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# A systematic review of maternal intrinsic risk factors associated with surgical site infection following Caesarean sections

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**Abstract.** We undertook a systematic review of maternal intrinsic risk factors associated with surgical site infection (SSI) following Caesarean section (CS). Studies published in the English language from 1990 to 2007, meeting specific inclusion criteria, were identified from searches of six health and medical literature electronic databases. Two reviewers independently assessed studies for inclusion and extracted data. Fifteen included studies found two independent risk factors for overall SSI: obesity and chorioamnionitis. Premature ruptured membrane >6 h and anaemia were associated with incisional SSI. Anaemia was associated with organ/space SSI. The maternal intrinsic risk factors identified can be used in surveillance programs to identify women at risk of SSI and to risk-adjust hospital infection rates for between-institution comparison.

**Additional keywords:** Caesarean section, systematic review, maternal, risk factors, infection.

## Introduction

Surgical site infection (SSI) following Caesarean section (CS) is an important and frequent complication in obstetrics.[1,2] Rates of SSI following CS vary between 1.4% and 1.8% for in-hospital patients[1,3] and between 0.9 to 12.2% when post-discharge infections are included.[1,3,4]

Endogenous maternal risk factors include obesity;[5–8] severe hypertension;[6,7] premature and prolonged ruptured membranes before surgery.[6,7,9–11] Exogenous factors include number of vaginal examinations[5,12] and use of intrauterine monitoring devices.[11]

Surveillance programs can be a useful tool for monitoring and reducing SSI.[1] A recent investigation of the discriminatory performance of the National Nosocomial Infection Surveillance (NNIS) risk index found it was not optimal for risk stratification of SSI for patients included in an Australian surveillance database.[13] The authors concluded that more informative risk factors should be identified for specific surgical procedures. This paper describes, to our knowledge, the findings of the first systematic review of maternal-specific intrinsic risk factors for SSI following CS that could inform the development of improved risk-based surveillance.

## Review methods

### Search methods

The United States Centres for Disease Control and Prevention (CDC) definition of SSI, used for this review, identified two main categories of SSI: incisional and organ/space.[14] Incisional SSI is further subdivided into superficial incisional (infection limited to the skin and subcutaneous layer) and deep incisional (involving the deeper soft tissue). Both incisional and organ/space SSI (endometritis or endomyometritis) can result from a CS procedure. This review includes studies that investigate either one or both types of infections and reports the results separately for overall, incisional and organ/space SSI (Table 1).

Electronic databases searched included: MEDLINE (OVID, 1990–2007); EMBASE (Elsevier, 1990–2007); PubMed (NLM, 1990–2007); CINAHL (EBSCOhost, 1990–2007); Web of Science (Thomson, 1990–2007); and the


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**Table 1. Inclusion criteria**

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| • Prospective observational cohort study designs, as well as those randomised controlled designs that investigated risk factors for SSI following CS. |
| • Studies published between 1990 and 2007. |
| • Studies written in the English language. |
| • Studies that investigated multiple intrinsic characteristics of women that predisposed them to the risk of an SSI following CS. |
| • Studies that investigated infections during hospitalisation (early SSI) as well as those that investigated post-discharge infections. |
| • Studies primarily investigating risk factors for outcomes other than SSI infections, but provided rates and risk factors for SSI. |

Cochrane library (Wiley, 1996–2007). Search terms were developed using the broad subject headings 'Caesarean section', 'surgical wound infection' and 'risk factors', and by mapping to the Medical Subject Heading (MeSH) in MEDLINE. The terms 'Caesarean', 'section', 'wound', 'infection', 'risk', 'surgical' and 'factors' were combined by using the Boolean operator 'AND' to search for relevant studies. A second search was conducted using 'Caesarean', 'section', 'endometritis', 'risk' and 'factors'.

All abstracts identified from the electronic searches were reviewed against the inclusion criteria by one reviewer. Abstracts or full articles meeting the inclusion criteria were first reviewed independently by two reviewers and then discussed together for inclusion, with any inconsistencies resolved by a third investigator as required. Authors were contacted for further information as required.

### *Data extraction*

A data extraction sheet (pilot tested and modified before use) was used independently by each of the paired reviewers to extract information from each study. Any inconsistencies were resolved by discussion. To minimise bias in data extraction, each article was blinded (to author, name of journal, date and place of publication and author affiliations) by a research assistant not part of the review team. A checklist, designed to assess risk factor studies, was used to assess quality of the included studies.[15] The main components of the checklist included descriptive information about the study as well as its appraisal (using criteria such as: definition of study population; refusal rate; measurement of outcomes in a valid and reliable manner; whether risk factors and outcomes were measured independently of each other; whether all important risk factors were included in analysis; and loss to follow-up). Quality assessment was conducted concurrently with data extraction.

### *Data synthesis*

The risk factors investigated and significance of association with SSI are described. The odds ratio (OR), 95% confidence intervals (CI) and *P*-values were not recalculated and are reported as provided in each article. A meta-analysis of findings from studies investigating the same risk factors was not conducted due to heterogeneity in the analysis methods and the different sets of risk factors examined in each study.

## Results

Figure 1 depicts the process of selecting articles for inclusion in the review.

Fifteen studies were included in the review (Table 2). The number of CS procedures ranged from 153 to 17 405. Maternity departments of hospitals in 11 different countries were the settings for the 14 studies that provided this information. Out of the 11 studies for which data was provided, inpatients and outpatients were included in eight[1,8,9,16–20] and three included inpatients only.[21–23] Thirteen studies used a prospective cohort and two studies used a randomised controlled study design (Table 2).

### *Definitions of infection*

Studies reported infections as SSI, or used terms 'wound infection', 'endometritis' or 'endomyometritis', 'incisional surgical site infection', 'superficial' or 'deep incisional' and 'organ/space SSI'. We assumed that studies investigating wound infections were referring to incisional SSI and studies investigating endometritis were referring to organ/space SSI. Out of the four studies investigating overall SSI, three used a CDC definition.[8,18,20]

Some studies used clinical signs to describe incisional SSI (commonly described as wound infection): presence of pus along the suture line;[22] pus, erythema and induration;[24] combination of purulent discharge, pyrexia, positive culture, wound dehiscence and antibiotic prescription;[16] presence of either purulent discharge or extensive cellulitis of the surgical wound;[17] serous or turbid discharge, a positive culture and wound dehiscence <2 cm for superficial infection;[10] and purulent discharge and wound dehiscence of 2 cm for deep

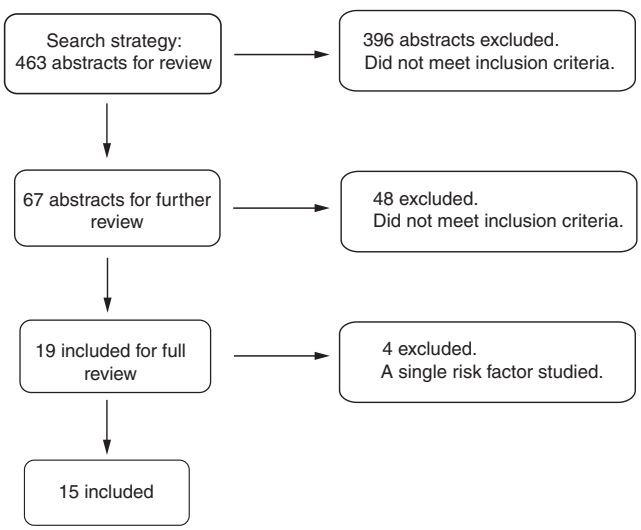


**Fig. 1.** Study selection process.