



SSI after Caesarean section: are risk factors different from other SSI?

Professor Jacqui Reilly

Lead consultant: HAI, AMR and Infection Control

Co authors: Sullivan C, Weir J, Bishop J and Robertson C

Overview

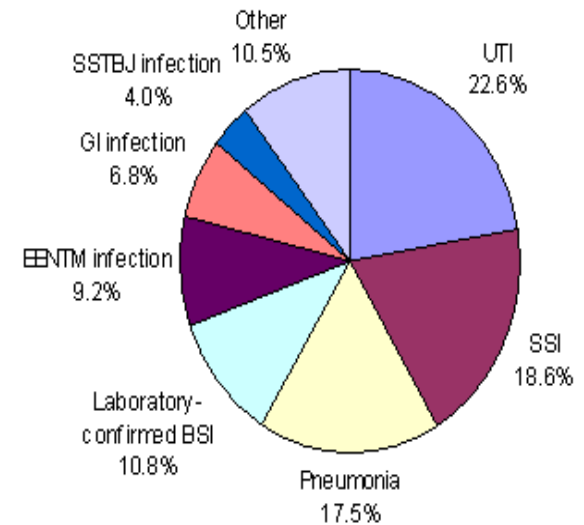
HAI and gender differences – are they real and do they matter?

- Incidence and burden of SSI and C. Section SSI
- Differences in the surgical population at risk (C. Section versus other categories of surgery)
- Risk factors for SSI and C. Section SSI
- Independent risk factors for SSI following c section from the Scottish national dataset



Background

- Surgical Site Infections (SSI) are a common post-surgical complication.
- Almost 1 in 5 of all inpatient healthcare associated infections (HAI) in Scotland are surgical site infections (Scottish National HAI Prevalence Survey, 2011).
- Most common causative organisms are *S. aureus* and *E. coli*
- Serious consequences for the patient and health services
 - extended lengths of stay, pain, suffering, further surgery, associated costs of treatment.
 - €42million/ year in Scotland
- SSI is a preventable HAI.



References:

1. Health Protection Scotland. Scottish National Point Prevalence Survey of Healthcare Associated Infection and Antimicrobial Prescribing 2011. 2012. 6-3-2013.
2. Broex, E.C., van Asselt, A.D., Bruggeman, C.A., & van Tiel, F.H. 2009. Surgical site infections: how high are the costs? *J Hosp Infect*, 72, (3) 193-201
3. Harbarth, S., Sax, H., & Gastmeier, P. 2003. The preventable proportion of nosocomial infections: an overview of published reports. *J Hosp Infect*, 54, (4) 258-266

Background

Caesarean Section

- Rates of SSI detected during inpatient stay following caesarean section range from 0.2 to 5.0% depending on the healthcare system and length of hospital stay.
- However, these rates will significantly underestimate the true rate of infection due to the average length of hospital stay of 2-4 days following caesarean section.
- In the ECDC 'Annual epidemiological report 2012' the percentage of SSI detected after hospital discharge in 2010 for caesarean section was 84%.
- Overall SSI rates of 3-18% have been identified within the literature when post discharge surveillance methods are employed.



References:

1. European Centre for Disease Prevention and Control. Annual Epidemiological Report 2012. Reporting on 2010 surveillance data and 2011 epidemic intelligence data. Stockholm: ECDC; 2013.
2. Health Protection Scotland. Surveillance of Surgical Site Infection Annual Report. For procedures carried out from: January 2003-December 2011. [Report]. Health Protection Scotland . 2012.
3. Johnson, A., Young, D., & Reilly, J. 2006. Caesarean section surgical site infection surveillance. *J Hosp Infect*, 64, (1) 30-35
4. Vincent, A., et al. 2008. Downward trends in surgical site and urinary tract infections after cesarean delivery in a French surveillance network, 1997-2003. *Infect Control Hosp Epidemiol*, 29, (3) 227-233
5. Ward, V.P., Charlett, A., Fagan, J., & Crawshaw, S.C. 2008. Enhanced surgical site infection surveillance following caesarean section: experience of a multicentre collaborative post-discharge system. *J Hosp Infect*, 70, (2) 166-173

SSI surveillance in Scotland

- The SSI surveillance programme began in September 2001 with national reporting introduced from 2003.
- All NHS boards (14 geographically-based local NHS Boards and one National Special Board) participate in inpatient SSI surveillance of at least two procedures from the following list:
 - abdominal hysterectomy,
 - breast surgery,
 - caesarean section,
 - cardiac surgery,
 - CABG,
 - cranial surgery,
 - hip arthroplasty,
 - knee arthroplasty,
 - colorectal surgery,
 - reduction of long bone fracture,
 - repair of neck of femur,
 - vascular surgery.
- Since 2007 if caesarean section and hip arthroplasty procedures are carried out within the hospital then surveillance must be conducted for these operational categories as a minimum.

Definitions and methods

Definitions

- ECDC (CDC/NHSN SSI) definitions
 - superficial, deep and organ space

Methods

- Prospective continuous in patient surveillance
- The period of post discharge surveillance (PDS) for caesarean sections is to ten post operative days.
- Readmission surveillance for other categories of surgery



Health
Protection
Scotland



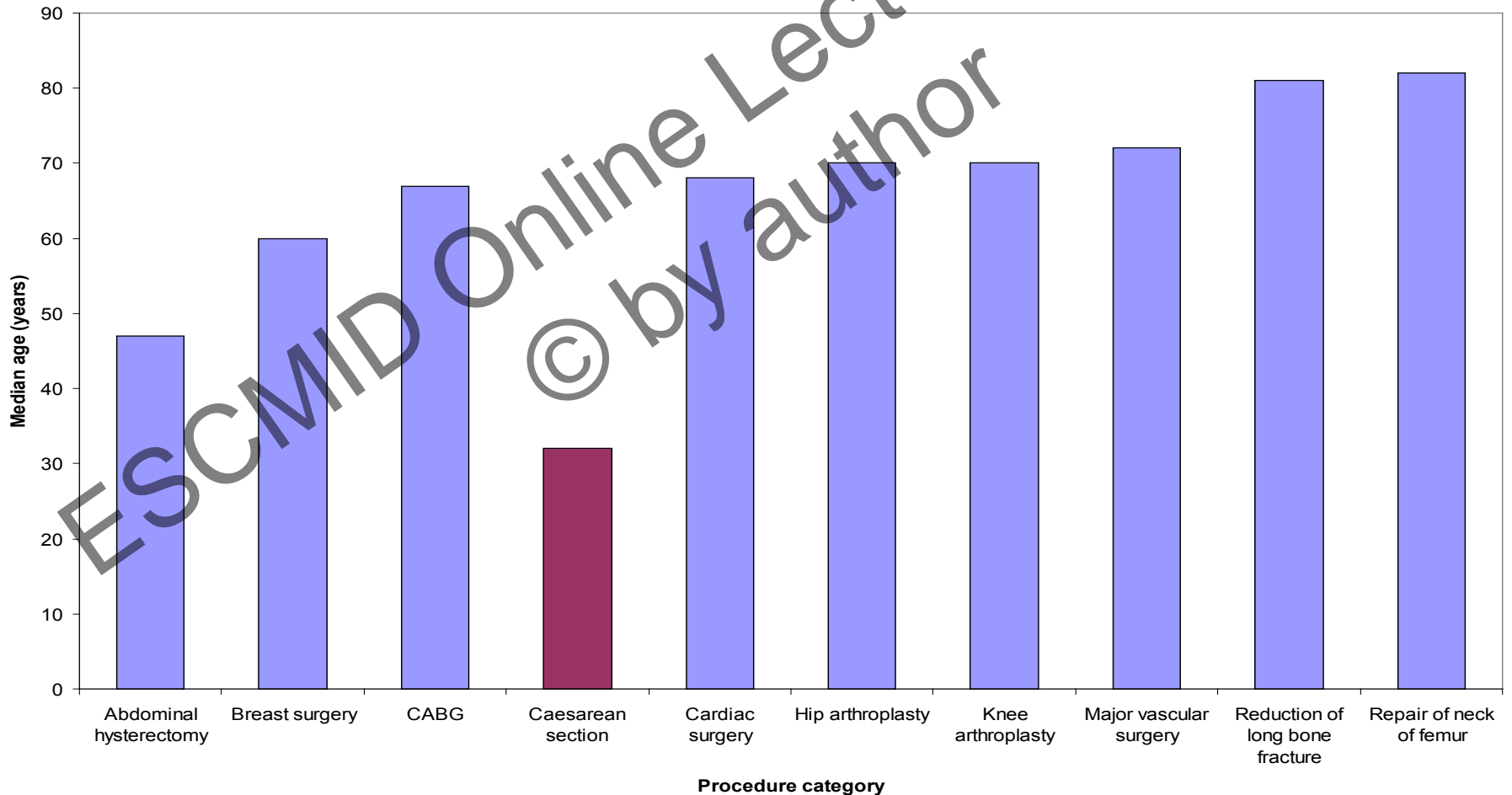
**Differences in the caesarean
section patient population
compared to the patient population
of other surgical procedures**

ESCMD Online Lecture Library
© by author

Gender in Scotland by procedure category from 1st January 2003 to 30th June 2011

Procedure category	Male (%)	Female (%)
Abdominal hysterectomy	0%	100.0%
Breast surgery	1.4%	98.6%
CABG	77.9%	22.1%
Caesarean section	0%	100.0%
Cardiac surgery	52.1%	47.9%
Hip arthroplasty	38.3%	61.7%
Knee arthroplasty	42.3%	57.7%
Major vascular surgery	71.5%	28.5%
Open reduction of long bone fracture	27.6%	72.4%
Repair of neck of femur	26.4%	73.6%

Median age in Scotland by procedure category from 1st January 2003 to 30th June 2011



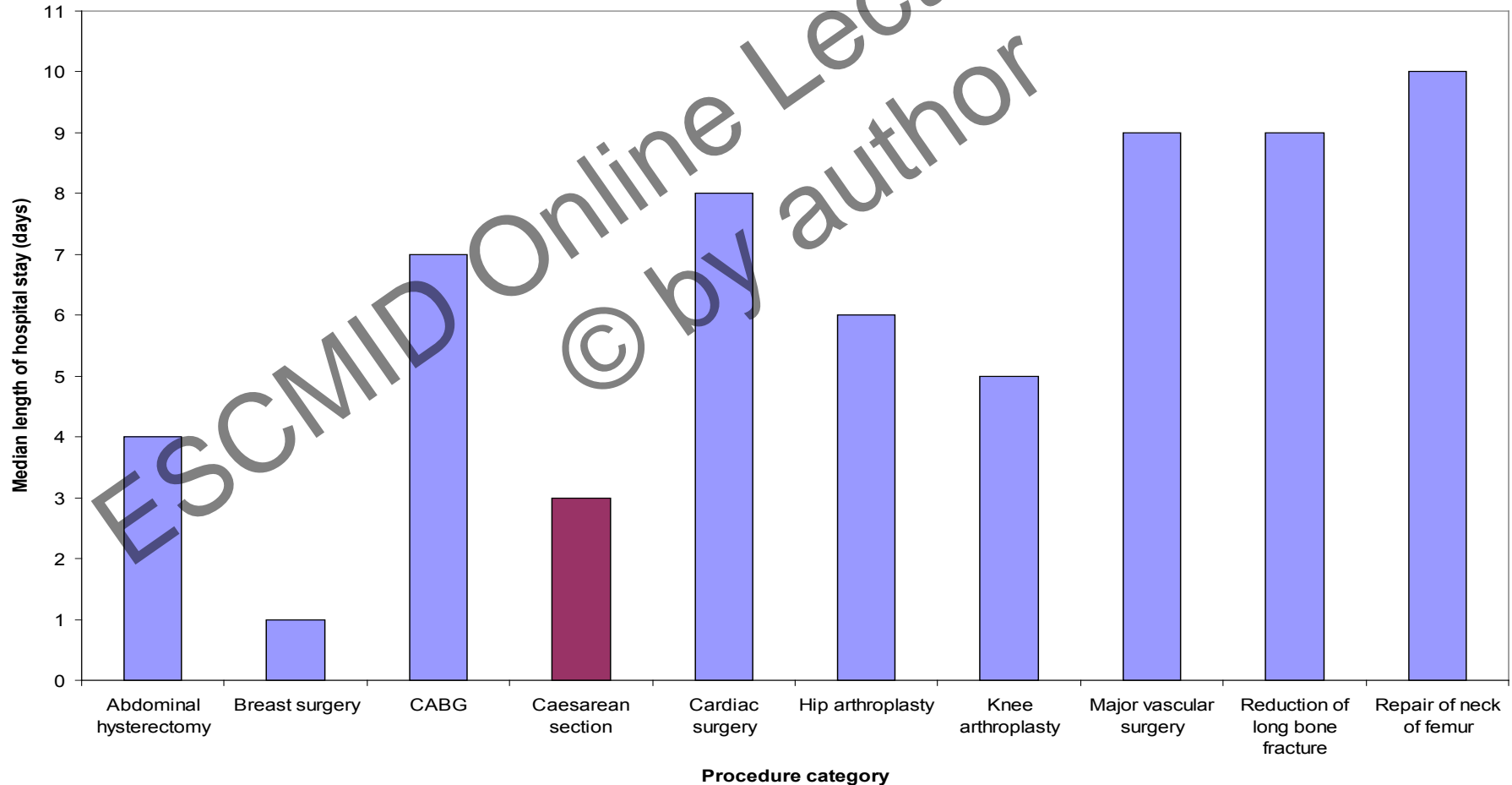
ASA Classification in Scotland by procedure category from 1st January 2003 to 30th June 2011

Procedure category	ASA Classification (%)			
	1	2	3	4 & 5
Abdominal hysterectomy	41.1%	48.0%	10.4%	0.4%
Breast surgery	37.4%	49.7%	11.4%	1.5%
CABG	0.1%	0.0%	0.4%	99.5%
Caesarean section	78.8%	19.0%	2.1%	0.2%
Cardiac surgery	0.0%	0.2%	0.3%	99.6%
Hip arthroplasty	10.6%	53.2%	31.6%	4.6%
Knee arthroplasty	9.0%	64.3%	25.6%	1.0%
Major vascular surgery	0.3%	13.8%	69.9%	16.0%
Reduction of long bone fracture	3.8%	25.7%	55.5%	15.0%
Repair of neck of femur	1.6%	21.1%	60.0%	17.4%

Presentation in Scotland by procedure category from 1st January 2003 to 30th June 2011

Procedure category	Presentation (%)	
	Elective	Emergency
Abdominal hysterectomy	98.4%	1.6%
Breast surgery	99.8%	0.2%
CABG	99.4%	0.6%
Caesarean section	42.6%	57.4%
Cardiac surgery	99.2%	0.8%
Hip arthroplasty	81.2%	18.8%
Knee arthroplasty	99.7%	0.3%
Major vascular surgery	86.1%	13.9%
Reduction of long bone fracture	2.3%	97.7%
Repair of neck of femur	15.5%	84.5%

Median length of hospital stay (days) in Scotland by procedure category from 1st January 2003 to 30th June 2011



Wound class in Scotland by procedure category from 1st January 2003 to 30th June 2011

Procedure category	Wound class (%)			
	Clean	Clean contaminated	Contaminated	Dirty
Abdominal hysterectomy	19.5%	80.2%	0.3%	0.1%
Breast surgery	99.1%	0.1%	0.0%	0.0%
CABG	92.1%	7.5%	0.4%	0.0%
Caesarean section	19.1%	80.8%	0.1%	0.0%
Cardiac surgery	90.0%	9.2%	0.5%	0.3%
Hip arthroplasty	98.2%	0.8%	0.6%	0.4%
Knee arthroplasty	98.7%	0.4%	0.5%	0.4%
Major vascular surgery	93.3%	5.7%	0.3%	0.8%
Reduction of long bone fracture	99.6%	0.4%	0.0%	0.0%
Repair of neck of femur	98.3%	1.5%	0.1%	0.0%

Anaesthetic in Scotland by procedure category from 1st January 2003 to 30th June 2011

Procedure category	Anaesthetic (%)			
	General	Local	Regional	Other
Abdominal hysterectomy	98.9%	0.1%	1.0%	0.0%
Breast surgery	98.4%	1.5%	0.1%	0.0%
CABG	98.9%	0.1%	1.0%	0.0%
Caesarean section	8.0%	0.7%	91.1%	0.2%
Cardiac surgery	98.4%	0.1%	1.5%	0.0%
Hip arthroplasty	34.2%	2.4%	62.4%	0.9%
Knee arthroplasty	29.4%	5.5%	64.3%	0.9%
Major vascular surgery	50.3%	11.0%	38.5%	0.2%
Reduction of long bone fracture	48.8%	2.1%	48.7%	0.5%
Repair of neck of femur	44.4%	2.0%	53.3%	0.3%

Grade of surgeon in Scotland by procedure category from 1st January 2003 to 30th June 2011

Procedure category	Grade of surgeon (%)			
	Consultant	Specialist registrar	F2	Non consultant career grade
Abdominal hysterectomy	81.5%	15.8%	1.4%	1.3%
Breast surgery	84.4%	5.6%	4.1%	5.8%
CABG	98.0%	1.9%	0.0%	0.1%
Caesarean section	26.2%	57.2%	12.9%	3.7%
Cardiac surgery	96.9%	3.0%	0.0%	0.1%
Hip arthroplasty	76.2%	20.3%	1.5%	2.1%
Knee arthroplasty	81.9%	16.1%	0.6%	1.5%
Major vascular surgery	90.5%	9.0%	0.3%	0.2%
Reduction of long bone fracture	29.0%	60.2%	8.1%	2.7%
Repair of neck of femur	35.6%	55.0%	1.4%	8.0%

Summary

- All female (of course!)
- Younger
- Healthier
- Spend less time in hospital after c-section
- C-section more likely to be an emergency
- Wound class clean/contaminated
- Regional anaesthetic
- Consultant less likely to operate

Analysis of Caesarean Section Risk Factors

ESCMID Online Lecture Library
© by author

SSI Rates by NNIS Risk Index and procedure category in Scotland from 1st January 2003 to 30th June 2011

Procedure category	NNIS Risk Index			
	0	1	2	3
Abdominal hysterectomy	2.9	6.8	14.8	0.0
Breast surgery	5.2	9.4	0.0	0.0
CABG	0.0	3.9	9.7	0.0
Caesarean section	3.3	4.6	10.4	0.0
Cardiac surgery	0.0	1.8	3.0	0.0
Hip arthroplasty	0.7	1.9	2.7	4.7
Knee arthroplasty	0.9	1.4	3.3	4.4
Major vascular surgery	5.1	8.0	8.5	20.0
Reduction of long bone fracture	1.0	1.6	4.2	0.0
Repair of neck of femur	1.1	2.8	33.3	0.0

Independent risk factors for SSI after

C. section

- A number of studies have attempted to identify the most important contributory factors for the development of an SSI following caesarean section.
- The most commonly identified factor within these studies is an increased body mass index (BMI)
- An increased BMI may interfere with the healing process and make a wound more vulnerable to microbial contamination and has been suggested to lead to insufficient antibiotic tissue levels.

References:

1. Johnson A, Young D, Reilly J. Caesarean section surgical site infection surveillance. *J Hosp Infect* 2006;64:30-5.
2. Olsen MA *et al.* Risk factors for endometritis after low transverse cesarean delivery. *Infect Control Hosp Epidemiol* 2010;31:69-77.
3. Opoien HK, *et al.* Post-cesarean surgical site infections according to CDC standards: rates and risk factors. A prospective cohort study. *Acta Obstet Gynecol Scand* 2007;86:1097-102.
4. Ward VP, Charlett A, Fagan J, Crawshaw SC. Enhanced surgical site infection surveillance following caesarean section: experience of a multicentre collaborative post-discharge system. *J Hosp Infect* 2008;70:166-73.
5. Wloch C, *et al.* Risk factors for surgical site infection following caesarean section in England: results from a multicentre cohort study. *BJOG* 2012;119:1324-33.

However there are many other risk factors which have been identified in studies. These include:

- **Age,**
- **Anaesthetic,**
- **ASA,**
- **Blood loss,**
- **Diabetes,**
- *Duration of operation,*
- **Grade of surgeon,**
- **Presentation,**
- **Prophylaxis,**
- *Wound class,*
- **The level of prenatal care or number of prenatal consultations,**
- **Type of closure (staples have shown to have higher rates of infection when compared with continuous sutures).**

Methods- Scottish Dataset Analyses

Poisson regression was performed

- Denominator was the number of days under follow-up (postoperative surveillance length)
- Numerator was the number of patients who developed SSI
- Incidences and rate ratios for SSIs were calculated for each risk factor
- Risk factors with p-value less than 0.05 at univariate analysis were included in the multivariate model
- Poisson regression models were developed to identify independent risk factors

Results

Study population

- 80840 caesarean section procedures were recorded from 1st January 2003 to 30th June 2011
- 4782 SSIs were developed with a cumulative incidence of 5.9%
- 631 inpatient SSIs were developed with a incidence of 0.8%

Univariate analyses

- Identified independent risk factors ($p < 0.05$) were:
 - Age
 - Antibiotic prophylaxis
 - Antibiotic timing
 - ASA
 - BMI
 - *Duration of surgery*
 - Grade of surgeon
 - Presentation
 - Reintervention within 48 hours
 - *Wound class*

Multivariable Analyses

Variable	Category	Incidence Rate Ratio (IRR)	P value	IRR 95% Confidence interval	
				Lower limit	Upper limit
BMI category	≥18.5 BMI <25 (normal)	Reference category			
	BMI <18.5 (underweight)	0.839	0.315	0.596	1.182
	≥25 BMI <30 (overweight)	1.320	<0.001	1.209	1.441
	BMI ≥30 (obese)	2.447	<0.001	2.260	2.650
Re-intervention	No re-intervention	Reference category			
	Reintervention	2.653	<0.001	1.803	3.903
ASA classification	ASA 1	Reference category			
	ASA class. 2	1.281	<0.001	1.189	1.380
	ASA class. 3	1.650	<0.001	1.390	1.958
	ASA class. 4 or 5	0.944	0.889	0.423	2.106
Grade of surgeon	Consultant	Reference category			
	Speciality registrar	0.900	0.004	0.837	0.968
	F2	1.188	<0.001	1.083	1.303
	Non consultant career grade	1.113	0.159	0.959	1.291

Multivariable Analyses (continued)

Variable	Category	Incidence Rate Ratio (IRR)	P value	IRR 95% Confidence interval	
				Lower limit	Upper limit
Age group (years)	31 - 35 yrs	Reference category			
	14 - 20 yrs	1.386	<0.001	1.228	1.563
	21 - 25 yrs	1.243	<0.001	1.140	1.356
	26 - 30 yrs	1.045	0.264	0.967	1.130
	36 - 40 yrs	1.031	0.485	0.946	1.124
	41 - 50 yrs	0.906	0.278	0.759	1.083
Duration of surgery (minutes)	≥30 and <60 minutes	Reference category			
	≥10 and <30 minutes	0.900	0.010	0.831	0.975
	≥60 and <180 minutes	1.205	<0.001	1.106	1.314
Presentation	Elective	Reference category			
	Emergency	1.127	<0.001	1.060	1.199

Limitations

- There may be factors which influence the development of a SSI which have not been considered within the scope of this study (e.g. method of skin closure, diabetes, blood loss).
- Further work is needed to examine the impact of these other variables thought to be important in the development of an SSI following caesarean section procedures.
- Underestimation of infections as PDS ceased at day 10 post operatively

Summary of Scottish risks

Confirming risk factors identified from previous studies*:

- BMI: ≥ 25 to < 30 (overweight) and ≥ 30 (obese)
- ASA class: 2 or 3
- Operator grade: F2
- Age: < 25 yrs
- Duration of procedure: ≥ 60 and < 180 minutes
- Presentation: Emergency

Identifying a new risk factor:

- *Re-intervention within 48 hours*

*References

Johnson A, Young D, Reilly J. Caesarean section surgical site infection surveillance. *J Hosp Infect* 2006;64:30-5.

Opoien HK, *et al.* Post-caesarean surgical site infections according to CDC standards: rates and risk factors. A prospective cohort study. *Acta Obstet Gynecol Scand* 2007;86:1097-102.

Wloch C, *et al.* Risk factors for surgical site infection following caesarean section in England: results from a multicentre cohort study. *BJOG* 2012;119:1324-33.

How are these different to other SSI risks?

Procedure category	Risk factors
Abdominal hysterectomy	BMI, ASA score, age , duration of operation
Breast surgery	ASA score, wound class, BMI, reoperation
CABG	Age , gender, BMI, diabetes
Cardiac surgery	Age , BMI
Hip arthroplasty	ASA score, wound class, age , duration of procedure, type of surgery
Knee arthroplasty	ASA score, wound class, age , duration, primary/ revision
Major vascular surgery	Age , anaesthetic, ASA, duration of surgery, presentation, BMI, grade of surgeon
Reduction of long bone fracture	ASA score, age , duration of surgery
Repair of neck of femur	ASA, presentation

References:

1. Abboud, C.S., et al. 2004. Risk factors for mediastinitis after cardiac surgery. *Ann Thorac.Surg*, 77, (2) 676-683
2. Brandt, C., et al. 2004. Finding a method for optimizing risk adjustment when comparing surgical-site infection rates. *Infect Control Hosp Epidemiol*, 25, (4) 313-318
3. de Boer, A.S., et al. 1999. Risk assessment for surgical-site infections in orthopedic patients. *Infect Control Hosp Epidemiol*, 20, (6) 402-407
4. Harrington, G., et al. 2004. Surgical-site infection rates and risk factor analysis in coronary artery bypass graft surgery. *Infect Control Hosp Epidemiol*, 25, (6) 472-476
5. Mu, Y., et al. 2011. Improving risk-adjusted measures of surgical site infection for the national healthcare safety network. *Infect Control Hosp Epidemiol*, 32, (10) 970-986
6. Namba, R.S., et al. 2012. Risk factors associated with surgical site infection in 30,491 primary total hip replacements. *J Bone Joint Surg Br*, 94, (10) 1330-1338
7. Neumayer, L., et al. 2007. Multivariable predictors of postoperative surgical site infection after general and vascular surgery: results from the patient safety in surgery study. *J Am Coll Surg*, 204, (6) 1178-1187
8. Olsen, M.A., et al. 2002. The risk factors for deep and superficial chest surgical-site infections after coronary artery bypass graft surgery are different. *J Thorac.Cardiovasc.Surg*, 124, (1) 136-145
9. Ott, E., et al. 2012. Risk factors associated with surgical site infections following vascular surgery at a German university hospital. *Epidemiol Infect* 1-7

Gender risks in other categories of surgery

- A retrospective cohort study of 3878 patients who had primary CABG surgery at a cardiovascular center in the American Southwest.
- SSI incidence rate:
 - among 957 females was 10.56%;
 - among 2921 males, it was 7.57%;
 - RR was 1.39 (1.12-1.75), (P = 0.004).
- Independent predictors of SSI:
 - female gender, diabetes, body mass index, and urgency of surgery.
- Potential interactions with pre, peri op. control of glucose levels in diabetics and preoperative reduction of weight in obese patients
- More studies are needed to understand gender-associated risk of SSI after CABG surgery.

Reference

Bundy JK et al (2006) Gender risk differences for surgical site infections among a primary coronary artery bypass graft surgery cohort: 1995-1998. *AJIC* 34(3): 114-121

Recent NHSN risk index improvements

- Risk models based on the NHSN risk index, although simple in design, showed poor predictive performance for many procedures.
- New procedure-specific predictive models developed
- 850,000 surgical procedures among 39 procedure categories
- Gender identified as an independent risk factor for 5 categories of surgery:
 - F versus M: CABG, herniorrhaphy, PVBG
 - M versus F: KPRO, rectal surgery
- C. Section model included BMI and whether the patient was in labor
 - significant improvement in predictive performance, compared with that reported previously (0.66 vs 0.55), which included only ASA score, procedure duration, age, and wound class.
- Further improvement can be expected with additional patient- and procedure-specific factors, such as diabetes, duration of preoperative hospital stay, indication for surgery, and the number of discharge diagnoses.

Conclusions

C Section SSI- are the risk factors different from other SSI?

The caesarean section patient population is different to the patient population for other surgical procedures

- Gender is confounded by other factors
- Procedure specific risk based models are needed

Risk factors identified in this Scottish study can help recognize patients at high-risk of developing a SSI following a caesarean section procedure

- Some confirm wider literature, one new risk factor identified

Where risk factors are modifiable, interventions can reduce risk of SSI:

- preoperatively by risk modification (e.g. BMI)
- postoperatively by identification of high risk patients enabling early detection and treatment of infections (e.g. re-intervention with 48 hours).