in O$_2$ dissociation curve
- increased BMR not met by oxygen delivery
- acidosis if cardiopulmonary response inadequate
- relative organ ischaemia  myocardial infarct
- prolonged drug action
- increased risk of pressure injuries
- increased risk of infectious complications
- surgical site infection

Kumar et al IWJ 2005; 2: 193-204
effect of warming on wound infection

Infection rates
- standard: 13.7%
- local warming: 3.6% (p = 0.003)
- systemic warming: 5.8% (p = 0.028)

Melling et al. Lancet 2001; 358: 876-880
the significance of local warming

<table>
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<td>post-op ABs</td>
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benefits of peri-operative warming: existing clinical evidence

- wound infection
- blood transfusion
- cardiac events
- morbidity and mortality
- intensive care and overall hospital stay
- cost effective

Odom and Mahoney AANA J 1999; 67: 155-164
Preventing Surgical-Site Infections in Nasal Carriers of Staphylococcus aureus

Lonneke G.M. Bode, M.D., Jan A.J.W. Kluymans, M.D., Ph.D., Heiman F.L. Wertheim, M.D., Ph.D., Diana Bogaers, I.C.P., Christina M.J.E. Vandenbroucke-Grauls, M.D., Ph.D., Robert Roosendaal, Ph.D., Annet Troelstra, M.D., Ph.D., Adrienne T.A. Box, B.A.Sc., Andreas Voss, M.D., Ph.D., Ingeborg van der Tweel, Ph.D., Alex van Belkum, Ph.D., Henri A. Verbrugh, M.D., Ph.D., and Margreet C. Vos, M.D., Ph.D.

ABSTRACT

BACKGROUND
Nasal carriers of Staphylococcus aureus are at increased risk for health care–associated infections with this organism. Decolonization of nasal and extranasal sites on hospital admission may reduce this risk.

METHODS
In a randomized, double-blind, placebo-controlled, multicenter trial, we assessed whether rapid identification of S. aureus nasal carriers by means of a real-time polymerase-chain-reaction (PCR) assay, followed by treatment with mupirocin nasal ointment and chlorhexidine soap, reduces the risk of hospital-associated S. aureus infection.
glucose control and sternal SSIs
continuous insulin infusion

poor evidence

- preoperative showering
- specific patient and staff theatre wear
- minimizing movement in the operating theatre
- banning of hand jewellery and nail polish
- nasal decontamination of all *Staphylococcus aureus*, not just MRSA, to reduce the risk of SSI is effective (Bode et al 2010)
- mechanical bowel preparation (Cochrane Collaboration)
- operative rituals: hand decontamination, gloves, drapes and gowns, diathermy, antiseptic lavage and wound dressings

research opportunities

- cost effectiveness of new antiseptic incise drapes
- benefits of improved blood glucose control
- effectiveness of intra-cavity and wound lavage with modern antiseptics
- most appropriate suture closure methods
- *antimicrobial* sutures
- role of supplemental oxygen in the recovery room
- adaptation of chronic wound management for SSIs
  - in prevention
  - postoperatively after wound separation
    - interactive dressings and topical antiseptics
- effectiveness of modern debridement techniques
- most appropriate warming methods
Ambroise Pare (1510 - 1590)
poisoned firearm wounds
boiling oil of elders with a little theriac
digestive of egg yolk, rose oil and turpentine

Ignaz Semmelweis
puerperal sepsis and handwashing before delivery

1846 11.4%
1848 1.3%
dans les champs de l'observation le hasard ne favorise que les esprits préparés

bacteria the cause of spoilt wine
not miasma/ “bad air”
ANTISEPTICS
(“antimicrobial” : antiseptic, antibiotic)

phenol
hexachlorophane
cetrimide
benzalkonium
honey, permanganate, etc.,
chlorhexidine
povidone iodine
triclosan
silver
polyhexamethylene biguanide

how can we do without antiseptics?
chlorhexidine-alcohol versus povidone-iodine for surgical site antisepsis
Darouiche et al. NEJM 2010

- multicentre (6 hospitals); 4 years
- 849: power and randomisation
- definition and surveillance of SSI
- 2% chlorhexidine 10% povidone iodine
- paint versus scrub and paint
- clean-contaminated category only
- 9.5% -16.1% overall; superficial and deep SSIs
- not sepsis or organ space
determinants for surgical site infection

- bacterial balance
- host resistance
- bacterial quantity and virulence

always consider any underlying pathology
biofilms are ubiquitous
biofilms
(Koch’s postulates upside down)

- complex microenvironment - bacteria and glycocalyx
- intercellular communication (quorum sensing)
- resist host-defences and antibiotics
- exist in acute and chronic wounds?
- promote inflammation (nitric oxide, cytokines, MMPs)
biofilm management

• undertake comprehensive holistic and local wound assessment

• suspect biofilm when there is static healing or slimy exudate

• vigorous cleansing

• maintenance debridement

• antiseptics cadexomer iodine, silver, PHMB, honey, chlorhexidine

• systematic antibiotics
biofilms...we could do with a diagnostic (swabs and biopsies unhelpful)

structural analysis
confocal laser scanning microscopy

molecular analysis
DNA extraction
Denaturing Gel Gradient Electrophoresis (DGGE)
Polymerase Chain Reaction (PCR)

*Pseudomonas aeruginosa* (PsaerFITC green)

*Staphylococcus aureus* (Cy5 red)
infection or failure to heal?

......are biofilms involved?
potential for antiseptic (triclosan) sutures to prevent biofilm in surgical wounds

• wide spectrum antimicrobial in deep tissues
• good for clean prosthetic surgery?
  - orthopaedics, vascular
• colorectal (dirty)surgery?
• potential in resistance? MRSA
• reduction of antibiotic use?
• reduction of biofilm and reformation? (prosthetics)

does it risk selection of antibiotic resistant organisms or transmissible resistance in human pathogens?
antiseptic use in sutures

potential advantages
• wide spectrum antimicrobial in deep tissues
• relates to non-specific action of antiseptics
• good for many classes of surgery including prosthetics
• reduction of antibiotic use?

potential dangers
• selection of resistant human pathogens from environment? .... none yet
• selection of resistance to antiseptics and antibiotics? .... none yet
• promotion of transmission of resistant forms? .... none yet

the SCCS recommended prudent use of triclosan, for example in applications where a health benefit can be demonstrated
antiseptic use in sutures
any belief that the controlled trial is the only way would mean not that the pendulum had swung too far, but that it had come right off its hook

Austin Bradford Hill MRC trials 1950s: RCT the gold standard
the myth of the RCT?

guidelines and protocols need evaluation of ALL the available data without level I evidence where do we go?
evidence based medicine
David Sackett

- conscientious, explicit, and judicious use of current best evidence in making decisions about care of individual patients

- integrating individual clinical expertise with the best external evidence from systematic research

involves: evidence
experience
patients and carers
(and health economics?)
meta-analysis

- Chang et al. Annals Surg 2012
  836 patients 7 studies
  RR 0.77; 95% CI 0.40, 1.51; p = 0.45 (too early)

  3720 patients 17 studies
  RR 0.70; 95% CI 0.57, 0.85; p < 0.001

- Edmiston et al. Surgery 2013
  3568 patients 13 studies
  RR 0.73; 95% CI 0.59, 0.91; p < 0.005

- Daoud et al. Surgical Infections 2014
  4800 patients 15 studies
  RR 0.67; 95% CI 0.54, 0.84; p = 0.0005

robustness of sensitivity analysis, publication bias, risk of bias, heterogeneity, classes and type of surgery
antimicrobial sutures: level I evidence that they work
• triclosan sutures (Vicryl plus, Monocryl plus and PDS plus) significantly reduce SSIs after clean, clean-contaminated and contaminated surgery

• no publication bias

• robust to removal of up to three trials

• overall effect: 33% reduction of SSIs (CI 0.53, 0.84; p<0.0005)

• this is level I evidence-based medicine
the days of chromic catgut and silk......

.........are gone
### criticisms of the PROUD study

- why multicentre? why did it take so long? where's the data on ITT?
- was there some "cherry-picking“? ... was there sequential recruitment?
- definition of SSI is suspect; superficial SSIs dismissed
- deep SSIs agreed on by more than one assessor (which IS laudable) but using photographic evidence?
- why weren't subcuticular antimicrobial sutures used instead of clips?
- clip closure is more at risk of subsequent exogenous SSI
- were closures left to junior unsupervised staff? ... unacceptable level of fascial closure
- less deep SSIs in the antimicrobial suture group ... underpowered?

### Meta-analysis of SSI RR: 19 peer-reviewed RCTs 10-Oct-2015 status

<table>
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<th>Study name</th>
<th>Statistics for each study</th>
<th>Infections / Total</th>
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surgeons don’t change…
give me what I want, not what I ask for!

should plus sutures be added to the SSI care bundle?
Implementation of the Guideline will not necessarily involve major changes in current practice but it does recommend the pooling of best practice into "care bundles" which should reduce the risk of SSI. The introduction of the Guideline into patient care needs to be across the whole spectrum of care from the decision to operate to recovery and return to normal life style.
tactics to improve compliance (and surveillance?)

• understand
  – people resist change
  – “buy-in” HAS to be achieved
  – antibiotics can’t do it alone

• emphasize
  – education
  – evidence
  – best interests of the PATIENT

• reward
  – replace the “culture of blame”

why aren’t SSI rates falling?

NICE
HII
SCIP
SSI Care Bundle

smoking advice                      no cost
pre-op body washing                 £2
optimum nutrition                   improve current practice
patient warming                     £15
antibiotic prophylaxis              improve current practice
hair removal                        £2
patient skin prep                   £6
surveillance feedback               no cost

TOTAL COST                           £25 per patient
cost effectiveness (£25/bundle)

colorectal (315 patients)
1 year SSI Care Bundle £7,875
1 colorectal SSI cost: £10,366
1 colorectal SSI prevented = cost effective

breast (477 patients)
1 year SSI Care Bundle £11,925
1 breast SSI cost: £1,403
8 breast SSIs prevented = cost effective
post discharge surveillance
(how robust can it be?)

• rolling programme
  3 monthly or continuously by specialty?
• who? primary/secondary care… doctors nurses?
  i. on the ward
  ii. specialist nurses breast/stoma
  iii. out patient
  iv. governance sessions
  v. specialist appointment (with what cost?)
• mandatory or voluntary?
• internationally comparable

independent unbiased blinded
trained direct observer
benchmarking and international comparisons

- definitions
- robust surveillance (not just readmission data)
- systems for quality control
- needs regular audit/ review

1% SSI after hip replacement

0.5% SSI after knee replacement
vancomycin powder in wounds?
he had never learned how to repair wounds [or manage infection]……this seemed a serious flaw in his magical education

Harry Potter

…and the Deathly Hallows

Jo Rowling  2007

what an inspiration!