Surgical Site Infection following Emergency Caesarean Section incidence and associated risk factors: a retrospective case-control study.

Karen Ousey[1], Joanna Blackburn[1], John Stephenson[1], and Tom Southern[1]

[1]University of Huddersfield School of Human and Health Sciences

June 25, 2020

Abstract

Objective: To quantify the incidence, risk and associated factors that contribute to the development of Surgical Site Infection (SSI) in emergency Caesarean Section (CS). Design: A retrospective case-control study. Setting: An acute District General Hospital in England. Sample: 206 patients (101 SSI patients and 105 non-SSI patients) who had emergency CS between January-December 2017. Methods: Grade of surgeon, smoking status, pre-operative vaginal swab, diabetes status, age, body mass index (BMI), membrane rupture to delivery interval and length of surgery were recorded. Risk factors significantly associated with SSI were identified using simple and multiple logistic regression procedures. Results: BMI (kg/m2) was significantly associated with SSI occurrence and age (odds ratio (OR) 1.17; 95% confidence interval (CI) 1.11 to 1.24; p<0.001). Substantive non-significant associations were recorded between SSI, patient age and vaginal swab. Conclusion: This study identified BMI as the only significant risk factor from a range of patient-level factors for the development of an SSI in emergency CS, possibly due to the impact of excessive adipose tissue on the body's immune system and reduced effectiveness of antibiotics. The importance of appropriate wound management including frequent wound cleaning, appropriate dressings and dressing change and education is highlighted. Improved guidelines and strategies for managing at-risk patients would enable clinicians to manage emergency CS patients better and reduce the risk of SSI development. Diabetes status, patient age and pre-op vaginal swab were not significantly associated with SSI in emergency CS. Future research on larger samples should be conducted to validate these findings.

Introduction

Caesarean Section (CS) occur in around 1 in 4 births in the UK[1] and are classified as elective, or emergency, where the procedure is undertaken to prevent risk to the mother and unborn child. Amongst the risks associated with a CS procedure is the development of a surgical site infection (SSI); a serious surgical complication defined as '*a type of healthcare-associated infection in which a wound infection occurs after an invasive (surgical) procedure* '. [2] The CDC [3] further define SSI as an infection that occurs after surgery in the part of the body where the surgery took place. Surgical site infections can sometimes be superficial infections involving the skin only. Other surgical site infections are more serious and can involve tissues under the skin, organs, or implanted material. The development of an SSI following CS can result in permanent injury to the bladder, uterus or rectum as well as scarring, increased pain, a reduction in mobility[4] and extended hospital stays.[5] A severe and potentially fatal complication of developing an SSI is necrotising fasciitis (NF), a rare bacterial infection affecting the soft tissue and fascia. [6]

The World Health Organization [WHO] [7] recommended C-section rates should be between 10% and 15%. However, there has been a gradual international increase in the amount of CS being undertaken. In the

United States, CS has been highlighted as a common procedure, increasing by 41% in a 13-year period to its current rate of about 32%[8] Similarly, high rates are currently observed in the UK (26.5%) [9]; in Australia (32.3%)[10]; and in China (41%). [11] In other countries both the current proportion and rate of increase are high: Zejnullahu et al. [12] report that in Kosovo, the rate of CS rose from 7.5% in 2000 to 27.3% in 2015 with 33.5% of deliveries in tertiary referral care services being C-sections.

The increase in CS risks an increase in SSI, with WHO[13] warning that SSIs affect up to one-third of patients who have undergone a surgical procedure. Almost half of SSIs reported in the European Centres for Disease Prevention and Control surveillance system [14] were identified as superficial, with 30% being deep, and 20% extending to organ/space. However, Wilson et al. [15] reported that procedures associated with a very short post-operative stay, e.g. CS, only had infections recognised and reported following discharge from hospital. These are therefore likely to be underestimated given that approximately 50% of SSIs become evident after discharge. [16] Incidence rates for the development of SSI in CS have been reported globally, as 4.6%.[17] However, Jenks et al. [18]reporting on a multicentre English trial, concluded that SSI was estimated to be just under 10% and the readmission rate due to SSI following CS was 0.6%.

SSI represents a significant financial and patient burden, with costs estimated at over £2 billion to the UK healthcare system, with a median cost of £7,467 per SSI CS patient compared to £3,572 for non-SSI CS patients. [19] Annual costs exceed US$1.6 billion in the US [20] AU$268 million in Australia,[21] and £930 million in the UK. [19]Increased financial expenditure are mainly attributable to increased length of hospital stay [18] and excess cost per operation of £3,855, with an estimated excess cost of over £7,000,000 per hospital in the UK. [22] The pain and isolation concomitant with suffering an SSI also significantly impacts on patient quality of life and experiences of care. [23] Umscheid et al. [24] argue that 60% of SSIs may be preventable and their risk minimised by applying best practice in the perioperative period.

The international literature has identified several risk factors that predispose an individual developing an SSI following a CS procedure in general, including obesity and an increased BMI, increased age, pre-eclampsia, grade of surgeon and existing comorbidities. Indeed, obesity, age and pre-eclampsia have been linked to post-surgical complications, possibly compounding wound healing and increasing the risk of infection. [25, 26] Extended labour time and the complexities surrounding an emergency CS also impact the possibility of post-surgical infection. [27, 28] However, there are some inconsistences; in a multicentre study of 4107 women who underwent a CS at 14 NHS hospitals in England, Wloch *et al.*[29] found obesity (defined as BMI>30 kg/m^2), age <20 years and grade of surgeon to be significantly associated with developing an SSI. Obesity was also found to increase the risk of SSI within 30 days after CS in a case control study of 240 women at a hospital in Ireland.[30] However, Najm and Majeed [31]failed to find evidence to suggest that obesity was a contributing factor in SSI development in a sample of 200 women in a hospital in Iraq. Poor infection control monitoring and procedures may have limited the extent to which these findings are generalisable to the wider population.

Although there appears to be several patient level factors that make developing an SSI following a CS more likely, the extent to which the interaction between these elements increase the likelihood of infection, and the distinction between the predisposing factors associated with an elective versus emergency CS is less obvious. This is problematic, as a lack of evidence-based guidelines contributes to inconsistencies in SSI prevention, treatment and management in CS, increasing the economic burden [22] and obvious detrimental effect on patient outcomes and experiences of care. Whilst evidence-based guidelines emphasise the prevention and treatment of SSI [1] there is an obvious lack of guidance for the management of SSI in emergency CS. The study objective was to quantify the incidence of Surgical Site Infection (SSI) in patients who have had an emergency Caesarean Section (CS), identifying the risk and associated factors that contribute to the development of SSI in order to develop a better understanding of the potential mechanisms that may increase the likelihood of infection and the distinction between the predisposing factors associated with an elective versus emergency CS.

Aim

The aim of this study was to quantify the incidence of Surgical Site Infection (SSI) in patients who have had an emergency Caesarean Section (CS), identifying the risk and associated factors that contribute to the development of SSI's.

METHODS

A retrospective case-control study of data from individuals who had an emergency CS procedure performed between 1st January 2017 and 31st December 2017 at Pinderfields General Hospital, Wakefield; part of the Mid Yorkshire NHS Hospitals Trust was conducted. Following written approval, data was collected from the electronic databases used by the Mid Yorkshire Maternity department, comprising data of all patients seen and treated by Pinderfields obstetrics department.

Inclusion criteria were:

- Women who had an emergency CS performed between 1st January 2017 and 31st December 2017
- Women with a positive wound swab indicating an infection less than 30 days after the procedure
- Women without a positive wound swab for non-SSI cases

Exclusion criteria were:

- Any women with an infection such as sepsis that could not be traced back to an SSI
- Any women who did not have an emergency CS performed between 1st January 2017 and 31st December 2017
- Patients with hypothyroidism

The following variables were collected: grade of CS (categorised as 1-4), smoking status (categorised as current smoker, ex-smoker or non-smoker), whether or not a pre-operative vaginal swab was taken, diabetes status (categorised as non-diabetic, Type I, Type II or gestational), grade of surgeon (categorised as registrar, specialist trainee, consultant, senior house officer (SHO) or associate specialist), patient age, patient body mass index (BMI), membrane rupture to delivery interval and length of surgery.

The sample was summarised descriptively. A series of uni-variable logistic regression screening analyses were conducted on the outcome of SSI status to identify variables substantively associated with the outcome ($p < 0.200$); with low-frequency categories of certain variables combined where appropriate. All such variables were carried forward into a corresponding multiple logistic regression analysis. All analyses reported unadjusted or adjusted odds ratios with associated 95% confidence intervals, P-value and the percentage of correct classifications.

Results

Data was obtained from 206 emergency CS patients for the study; including 101 who had an SSI and 105 who did not have an SSI. The sample is summarised in Table 1 below.

INSERT TABLE ONE HERE

For inferential analysis, CS grades were merged into G1 and G2 (reference); and G3 and G4. Smoking status was merged into non-smoker (reference); and current/ex-smoker. Diabetes status was merged into no diabetes (reference); and any kind of diabetes. Grade of surgeon was merged into registrar (reference) and Other.

Regression parameters from a series of uni-variable binary logistic regression analyses conducted on all included variables are summarised in Table 2.

INSERT TABLE 2 HERE

According to the level of substantive association with the outcome, BMI, age, diabetes status and pre-operative vaginal swab were carried forward for inclusion in the multiple model. Parameters from this model are summarised in Table 3.

INSERT TABLE 3 HERE

DISCUSSION

Main findings

Findings from this study identified BMI as the only significant risk factor from a range of patient-level factors for the development of an SSI in emergency CS. Interestingly, for every increase in unit of BMI kg/m^2, the risk of SSI increased by 17% Patient age, diabetes status and pre-operative vaginal swab were not found to be significantly associated with an increased risk of SSI.

Interpretation

BMI and obesity

The finding that BMI poses a significant risk factor for developing an SSI following emergency CS is consistent with previous research demonstrating the negative impact on post-surgical infection risk[29, 30, 25, 27, 26,] Wloch *et al.*[29] and Ghuman *et al.* [27] both cited impaired immune response, larger wound area size and poor perfusion of prophylactic antibiotics in obese individuals as possible reasons for this increased risk. One possible explanation is the pathophysiological role that BMI plays in emergency CS due to the decreased efficacy of excess adipose tissue on the immune system and a decrease in perioperative tissue deoxygenation. [32]There is evidence to support this; in a meta-analysis of the use of perioperative supplemental oxygen therapy on the rate of SSI, Qadan*et al.* [33] found that administering supplemental oxygen following an operation had a significant effect in preventing the development of an SSI, possibly due to 'oxidative killing', which requires sufficient oxygen partial pressures in order to function. Metabolic and hormonal changes attributable to obesity have been cited as increasing the risk of infection [34] and impaired wound healing [35, 36, 37] suggesting that the physiological impact of an increased body mass compounds the body's ability to recover following a surgical procedure. However, other studies have failed to substantiate these findings or indeed identify possible causes for the increased risk of infection in obese patients.[25, 30] The impact of BMI on post-surgical outcomes has been recognised more widely in general surgery as a possible consequence of impaired wound healing due to increased volume of subcutaneous fat, increased tension on surgical incision and elevated blood glucose levels. [38] Impaired antibiotic performances and altered immune cell function [39, 40] as well as a larger surgical incision and more complex surgical procedure[41] have also been cited as explanations for the increased risk of infection in obesity.

Associated risk factors

Smoking status, existing health conditions such as diabetes, age, or skin closure techniques were not found to contribute to an increased risk of infection in this study. This is in contrast to other research which has found significant relationships for smoking and delayed wound healing, [42] diabetes [28, 43, 44] and skin closure techniques. [45] Indeed Henman *et al.* [28] found age was not associated with SSI in CS, however, other evidence suggests that up to the age of 65 years, there is an increased risk of SSI more generally, [46]possibly due to an impaired immune system. [47] An increase in age-related comorbidities could also increase the risk of developing an SSI following emergency CS. [48] One possible reason for age being unrelated to SSI in this study is the small age range within an already young sample. In addition, the risk factor of diabetes has been identified in the literature as a risk factor for SSI due to a reduction in the body's immune response to defending against microbes as well as impairing wound healing[49] and it is likely that hyperglycaemia, hypoxia and chronic inflammation all playing a role in interrupting the different crucial stages of wound healing. [50]

Strengths and Limitations

This study used BMI to diagnose obesity and the accuracy of BMI has been questioned; Romero-Corral *et al.* [53] found that the use of BMI to diagnose obesity was not completely accurate, especially in those individuals with a BMI <30 kg/m^2 with 12% of women being misclassified as being obese (Romero-Corral *et al.* 2008). However, BMI [?] 30 kg/m^2 has greater specificity for females in general due to the greater correlation with body fat percentage compared to males. Indeed, BMI remains one of the most commonly used methods to calculate body composition.

This study utilised data collected from a single hospital in a single NHS Trust and a relatively small sample size may have contributed to the finding that certain patient-related factors were not associated with an increased risk of SSI following CS. It was also difficult to capture data on certain variables due to missing or inaccurate data recording. In addition, the identification of patients with SSIs relied on wound swabs. Use of swabs to identify an infection can lead to both false negative results (due to decreased volume of bacteria collected by the swab, as identified by Aggarwal *et al.* [54]; and false positive results (when the swab becomes contaminated by commensal organisms). However, alternatives such as the use of tissue cultures to increase sensitivity and specificity would be more invasive for the patient therefore swabs were considered the most accurate method of identifying infection in this study.

Conclusion

The finding that obesity is a significant risk factor in the development of an SSI following CS highlights the importance of appropriate wound management in this patient group. Frequent wound cleaning and the use of appropriate dressings, along with regular dressing changes is an important aspect of wound care for health care professionals and patients and demonstrates the importance of education in skin integrity. The prevention of wound ischemia could also help to reduce the risk of SSI as fat necrosis can lead to the development of an infection.[51] Surgical wound irrigation could also help to lower the risk of an SSI developing following an emergency CS, with surgeons using antibacterial solutions to flush out the wound site in order to remove any contaminants. [52] Targeted weight management interventions for individuals with a higher BMI could also limit the risks associated with an increased BMI. Improved guidelines and strategies for at-risk patients would also enable clinicians to manage emergency CS patients better and reduce the risk of SSI development.

Whilst some research has focused on investigating risk factors of developing and SSI in CS, there has been less of a focus on the difference between the risks associated with emergency and elective CS procedures and there has been a distinct lack of evidence pertaining the risk factors for emergency CS in particular.

This study identified BMI (kg/m^2) as a significant risk factor associated with the development of an SSI in emergency CS's. Possible reasons for BMI's (kg/m^2) significance could be the negative effect of excessive adipose tissue on the body's immune system as well as the reduced effectiveness of antibiotics in individuals with an obese BMI (kg/m^2). Other potential risk factors such as diabetes status, patient age and pre-op vaginal swab did not reach statistical significance in this study. Future research on larger samples should be conducted to validate these findings to substantially improve the knowledge and evidence base on the treatment and management of SSI and associated risk factors following emergency CS.

Disclosure of interests:

There are no disclosure of interests.

Contribution of authorship:

All authors made significant contribution to the manuscript. KO was responsible for study design and conception. TS, JB, JS and KO wrote the manuscript, which was developed from an MRes thesis submitted to the University of Huddersfield by TS; supervised by JB and JS.

JS and TS conducted the statistical analysis. JB, JS and KO provided critical feedback.

All authors approved the final manuscript for submission.

Ethical approval

Ethical approval for this retrospective study was received from The University of Huddersfield's School Research Ethics Panel: Reference: SREP-2019-061, 25th July 2019.

Written consent was also obtained from the maternity department at Mid Yorkshire Hospital NHS Trust and approval from occupational health at Pinderfields General Hospital.

Funding

No funding was received for undertaking this study.

References

1. NICE. (2019). *Surgical site infections: prevention and treatment* . (NICE guideline [NG125]). Available at: https://www.nice.org.uk/guidance/ng125. *[accessed 11.06.2020].*
2. National Institute for Health Care and Excellence (NICE), 2008)*Surgical site infections: prevention and treatment* . Available at: https://www.nice.org.uk/guidance/cg74/chapter/Introduction. [accessed 06.06.2020].
3. CDC National Healthcare Safety Network, Centers for Disease Control and Prevention. Surgical site infection (SSI) event. Available at: http://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf. *[accessed 19.06.2020].*
4. (Public Health Wales, 2018) Public Health Wales. (2018). *Caesarean Section Surgical Site Infection Surveillance.* Available at: http://www2.nphs.wales.nhs.uk:8080/WHAIPDocs.nsf/3dc04669c9e1eaa880257062003b246b/5080b5c31da10d5b802582 %20All%20Wales%20-%20V1.pdf
5. Olsen, M. A., Butler, A. M., Willers, D. M., Gross, G. A., Hamilton, B. H., & Fraser, V. J. (2010). Attributable Costs of Surgical Site Infection and Endometritis After Low Transverse Cesarean Section. *Infection Control Hospital Epidemiology, 31* (3), 276–282. doi: 10.1086/650755
6. Public Health England (2013). *Necrotising Fasciitis (NF)* . Retrieved from https://www.gov.uk/guidance/necrotising-fasciitis-nf
7. WHO. (2015). *WHO Statement on Caesarean Section Rates* . Available at: https://apps.who.int/iris/bitstream/handle/10665/161442/WHO_RHR_15.02_eng.pdf?sequence=1. [accessed 19.06.2020]
8. Betran, A. P., Ye, J., Moller, A. B., Zhang, J., Gulmezoglu, A. M., & Torloni, M. R. (2016). The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014. *PloS one* , *11* (2), e0148343. https://doi.org/10.1371/journal.pone.0148343
9. Hospital Episode Statistics Analysis HaSCIC. NHS Maternity Statistics—England, 2014–15. Available at: http://www.hscic.gov.uk2015. *[accessed 19.06.2020]*

10. Li Z, Zeki R, Hilder L, et al . 2013. Australia's mothers and babies 2011. Perinatal statistics series no. 28. Cat. no. PER 59. Canberra: AIHW National Perinatal Epidemiology and Statistics Unit, 2011
11. Betran AP, Merialdi M, Lauer JA, et al. Rates of caesarean section: analysis of global, regional and national estimates. Paediatr Perinat Epidemiol. 2007;21(2):98-113. doi:10.1111/j.1365-3016.2007.00786.x
12. Zejnullahu, V.A., Isjanovska, R., Sejfija, Z. et al. Surgical site infections after cesarean sections at the University Clinical Center of Kosovo: rates, microbiological profile and risk factors. BMC Infect Dis 19, 752 (2019). https://doi.org/10.1186/s12879-019-4383-7.
13. World Health Organization. Global Guidelines for the Prevention of Surgical Site Infection. World Health Organization. 2016. Available at: https://apps.who.int/iris/bitstream/handle/10665/250680/9789241549882-eng.pdf?sequence=8. [accessed 19.06.2020]
14. European Centre for Disease Prevention and Control. Surgical site infections. In: ECDC. Annual epidemiological report for 2016.
15. Wilson J, Wloch C, Saei A et al. Inter-hospital comparison of rates of surgical site infection following caesarean section delivery: evaluation of a multicentre surveillance study. J Hosp Infect 2013; 84(1):44–51. https://doi.org/10.1016/j.jhin.2013.01.009 17.
16. Berrios-Torres SI, Umscheid CA, Bratzler DW et al. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. JAMA Surg 2017; 152(8):784–791. https://doi.org/10.1001/jamasurg.2017.0904
17. Zuarez-Easton S, Zafran N, Garmi G, Salim R. Postcesarean wound infection: prevalence, impact, prevention, and management challenges. *Int J Womens Health* . 2017;9:81-88. Published 2017 Feb 17. doi:10.2147/IJWH.S98876
18. Jenks PJ, Laurent M, McQuarry S, Watkins R. Clinical and economic burden of surgical site infection (SSI) and predicted financial consequences of elimination of SSI from an English hospital. J Hosp Infect. 2014;86(1):24-33. doi:10.1016/j.jhin.2013.09.012.
19. Plowman R, Graves N, Griffin MA et al et al. The rate and cost of hospital-acquired infections occurring in patients admitted to selected specialties of a district general hospital in England and the national burden imposed. J Hosp Infect 2001; 47(3):198–209.
20. de Lissovoy G, Fraeman K, Hutchins V et al Surgical site infection: Incidence and impact on hospital utilization and treatment costs. Am J Infect Control 2009; 37(5):387–397. https://doi.org/10.1016/j.ajic.2008.12.010
21. McLaws ML, Taylor PC. The Hospital Infection Standardised Surveillance (HISS) programme: analysis of a two-year pilot. J Hosp Infect 2003; 53(4):259–267. https://doi.org/10.1053/jhin.2002.1361
22. Troughton, R., Birgand, G., Johnson, A.P., Naylor, N., Gharbi, M., Aylin, P. . . . Holmes, A. (2018). Mapping national surveillance of surgical site infections in England: needs and priorities. Journal of Hospital Infection, 100 (-), 378-385. doi: https://doi.org/10.1016/j.jhin.2018.06.006.
23. Andersson, A.E., Bergh, I., Karlsson, J., & Nilsson, K. (2010). Patients' experiences of acquiring a deep surgical site infection: An interview study. American Journal of infection control, 38 (9), 711-717. doi: https://doi.org/10.1016/j.ajic.2010.03.017.
24. Umscheid CA, Mitchell MD, Doshi JA et al. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. Infect Control Hosp Epidemiol 2011; 32(2):101–114. https://doi. org/10.1086/657912
25. Pallasmaa, N., Ekblad, U., Aitokallio-Tallberg, A., Uotila, J., Raudaskoski, T., Ulander, V., & Hurme, S. (2010). Cesarean delivery in finland: Maternal complications and obstetric risk factors. *Acta Obstetricia Et Gynecologica Scandinavica, 89* (7), 896-902. doi:10.3109/00016349.2010.487893
26. Newlin, C., Kuehl, T.J., Pickrel, A., Cawyer, C.R., & Jones, R.O. (2015). Cesarean Section Incision Complications and Associated Risk Factors: A Quality Assurance Project. Open Journal of Obstetrics and Gynecology, 5, 789-794. doi: http://dx.doi.org/10.4236/ojog.2015.514111.
27. Ghuman, M., Rohlandt, D., Joshy, G., & Lawrenson, R. (2011). Post-caesarean section surgical site infection: rate and risk factors. The New Zealand Medical Journal, 124 (1339), 32-36. Retrieved from http://www.nzma.org.nz/journal/124-1339/4783/.

28. Henman, K., Gordon, C., Gardiner, T., Thorn, J., Spain, B., Davies, J., & Baird, R. (2012). Surgical site infections following Caesarean section at royal Darwin Hospital, Northern Territory. Healthcare Infection, 17 (N/A), 47-51. doi: 10.1071/H11027.
29. Wloch C1, Wilson J, Lamagni T, Harrington P, Charlett A, Sheridan E. Risk factors for surgical site infection following caesarean section in England: results from a multicentre cohort study. BJOG. 2012 Oct;119(11):1324-33. doi: 10.1111/j.1471-0528.2012.03452.x. Epub 2012 Aug 1
30. Saeed, K., Corcoran, P., O'Riordan, M., & Greene, R.A. (2019). Risk factors for surgical site infection after cesarean delivery: A case-control study. American Journal of Infection Control, 47, 164-169. doi: org/10.1016/j.ajic.2018.07.023.
31. Najm, B. & Majeed, K. (2019). Factors related to surgical site infection following cesarean section in a Baghdad's women. World Journal of Pharmaceutical Research, 8 (2), 101-124. doi: 10.20959/wjpr20192-14162.
32. Kabon, B., Nagele, A., Reddy, D., Eagon, C., Fleshman, J.W., Sessler, D.I., & Kurz, A. (2004). Obesity Decreases Perioperative Tissue Oxygenation. American Society of Anesthesiologists, 100 (2), 274-280. Retrieved from https://anesthesiology.pubs.asahq.org/article.aspx?articleid=1942778.
33. Qadan, M., Akca, O., Mahid, S.S., Hornung, C.A., & Polk, H.C. (2009). Perioperative Supplemental Oxygen Therapy and Surgical Site Infection A Meta-analysis of Randomized Controlled Trials. American Medical Association, 144(4), 359-366. doi: 10.1001/archsurg.2009.1.
34. Genoni, G., Prodam, F., Marolda, A., Giglione, E., Demarchi, I., Bellone, S., & Bona, G. (2014). Obesity and infection: two sides of one coin. European Journal of Pediatrics, 173 (1), 25-32. doi: 10.1007/s00431-013-2178-1.
35. Avishai, E., Yeghiazaryan, K., & Golubnitschaja, O. (2017). Impaired wound healing: facts and hypotheses for multi-professional considerations in predictive, preventive and personalised medicine. The EMPA Journal, 8 (1), 23-33. doi: 10.1007/s13167-017-0081-y.
36. Guo, S. & DiPierto, L.A. (2010). Factors affecting wound healing. Journal of Dental Research, 89 (3), 219-229. doi: 10.1177/0022034509359125.
37. Pierpont, Y., Phuong Dinh, T., Emerick Salas, R., Johnson, E., Wright, T., Robson, M., & Payne, W. (2014). Obesity and surgical wound healing: A Current review. ISRN Obesity, 2014 (-), 1-13. doi: http://dx.doi.org/10.1155/2014/638936.
38. Tjeertes, E.K.M., Hoeks, S.E., Beks, S.B.J.C., Valentijn, T.M., Hoofwijk, A.G.M., & Stolker, R.J. (2015). Obesity -a risk factor for postoperative complications in general surgery? BMC Anesthesiology, 15 (155), 1-7. doi: https://doi.org/10.1186/s12871-015-0096-7.
39. Falagas, M.E. & Karageorgopoulos, D.E. (2010). Adjustment of dosing of antimicrobial agents for bodyweight in adults. Lancet, 375 (-), 248-251. doi: 10.1016/S0140-6736(09)60743-1.
40. Thelwall, S., Harrington, P., Sheridan, E., & Lamagni, T. (2015). Impact of obesity on the risk of wound infection following surgery: results from a nationwide prospective multicentre cohort study in England. Clinical Microbiology and Infection, 21 (11), 1008.e1-1008.e8. doi: https://doi.org/10.1016/j.cmi.2015.07.003.
41. Corneille, M. G., Steigelman, M. B., Myers, J. G., Jundt, J., Dent, D. L., Lopez, P. P., . . . Stewart R. M. (2007). Laparoscopic appendectomy is superior to open appendectomy in obese patients. The American Journal of Surgery, 194(6), 877-881. doi: 10.1016/j.amjsurg.2007.08.043
42. Nolan, M., Martin, D., Thompson, R., Schroeder, D., Hanson, A., & Warner, D. (2017). Association between smoking status, preoperative exhaled carbon monoxide levels, and postoperative surgical site infection in patients undergoing elective surgery. JAMA Surgery, 152 (5), 476-483. doi: 10.1001/jamasurg.2016.5704.
43. Muller, L.M.A.J., Gorter, K.J., Hak, E., Goudzwaard, W.L., Schellevis, F.G., Hoepelman, A.I.M., & Rutten, G.E.H.M. (2005). Increased Risk of Common Infections in Patients with Type 1 and Type 2 Diabetes Mellitus. Clinical Infectious Diseases, 41 (3), 281-288. doi: https://doi.org/10.1086/431587.
44. Shah, B.R. & Hux, J.E. (2003). Quantifying the risk of infectious diseases for people with diabetes. Diabetes care,26 (2), 510-513. doi: https://doi.org/10.2337/diacare.26.2.510.
45. Figueroa, D., Chapman Juak, V., Szychowski, J.M., Garner, R., Biggio, J.R., Andrews, W.W.

... Tita, A.T.N. (2013). Surgical Staples Compared with Subcuticular Suture for Skin Closure After Cesarean Delivery: A Randomized Controlled Trial. Obstetrics and Gynecology, 121 (1), 33-38. doi: https://www.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?dbfrom=pubmed&retmode=ref&cmd=prlinks&id=23262925.

46. Kaye, K. S., Schmit, K., Pieper, C., Sloane, R., Caughlan, K. F., Sexton, D. J., & Schmader, K. E. (2005). The Effect of Increasing Age on the Risk of Surgical Site Infection. The Journal of infectious Diseases, 191(7), 1056–1062. doi: 10.1086/428626.
47. Valiathan, R., Ashman, M., & Asthana, D. (2016). Effects of Ageing on the Immune System: Infants toElderly. Scandinavian Journal of Immunology , 83 (-), 255-266. doi: 10.1111/sji.12413.
48. Agodi, A., Quattrocchi, A., Barchitta, M., Adornetto, V., Cocuzza, A., Latino, R., Li Destri, G., & Di Cataldo, A. (2015). Risk of surgical site infection in older patients in a cohort survey: targets for quality improvement in antibiotic prophylaxis. International surgery, 100(3), 473–479. https://doi.org/10.9738/INTSURG-D-14-00042.1
49. Brem, H. & Tomic-Canic, M. (2007). Cellular and molecular basis of wound healing in diabetes. The Journal of Clinical Investigation, 117 (5), 1219-1222. doi: https://doi.org/10.1172/JCI32169.
50. Baltzis, D., Eleftheriadou, I., & Veves, A. (2014). Pathogenesis and Treatment of Impaired Wound Healing in Diabetes Mellitus: New Insights. Advances in Therapy, 31 (8), 817-836. doi: 10.1007/s12325-014-0140-x.
51. Rangaswamy, M. (2013). Minimising complications in abdominoplasty: An approach based on the root cause analysis and focused preventive steps. Indian Journal of Plastic Surgery, 46(2), 365–376.. doi: 10.4103/0970-0358.118615
52. Barnes, S., Spencer, M., Graham, D., & Boehm Johnson, H. (2014). Surgical wound irrigation: A call for evidence-based standardization of practice. American Journal of infection control, 42(5), 525-529. doi: 10.1016/j.ajic.2014.01.012.
53. Romero-Corral, A., Somers, V.K., Sierra-Johnson, J., Thomas, R.J., Collazo-Clavell, M.L., Korinek, J. ... Lopez-Jimenez, F. (2008). Accuracy of body mass index in diagnosing obesity in the adult general population. international journal of obesity, 32 , 959-966. Retrieved from https://www.nature.com/articles/ijo200811.
54. Aggarwal, V. K., Higuera, C., Deirmengian, G., Parvizi, J., & Austin, M. S. (2013). Swab Cultures Are Not As Effective As Tissue Cultures for Diagnosis of Periprosthetic Joint Infection. Clinical Orthopaedics and clinical research,471(10), 3196–3203. doi: 10.1007/s11999-013-2974-y

Conflict of interest statement: There are no conflicts of interest.

Hosted file

`Table 1_descriptives_finalversion230620.docx` available at https://authorea.com/users/336836/articles/462513-surgical-site-infection-following-emergency-caesarean-section-incidence-and-associated-risk-factors-a-retrospective-case-control-study

Hosted file

`Table 2_BINARY_FINALVERSION230620.docx` available at https://authorea.com/users/336836/articles/462513-surgical-site-infection-following-emergency-caesarean-section-incidence-and-associated-risk-factors-a-retrospective-case-control-study

Hosted file

`Table 3_multipleregression_finalversion230620.docx` available at https://authorea.com/users/336836/articles/462513-surgical-site-infection-following-emergency-caesarean-section-incidence-and-associated-risk-factors-a-retrospective-case-control-study