A systematic review of surgical site infections following day surgery: a frequentist and a Bayesian meta-analysis of prevalence

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‘Declaration of interest: none’

No previous communication to a society or meeting

Running title: Meta-analysis of surgical site infections

Word count : 3842

Summary

Background:

Since 1990, several studies have focused on safety and patient satisfaction in connection with day surgery. However, no meta-analysis had investigated the overall prevalence of surgical site infections (SSI).

Aim:

The aim of the study was to estimate the overall prevalence of SSI following day surgery, whatever the type of surgery.

Method:

We conducted a systematic review and a meta-analysis of the prevalence of SSI following day surgery regardless of the type of surgery seeking all studies before June 2016.

A pooled-random effects model using the DerSimonian and Laird approach was used to estimate overall prevalence. A double arcsine transformation was used to stabilize the variance of proportions. After carrying out a sensitivity analysis to validate the robustness of the method, we used univariate and multivariate meta-regressions to test the effect of the date of publication; country of study; study population; type of specialty; contamination class; the time of the post-operative patient visit after day surgery and duration of hospital care.

Findings:

Ninety articles, both observational and randomized, were analyzed. The estimated overall prevalence of SSI among patients who underwent day surgery was 1.36% (95% CI [1.1; 1.6]) with a Bayesian probability to be comprised between 1 and 2% of 96.5%. The date of publication was associated with SSI prevalence (coefficient -0.001, $p=0.04$) and the specialty (digestive vs non-digestive surgery) tended to be associated with SSI prevalence (coefficient 0.03, $p=0.064$).

Conclusion:

The meta-analysis showed a low prevalence of SSI following day surgery, whatever the surgical procedure.

Keywords: meta-analysis; surgical site infections; prevalence; day surgery; bayesian

Introduction

Since the establishment of day surgery in the United States, the United Kingdom and Canada in the 60s, the practice of day surgery has developed considerably. The advantages of day surgery increased patient and surgeon satisfaction, and also include more convenient scheduling and lower costs [1-4].

In parallel, there has been a marked increase in day surgery for many common low-risk interventions that do not require hospitalization or post-operative stay for more than 24 hours [1].

Even if day surgery has many interests, it is extremely important to monitor patients for post-surgical complications, especially surgical site infections (SSI). Moreover, it is known that SSIs can constitute a financial burden either for health centers and for patients and are usually associated with increased morbidity and even mortality [3, 5-7]. There are several definitions of day surgery according to the country considered. For example, day surgery is defined as any hospitalization of less than 12 hours without overnight stay in France. We used the International Association for Ambulatory Surgery (IAAS) definition which is “A patient having an operation, procedure excluding an office/surgery or outpatient operation/procedure, who is admitted and discharged on the same working day” [8].

Since 1990, several studies around the world have focused on day surgery in terms of safety and patient satisfaction, for various surgical procedures. Each study presents results of their own institution in terms of complications following surgery, length of time in hospital and cost. However, little is known about the global prevalence of SSI following these procedures [1, 4, 9].

Ahmad *et al.* published a meta-analysis assessing various postoperative outcomes in day surgery patients versus inpatients undergoing laparoscopic cholecystectomy. In the same way,

Hopkins *et al.* published a literature review focusing on general complications of thyroid surgery. However, neither Ahmad nor Hopkins reported SSI rates following surgery [10, 11]. To date, no meta-analysis has reported the overall prevalence of SSI, whatever the surgical procedure. There are several estimates available from studies published in different countries with different sample size ranging from small size (few dozens) to big database (several thousands). Conducting a meta-analysis allowed us to take into account possible heterogeneity and to provide more accurate results by pooling different types of studies and specialties and thus to strengthen the analysis.

After performing a systematic review, we used previously published and available studies to estimate the overall prevalence of SSI consecutive to day surgery related to different surgical procedures in a meta-analysis of prevalence.

Methods

The MOOSE (Meta-analysis Of Observational Studies in Epidemiology) and PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analysis) statements were used as guidance for the completion of this meta-analysis [12-14].

Search strategy

An extensive unrestricted computerized literature search was conducted on several sources, including “MEDLINE”, “ScienceDirect”, “Cochrane database” AND “EMBASE”.

To identify all studies before June 2016, we crossed the words “day surgery”, “ambulatory surgery”, “same-day surgery”, “day-only surgery” AND “surgical site infections”, “wound complication” as defined in IAAS terminology [8]. We also used “outpatient surgery” which was usually used before the second edition of the definition of IAAS (2014)[2].

Studies which the titles and abstracts were potentially relevant were read. When the studies seemed to meet eligibility criteria, or when information was insufficient to exclude them, the full article was read by two reviewers (DP and LSAG) to determine those that provided sufficient information to be included in our meta-analysis. Any discrepancies by the two reviewers were resolved by consensus.

Finally, the references cited by each eligible study were scrutinized to identify additional articles.

Inclusion and exclusion criteria

Studies were restricted to those published in English, German, Italian, Dutch and French.

Definition of SSI was that given by each author.

Studies were included if they reported extractable data on the prevalence of SSI following day surgery regardless of the type of surgery.

We looked for the presence and the number of SSIs following day surgery (numerator) and the number of subjects who underwent day surgery (denominator).

Studies which provided data on two or more periods were also included. There were no restrictions concerning the design of the studies to include.

Articles which did not deal with day surgery and SSI prevalence were excluded. If either the numerator or the denominator numbers were not available, we excluded the related articles.

Studies focusing only on patients' satisfaction or presenting complications following day surgery in general were not included. Articles with duplicated data were also excluded.

For each article included, the following epidemiological data were recorded: study design (randomized control trial; cross-sectional, prospective and retrospective studies), country of study, date of publication, type of specialty (digestive surgery, thyroid surgery, other surgery specialties or multiple specialties), contamination class (clean and clean-contaminated, contaminated and dirty, combined), status of the population included (children, adults or combined), duration of hospital care for day surgery (less than 12 hours, less than 23 hours, not available) and time of follow-up which were retrieved. The type of surveillance, SSI definition and interventional character were not mentioned in articles.

In order to limit publication bias, we looked at Open Grey database which is known to be one of the biggest grey literature databases to seek studies not published. Indeed, grey literature can include original articles that have not been published in addition to technical reports, dissertations, congress presentations or official publications. We found a majority of dissertation (n=14), a poster and a conference that did not meet our criteria and were thus not included in the analysis.

Statistical analysis

A systematic review focusing on SSI following day surgery was performed in order to estimate it in a meta-analysis.

First, to estimate the global prevalence of SSI following day surgery, we use a double arcsine transformation was used to stabilize the variance of proportions [15]. I^2 was used as a measure of heterogeneity. I^2 values exceeding 50 % were defined as high heterogeneity. A pooled random effects analysis was used to calculate the combined prevalence of SSI following day surgery and their 95% confidence intervals (CIs) by using the DerSimonian and Laird approach [16]. The Restricted Maximum Likelihood Estimation (REML) method and the Sidik-Jonkman method were used among several available methods to estimate Tau [17]. A cumulative meta-analysis that included studies from the oldest to the most recent was also done. Sensitivity analyses were carried out to assess the robustness of the statistical methodology by removing each study one by one. Publication bias was explored by Egger's test and represented graphically with a funnel plot to seek asymmetry [18].

Second, univariate meta-regressions were first done to test the effect of the date of publication, population included, country of study, existence of a randomized clinical trial or not, type of specialty presented in each study, class of contamination, the time of the post-operative patient visit after day surgery and duration of hospital care on SSI prevalence. We decided not to use multiple imputations or to remove studies with missing data in the meta-regression when the amount of missing data was too large (>50%).

Subgroup analyses were carried out with each of the variables presented above.

Third, to better understand the factors associated with SSI following day surgery, a multivariate analysis using a backward selection algorithm was performed. Only variables reported in totality in studies were eligible for multivariate model.

All variables whose p values were less than 0.25 in backward selection algorithm were finally evaluated. Variables with p values less than 0.05 in the final multivariate model were considered significant. The overall statistical analysis was then internally validated using a Bayesian model with a binomial distribution. This model is more accurate than the frequentist

one as it can incorporate zero-events studies without neither correction nor transformation.

Non-informative priors were used for the Bayesian model. From these priors and each explicative variable, the model was estimated by Monte Carlo Markov Chain sampling techniques. The precision of these estimates is given with 95% credible intervals (95% CrIs). Estimating the probability that the prevalence obtained lies in the credible interval provided was then calculated using the interval hypothesis test.

STATA 14 (“metaprop” package; bayesmh command) and R 3.1.1 (“meta” and “metafor” packages) were used for the analyses [19, 20].

Results

A total of 1871 articles were obtained by our search strategy. Among these 90 met the eligibility criteria (**Figure 1**). Three studies [21-23] provided data on two or three periods. They were included as two or three distinct articles. Thus, 90 articles led to 94 sets of data analysed [4, 9, 21-108].

Description of included studies

Most studies (60 %) were conducted in the USA (33 studies) and Europe (29 studies) (**Table I**).

The size of the sample varied from 14 patients [56] to 411,670 [62] with a median of 211 patients (IQR 97.5 - 1775). Overall, 1 342 167 subjects were included.

Most studies included adult populations (n= 82). Ten studies involved only children and two studies included populations of all ages. Altemeier class I and II were the most frequent, representing 74.2% (n=69) of studies [109, 110].

There were seven surgical specialties initially (Urologic surgery N = 3; neurosurgery N=3; orthopedic surgery N=4; thyroid surgery N=11; digestive surgery N=36; other surgical specialties N=18 and multiple specialties N=18).

Some specialties, which were poorly represented, were regrouped in the variable “Type of specialty” that included four modalities (Digestive surgery, thyroid surgery, other surgical specialties and multiple specialties). We also recode the variable “Type of specialty” into a variable presenting digestive surgery versus non-digestive surgery called “Specialty” in order to increase power.

Duration of hospital care for day surgery was provided for less than 50 % of the studies.

The characteristics of each study are shown in Appendix A, **Supplementary material online**.

Most studies were observational but five studies were randomized clinical trials [9, 40, 54, 61, 73].

The time between the day surgery and the post-operative consultations was mentioned in 51 of the studies. They are reported in **Table II**.

Prevalence of SSI

Using the Restricted Maximum Likelihood Estimation (REML) method to estimate Tau, the estimated global prevalence of SSI following day surgery was 1.36% (95% CI [1.1; 1.6]). The heterogeneity was very high ($I^2 = 98.85\%$) (**Figure 2**).

Using Sidik-Jonkman method to estimate Tau, the estimated prevalence of SSI following day surgery was 1.8% (95% CI [1.3; 2.4]). The heterogeneity was very high ($I^2 = 98.9\%$, 95% CI 98.8%; 98.9%).

As the heterogeneity was very high, subgroup analyses were performed to seek interactions between each explicative variable.

Using the Bayesian model, the estimated prevalence of SSI was similar, 1.32 (95% CrI [0.9; 1.8]) with a probability that SSI' prevalence lies between 1 and 2 % of 96.5 % (Appendix B, **Supplemental Supplementary material online**).

The funnel plot shows asymmetry (**Figure 3**) which was confirmed by a significant Egger test ($p=0.001$).

Sensitivity analyses led to consistent results. The pooled prevalence when each article was removed one by one remained nearly identical to the main prevalence using REML method to estimate Tau, 1.01% (95% CI [0.55; 1.5]). The result was similar using Sidik-Jonkman method 1.35% (95% CI [1.1; 1.6]).

The influence of large studies (more than 10, 000 individuals) was small, as shown when these studies were removed [4, 22, 42, 43, 60, 62, 63, 70, 71, 74, 76, 79, 107].

When the three largest studies [22, 62], representing 73% of the overall population, were removed, the global prevalence was 1.8% (95% CI [1.36; 2.3]). There was no significant difference between the two prevalences.

Using Sidik-Jonkman method to estimate Tau, the cumulative meta-analysis, which included studies from the oldest to the most recent, showed a slight trend towards a lower prevalence of SSI following day surgery in more recent studies with a prevalence of 6.4% in 1975 (95% CI [3.6; 10]) up to 1.8% in 2016 (95% CI [1.3; 2.4]). This also corresponded to the pooled prevalence obtained (Appendix C, **Supplementary material online**).

Subgroup meta-analyses

All analyses by subgroup (date of publication, country of study, study design, type of specialty or specialty, contamination class and population included) found intergroup heterogeneity (Table I).

Factors associated with the prevalence of SSI

Univariate meta-regressions showed significant of association between the prevalence of SSI and the date of publication (coefficient -0.001, $p=0.037$). The prevalence of SSI decreases when the publication date is more recent. The type of specialty (four modalities) was not associated with the prevalence of SSI ($p=0.29$) (See **Table III** for more details) with most SSI occurring after digestive surgery compared to thyroid surgery, other surgical specialties and multiple specialties. But specialty (digestive vs non-digestive surgery) tended to be associated with the prevalence of SSI (coefficient 0.03, $p=0.059$). No other potentially explicative variable was statistically associated with the global prevalence of SSI. For example, duration of hospital care (defined as a threshold <12 hours or ≥ 12 , the all less than one day) for day surgery was not associated with the prevalence of SSI.

The time between the day surgery and the post-operative consultation, which was known in 52% of all studies, was not associated with the prevalence of SSI in univariate meta-regression (coefficient 0.0017, $p=0.39$) (**Table III**).

Because of the large amount of missing data for the time to the post-operative consultation in our meta-analysis, we compared “characteristics” of studies with or without reported time to post-operative consultations. We evaluated the relationship between the probability of having no time to post-operative consultations in studies (i.e. missing data) and our principal dependent variables.

Neither any dependent variable nor study population size was associated with the probability of having missing time to post-operative consultations ($p > 0.05$).

Eligible variables for multivariate meta-regressions were “Date of publication”; “Study design”; “Specialty”; “Country of study”; “Contamination class” and “Status of the population included”.

Performing the backward selection algorithm, the variables “study design”, “country of study”, “contamination class” and “status of the population included” were removed.

The final multivariate meta-regression performed on “Date of publication” and “Specialty” showed an effect of time with a significant association with the prevalence of SSI (coefficient – 0.001, $p=0.04$). Specialty tended to be associated (coefficient 0.029, $p=0.064$, see **Table III** for more details).

We observed an effect of time with a significantly higher prevalence in studies conducted before 1990-91 [55, 67, 100, 106] than after 1990-91 (highest prevalence in 1975, 6.4% (95% CI [3.9; 10.4]) [67] and lowest in 2016, 0.04% (95% CI [0.03; 0.08]) [107]).

Discussion

In our meta-analysis of 90 studies, which included a majority of observational studies, the estimated overall prevalence of SSI following day surgery was quite low at 1.36% (95% CI [1.1; 1.6]) with a Bayesian probability of having a prevalence comprised between 1 and 2 % of 96.5 %. Heterogeneity was very high (above 50 %) and could be explained by each variable included in the analysis. The heterogeneity could also be due to other, non-tested variables. Sensitivity analysis did not show any differences in prevalence for studies that were duplicated or for studies with a very large population.

The date of publication was still associated with SSI prevalence in multivariate analysis (Coefficient -0.001, $p=0.040$ (95% CI [-0.0019; -0.000045])). the ECDC report showed a decrease in SSI whatever type of surgery and the country [111]. However, this decrease was shown only over 2 (2010-2011) or 4 years (2008-2011) that doesn't represents a long period. Several authors including Rioux et al [112] have also noted a statistically significant decrease of surgical site infection rates, over time The time trend of Rioux's study is six years, while

ours is about 25 years (not including the 1975 study). Finally, Rioux's study is based on national surveillance data, while our meta-analysis takes international data into account.

Since the study by Haley et al [113], it is well known that infection surveillance, regardless of anatomical site, contributes to the reduction of healthcare associated infections, over time. In our meta-analysis, there is a statistically significant downward trend.

It could be thought that studies with a large population (more than 10 000 subjects) might influence the results for the overall prevalence of SSI [4, 21, 22, 42, 43, 60, 62, 63, 70, 71, 74, 76, 79, 107]. However, as shown in the sensitivity analyses, which were performed by removing each study one by one, did not change the overall prevalence, it is likely that the huge studies did not influence the results. The biggest, published by Keyes *et al.* in 2004, was based on an analysis of Internet databases from the American Association for the Accreditation of Ambulatory Surgery Facilities. More than 400,000 patients undergoing day surgery were included in this study in which general and infectious complications were screened. Less than 1% of SSI was diagnosed in this cohort of plastic and reconstructive surgery [62].

Removing the biggest studies, 979,866/1,342,167 patients (i.e. 70%), led to no significant difference in prevalence (overlapping confidence intervals). Moreover, on the 94 sets of data analysed, only two were correlated; indeed, Owens reported the same outcome at two different times (14 days and 30 days post intervention)[22]. However, there was no impact on the global prevalence as shown in the sensitivity analysis.

An effect of the specialty (digestive vs non-digestive surgery) tended to be observed either in univariate meta-regression ($p = 0.059$) and in the multivariate meta-regression ($p=0.064$).

No other explicative variable influenced the overall prevalence. Surprisingly, whereas the specialty tended to be associated with SSI prevalence, contamination class was not ($p= 0.96$).

In this meta-analysis, the global prevalence of SSI in patients undergoing digestive day surgery was 3.6%; (95% CI [2.4; 5.0]). It is difficult to compare the prevalence of SSI in day surgery with that in conventional surgery since data provided by ECDC surveillance are stratified by specific type of surgery. For example, the incidence of SSI after cholecystectomy in conventional surgery was 1.4% (95% CI, estimated by us as: 1.3; 1.5) in 2010-2011 [111]. Moreover, the comparison between the two prevalences might be limited by a potential underestimation in conventional surgery. Indeed, we can suppose that national prevalence/incidence rates could be underestimated since data are provided by voluntary services. Rücker *et al.* provided evidence that the German KISS ICU surveillance network tended to underestimate the true incidence rates of nosocomial infections in German Intensive Care Units [114]. It could be the same with SSI.

Few data are available in the literature concerning the comparison of prevalence of SSI between day surgery and conventional surgery. We found a global prevalence of SSI of 2.1% (95% CI [0.2 ; 5.0]) following day surgery versus 0.1 % (95% CI [0.0 ; 1.7] following conventional surgery. There was no significant difference (overlapping confidence interval). It was confirmed using the Bayesian method (1.46% (95% CrI [0.6 ; 5.6]) following day surgery versus 2.8% (95% CrI [0.0 ; 24.1]) following conventional surgery).

Day surgery is known to result in fewer postoperative complications, especially SSI but this has to be further confirmed.

Patients undergoing day surgery are usually healthier (ASA score I or II) than inpatients as they are able to go to the hospital and have fewer common SSI risk factors (age, emergency surgery, contamination class, operative time) [4, 32, 91, 107]. This has also been advocated by Bona *et al.*, Majholm *et al* and Goyal *et al.* This could lead to selection bias towards lower complications, including SSI. As mentioned in the IAAS “The patient and their carer should be able to understand the planned procedure and subsequent postoperative care. The patient

should be either fully fit or chronic diseases such as asthma, diabetes, hypertension or epilepsy should be well controlled. Patients should be selected according to their physiological status as found at assessment” [8].

We used the prevalence of SSI because patients’ follow-up is rarely available (around 50 % i.e. $n=51/94$). However, patients’ follow-up is necessary to calculate an incidence rate. As a reminder, incidence is defined as “number of disease onset/sum of persons-time spent in population” [115].

Information on standardized and reproducible monitoring criteria was not often available.

This can lead to a kind measurement bias in the definition of the disease (SSI). We hypothesized that this bias was non-differential. An example of a differential bias would be the existence of a relationship between the year of publication of articles and the use of standardized monitoring criteria. We showed, that there was no statistically significant variation in prevalence rates according to the year of publication via meta-regression.

If information on standardized or non-standardized surveillance modalities had been available, a subgroup meta-analysis or meta-regression would have allowed this variable ("use of a standardized definition of surveillance") to be taken into account in adjusting the estimate of the prevalence rate of SSI.

The definitions of SSI and method of post-discharge surveillance must be taken into account as it can differ between studies and thus lead to bias in estimating the overall prevalence [116, 117]. Several methods for detecting SSI have been proposed. For example, some of them take into account the existence of antibiotic therapy. This is the case with studies by Yoko et al [118, 119]. Such data were not available in the studies analyzed in our meta-analysis.

This study has some limitations. Firstly, a high degree of heterogeneity was observed and variables included in the meta-regression could not explain this heterogeneity.

Moreover, major risk factors of SSI such as the ASA score, 75^e percentile of operative time or median age were not provided in all of the studies. However, these variables could probably explain in part the heterogeneity we found.

Several potential sources of heterogeneity have not been studied because they were lacked: revision surgery; antibiotic prophylaxis; ASA score and others.

We can also think that at-risk and dirty surgeries are less often done in day surgery. This could lead to a smaller number of such interventions, thus contributing to the asymmetry we observed. Moreover, this asymmetry is probably due to the very high heterogeneity.

Thirdly, the majority of the studies included were observational studies. There were only five randomized clinical trials, thus inducing a potential methodological bias [9, 40, 54, 61, 73].

This study is the first meta-analysis to assess the prevalence of SSI following day surgery, which may be useful either for the practice of surgeons and for national campaigns promoting day surgery. This is the first meta-regression to investigate the influence of all the main SSI factors. This is the first meta-analysis to use a frequentist and a Bayesian approaches on this topic.

Conclusion

Our main result is that overall SSI prevalence was low, around 1.36%, and probably lower than the prevalence of SSI in conventional surgery. This result was confirmed using a Bayesian model with uninformative priors that support the robustness of the methodology.

Huge heterogeneity has been shown in this analysis, thus, it would be important to complete a precise methodological framework for surveillance. It is necessary to have good quality studies in the field of day surgery patient in order to be able to estimate precisely infectious or non-infectious complications, taking into account potential confounding factors.

Further studies are needed to better understand the predictive factors associated with SSI prevalence following day surgery in comparison with inpatients following the same type of surgical procedure in order to develop specific infection control strategies.

References

- [1] Barie PS Infection control practices in ambulatory surgical centers. *JAMA* 2010; **303**: 2295-7.
- [2] Surgery AfA. AMBULATORY (DAY) SURGERY Suggested international terminology and definitions. 2003.
- [3] Olsen MA, Tian F, Wallace AE *et al.* Use of Quantile Regression to Determine the Impact on Total Health Care Costs of Surgical Site Infections Following Common Ambulatory Procedures. *Ann Surg* 2017; **265**: 331-9.
- [4] Majholm B, Engbæk J, Bartholdy J *et al.* Is day surgery safe? A Danish multicentre study of morbidity after 57,709 day surgery procedures. *Acta Anaesthesiol Scand* 2012; **56**: 323-31.
- [5] Badia JM, Casey AL, Petrosillo N, Hudson PM, Mitchell SA, Crosby C Impact of surgical site infection on healthcare costs and patient outcomes: a systematic review in six European countries. *Journal of Hospital Infection* 2017; **96**: 1-15.
- [6] Broex ECJ, van Asselt ADI, Bruggeman CA, van Tiel FH Surgical site infections: how high are the costs? *J Hosp Infect* 2009; **72**: 193-201.
- [7] O'Keeffe AB, Lawrence T, Bojanic S Oxford craniotomy infections database: a cost analysis of craniotomy infection. *Br J Neurosurg* 2012; **26**: 265-9.
- [8] Surgery IAfA. IAAS Homepage. 2014.
- [9] Osuigwe AN, Ekwunife CN, Ihekowba CH Use of prophylactic antibiotics in a paediatric day-case surgery at NAUTH, Nnewi, Nigeria: a randomized double-blinded study. *Trop Doct* 2006; **36**: 42-4.
- [10] Ahmad NZ, Byrnes G, Naqvi SA A meta-analysis of ambulatory versus inpatient laparoscopic cholecystectomy. *Surg Endosc* 2008; **22**: 1928-34.

- [11] Hopkins B, Steward D Outpatient thyroid surgery and the advances making it possible. *Curr Opin Otolaryngol Head Neck Surg* 2009; **17**: 95-9.
- [12] Moher D, Liberati A, Tetzlaff J, Altman DG, Group P Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Int J Surg* 2010; **8**: 336-41.
- [13] Umscheid CA A Primer on Performing Systematic Reviews and Meta-analyses. *Clin Infect Dis* 2013; **57**: 725-34.
- [14] Stroup DF, Berlin JA, Morton SC *et al.* Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. *JAMA* 2000; **283**: 2008-12.
- [15] Freeman MF, Tukey JW Transformations Related to the Angular and the Square Root. *The Annals of Mathematical Statistics* 1950; **21**: 607-11.
- [16] DerSimonian R, Kacker R Random-effects model for meta-analysis of clinical trials: an update. *Contemp Clin Trials* 2007; **28**: 105-14.
- [17] IntHout J, Ioannidis JPA, Borm GF The Hartung-Knapp-Sidik-Jonkman method for random effects meta-analysis is straightforward and considerably outperforms the standard DerSimonian-Laird method. *BMC Medical Research Methodology* 2014; **14**: 25.
- [18] Egger M, Davey Smith G, Schneider M, Minder C Bias in meta-analysis detected by a simple, graphical test. *BMJ* 1997; **315**: 629-34.
- [19] Stata. Stata Statistical Software: Release 14. College Station, TX: StataCorp, LP 2015.
- [20] Team RC. R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing 2014.

- [21] Manian FA, Meyer L Surgical-site infection rates in patients who undergo elective surgery on the same day as their hospital admission. *Infect Control Hosp Epidemiol* 1998; **19**: 17-22.
- [22] Owens PL, Barrett ML, Raetzman S, Maggard-Gibbons M, Steiner CA Surgical site infections following ambulatory surgery procedures. *JAMA* 2014; **311**: 709-16.
- [23] Putnam LR, Levy SM, Johnson E *et al.* Impact of a 24-hour discharge pathway on outcomes of pediatric appendectomy. *Surgery* 2014; **156**: 455-61.
- [24] Aguayo P, Alemayehu H, Desai AA, Fraser JD, St. Peter SD Initial experience with same day discharge after laparoscopic appendectomy for nonperforated appendicitis. *Journal of Surgical Research* 2014; **190**: 93-7.
- [25] Alkhoury F, Burnweit C, Malvezzi L *et al.* A prospective study of safety and satisfaction with same-day discharge after laparoscopic appendectomy for acute appendicitis. *Journal of Pediatric Surgery* 2012; **47**: 313-6.
- [26] Al-Qahtani HH, Alam MK, Asalamah S, Akeely M, Ibrar M Day-case laparoscopic cholecystectomy. *Saudi Med J* 2015; **36**: 46-51.
- [27] Amici JM, Rogues AM, Lasheras A *et al.* A prospective study of the incidence of complications associated with dermatological surgery. *Br J Dermatol* 2005; **153**: 967-71.
- [28] Astfalk W, Häcker FM, Kirschner HJ, Stuhldreier G, Schweizer P [Hospital ambulatory pediatric surgery]. *Zentralbl Chir* 1997; **122**: 898-900.
- [29] Athey N, Gilliam AD, Sinha P, Kurup VJ, Hennessey C, Leaper DJ Day-case breast cancer axillary surgery. *Ann R Coll Surg Engl* 2005; **87**: 96-8.
- [30] Audry G, Johanet S, Achrafi H, Lupold M, Gruner M The risk of wound infection after inguinal incision in pediatric outpatient surgery. *Eur J Pediatr Surg* 1994; **4**: 87-9.

- [31] Bergenfelz A, Jansson S, Kristoffersson A *et al.* Complications to thyroid surgery: results as reported in a database from a multicenter audit comprising 3,660 patients. *Langenbecks Arch Surg* 2008; **393**: 667-73.
- [32] Bona S, Monzani R, Fumagalli Romario U, Zago M, Mariani D, Rosati R Outpatient laparoscopic cholecystectomy: a prospective study on 250 patients. *Gastroenterol Clin Biol* 2007; **31**: 1010-5.
- [33] Bray D, Young JP, Harries ML Complications after type one thyroplasty: is day-case surgery feasible? *J Laryngol Otol* 2008; **122**: 715-8.
- [34] Brebbia G, Boni L, Dionigi G *et al.* Surgical site infections in day surgery settings. *Surg Infect (Larchmt)* 2006; **7 Suppl 2**: S121-3.
- [35] Bringman S, Anderberg B, Heikkinen T *et al.* Outpatient laparoscopic cholecystectomy. A prospective study with 100 consecutive patients. *Ambul Surg* 2001; **9**: 83-6.
- [36] Brosseuk DT, Bathe OF Day-care laparoscopic appendectomies. *Can J Surg* 1999; **42**: 138-42.
- [37] Chok KSH, Yuen WK, Lau H, Lee F, Fan ST Outpatient laparoscopic cholecystectomy in Hong Kong Chinese -- an outcome analysis. *Asian J Surg* 2004; **27**: 313-6.
- [38] de Boisanger L, Blackwell N, Magos T, Adamson R, Hilmi O Day case hemithyroidectomy is safe and feasible: experience in Scotland. *Scott Med J* 2015; **60**: 239-43.
- [39] Dionigi G, Rovera F, Boni L, Dionigi R Surveillance of surgical site infections after thyroidectomy in a one-day surgery setting. *Int J Surg* 2008; **6 Suppl 1**: S13-5.
- [40] Dirksen CD, Schmitz RF, Hans KM, Nieman FH, Hoogenboom LJ, Go PM
[Ambulatory laparoscopic cholecystectomy is as effective as hospitalization and from

- a social perspective less expensive: a randomized study]. *Ned Tijdschr Geneesk* 2001; **145**: 2434-9.
- [41] Dooley WC Ambulatory mastectomy. *The American Journal of Surgery* 2002; **184**: 545-8.
- [42] Edmonston DL, Foulkes GD Infection rate and risk factor analysis in an orthopaedic ambulatory surgical center. *J Surg Orthop Adv* 2010; **19**: 174-6.
- [43] Engbaek J, Bartholdy J, Hjortsø NC Return hospital visits and morbidity within 60 days after day surgery: a retrospective study of 18,736 day surgical procedures. *Acta Anaesthesiol Scand* 2006; **50**: 911-9.
- [44] Engel AF, Eijssbouts QA, Ephraim EP [Same-day diathermic hemorrhoidectomy in 48 patients; few complications and tolerable pain]. *Ned Tijdschr Geneesk* 2000; **144**: 328-32.
- [45] Engledow AH, Sengupta N, Akhras F, Tutton M, Warren SJ Day case laparoscopic incisional hernia repair is feasible, acceptable, and cost effective. *Surg Endosc* 2007; **21**: 84-6.
- [46] Fernández-Jorge B, Peña-Penabad C, Vieira V *et al.* Outpatient dermatology major surgery: a 1-year experience in a Spanish tertiary hospital. *J Eur Acad Dermatol Venereol* 2006; **20**: 1271-6.
- [47] Gabrielli F, Potenza C, Puddu P, Sera F, Masini C, Abeni D Suture materials and other factors associated with tissue reactivity, infection, and wound dehiscence among plastic surgery outpatients. *Plast Reconstr Surg* 2001; **107**: 38-45.
- [48] Gaillard M, Tranchart H, Lainas P, Tzanis D, Franco D, Dagher I Ambulatory laparoscopic minor hepatic surgery: Retrospective observational study. *Journal of Visceral Surgery* 2015; **152**: 292-6.

- [49] Gilliam AD, Anand R, Horgan LF, Attwood SE Day case emergency laparoscopic appendectomy. *Surg Endosc* 2008; **22**: 483-6.
- [50] Grøgaard B, Kimsås E, Raeder J Wound infection in day-surgery. *Ambul Surg* 2001; **9**: 109-12.
- [51] Guy RJ, Ng CE, Eu K-W Stapled anoplasty for haemorrhoids: a comparison of ambulatory vs. in-patient procedures. *Colorectal Dis* 2003; **5**: 29-32.
- [52] Hashemi K, Blakeley CJ Wound infections in day-case hand surgery: a prospective study. *Ann R Coll Surg Engl* 2004; **86**: 449-50.
- [53] Hirsemann S, Sohr D, Gastmeier K, Gastmeier P Risk factors for surgical site infections in a free-standing outpatient setting. *Am J Infect Control* 2005; **33**: 6-10.
- [54] Hollington P, Toogood GJ, Padbury RT A prospective randomized trial of day-stay only versus overnight-stay laparoscopic cholecystectomy. *Aust N Z J Surg* 1999; **69**: 841-3.
- [55] Hugar DW, Newman PS, Hugar RW, Spencer RB, Salvino K Incidence of postoperative infection in a free-standing ambulatory surgery center. *J Foot Surg* 1990; **29**: 265-7.
- [56] Ilie CP, Luscombe CJ, Smith I, Boddy J, Mischianu D, Golash A Day case laparoscopic nephrectomy: initial experience. *J Med Life* 2011; **4**: 36-9.
- [57] Ivaldi L, Perino M, Gambetta G *et al.* [Day Surgery. Five years of experience and activity]. *Minerva Chir* 2003; **58**: 149-55.
- [58] Jain A, Mercado PD, Grafton KP, Dorazio RA Outpatient laparoscopic appendectomy. *Surg Endosc* 1995; **9**: 424-5.
- [59] Jensen CD, Gilliam AD, Horgan LF, Bawa S, Attwood SE Day-case laparoscopic Nissen fundoplication. *Surg Endosc* 2009; **23**: 1745-9.

- [60] Jiang H, Han J, Lu A, Liu X Day surgery management model in china: practical experience and initial evaluation. *Int J Clin Exp Med* 2014; **7**: 4471-4.
- [61] Keulemans Y, Eshuis J, de Haes H, de Wit LT, Gouma DJ Laparoscopic cholecystectomy: day-care versus clinical observation. *Ann Surg* 1998; **228**: 734-40.
- [62] Keyes GR, Singer R, Iverson RE *et al.* Analysis of outpatient surgery center safety using an internet-based quality improvement and peer review program. *Plast Reconstr Surg* 2004; **113**: 1760-70.
- [63] Klug W [Ambulatory surgery in the hospital--analysis of a 1978-1994 patient sample]. *Zentralbl Chir* 1995; **120**: 598-603.
- [64] Kurzer M, Belsham PA, Kark AE Tension-free mesh repair of umbilical hernia as a day case using local anaesthesia. *Hernia* 2004; **8**: 104-7.
- [65] Lam D, Miranda R, Hom SJ Laparoscopic cholecystectomy as an outpatient procedure. *J Am Coll Surg* 1997; **185**: 152-5.
- [66] Lau H, Lee F An audit of the early outcomes of ambulatory inguinal hernia repair at a surgical day-care centre. *Hong Kong Med J* 2000; **6**: 218-20.
- [67] Lewis AA Outpatient surgery in a developing country. *Lancet* 1975; **1**: 910-2.
- [68] Lieng M, Istre O, Langebrekke A, Jungersen M, Busund B Outpatient laparoscopic supracervical hysterectomy with assistance of the lap loop. *J Minim Invasive Gynecol* 2005; **12**: 290-4.
- [69] Lim S, Jordan SW, Jain U, Kim JYS Predictors and causes of unplanned re-operations in outpatient plastic surgery: a multi-institutional analysis of 6749 patients using the 2011 NSQIP database. *J Plast Surg Hand Surg* 2014; **48**: 270-5.
- [70] Manian FA, Meyer L Adjunctive use of monthly physician questionnaires for surveillance of surgical site infections after hospital discharge and in ambulatory

- surgical patients: report of a seven-year experience. *Am J Infect Control* 1997; **25**: 390-4.
- [71] Martín-Ferrero MA, Faour-Martín O, Simon-Perez C, Pérez-Herrero M, de Pedro-Moro JA Ambulatory surgery in orthopedics: experience of over 10,000 patients. *J Orthop Sci* 2014; **19**: 332-8.
- [72] Materazzi G, Dionigi G, Berti P *et al.* One-day thyroid surgery: retrospective analysis of safety and patient satisfaction on a consecutive series of 1,571 cases over a three-year period. *Eur Surg Res* 2007; **39**: 182-8.
- [73] Mattila K, Vironen J, Eklund A, Kontinen VK, Hynynen M Randomized clinical trial comparing ambulatory and inpatient care after inguinal hernia repair in patients aged 65 years or older. *The American Journal of Surgery* 2011; **201**: 179-85.
- [74] Mezei G, Chung F Return hospital visits and hospital readmissions after ambulatory surgery. *Ann Surg* 1999; **230**: 721-7.
- [75] Minatti WR, Perriello J, Dicaprio M, Pierini L, Mendiburo A Postoperative outcomes in ambulatory surgery: Are they the same, worse or better? *Ambul Surg* 2002; **10**: 17-9.
- [76] Mlangeni D, Babikir R, Dettenkofer M, Daschner F, Gastmeier P, Rüden H AMBU-KISS: quality control in ambulatory surgery. *Am J Infect Control* 2005; **33**: 11-4.
- [77] Nagpal K, Glore RJ, Chong PL *et al.* Day-case re-do varicose vein surgery. *Phlebology* 2014; **29**: 355-7.
- [78] Obalum DC, Eyesan SU, Ogo CN, Atoyebi OA Day-case surgery for inguinal hernia: a multi-specialist private hospital experience in Nigeria. *Nig Q J Hosp Med* 2008; **18**: 42-4.
- [79] Orosco RK, Lin HW, Bhattacharyya N Ambulatory thyroidectomy: a multistate study of revisits and complications. *Otolaryngol Head Neck Surg* 2015; **152**: 1017-23.

- [80] Paradela S, Pita-Fernández S, Peña C *et al.* Complications of ambulatory major dermatological surgery in patients older than 85 years. *J Eur Acad Dermatol Venereol* 2010; **24**: 1207-13.
- [81] Pardhan A, Mazahir S, Alvi AR, Murtaza G Surgical site infection following hernia repair in the day care setting of a developing country: a retrospective review. *J Pak Med Assoc* 2013; **63**: 760-2.
- [82] Proske JM, Dagher I, Revitea C *et al.* Day-case laparoscopic cholecystectomy: results of 211 consecutive patients. *Gastroenterol Clin Biol* 2007; **31**: 421-4.
- [83] Pugely AJ, Martin CT, Gao Y, Mendoza-Lattes SA Outpatient surgery reduces short-term complications in lumbar discectomy: an analysis of 4310 patients from the ACS-NSQIP database. *Spine* 2013; **38**: 264-71.
- [84] Rajeev P, Sutaria R, Ezzat T, Mihai R, Sadler GP Changing trends in thyroid and parathyroid surgery over the decade: is same-day discharge feasible in the United Kingdom? *World J Surg* 2014; **38**: 2825-30.
- [85] Rambachan A, Matulewicz RS, Pilecki M, Kim JYS, Kundu SD Predictors of Readmission following Outpatient Urological Surgery. *The Journal of Urology* 2014; **192**: 183-8.
- [86] Ranieri E, Caprio G, Fobert MT *et al.* One-day surgery in a series of 150 breast cancer patients: efficacy and cost-benefit analysis. *Chir Ital* 2004; **56**: 415-8.
- [87] Rhee C, Huang SS, Berríos-Torres SI *et al.* Surgical site infection surveillance following ambulatory surgery. *Infect Control Hosp Epidemiol* 2015; **36**: 225-8.
- [88] Sahai A, Symes A, Jeddy T Short-stay thyroid surgery. *Br J Surg* 2005; **92**: 58-9.
- [89] Sahin C, Aksoy Y, Ozbey I, Polat O Outpatient urethrocutaneous fistula repair with local anesthesia in adult patients. *Ann Plast Surg* 2003; **50**: 378-81.

- [90] Sahmkow SI, Audet N, Nadeau S, Camiré M, Beaudoin D Outpatient thyroidectomy: safety and patients' satisfaction. *J Otolaryngol Head Neck Surg* 2012; **41 Suppl 1**: S1-12.
- [91] Sewonou A, Rioux C, Golliot F *et al.* [Incidence of surgical site infection in ambulatory surgery: results of the INCISCO surveillance network in 1999-2000]. *Ann Chir* 2002; **127**: 262-7.
- [92] Shah P, Mohanty SR, Dewoolkar VV, Changlani TT Ambulatory surgery for hydrocele: a review of 200 cases. *Ambul Surg* 1995; **3**: 87-9.
- [93] Shaikh I, Willder JM, Kumar S Same day discharge, surgical training and early complications after open and laparoscopic repair of primary paraumbilical hernia. *Hernia* 2013; **17**: 505-9.
- [94] Snyder SK, Hamid KS, Roberson CR *et al.* Outpatient Thyroidectomy Is Safe and Reasonable: Experience with More than 1,000 Planned Outpatient Procedures. *J Am Coll Surg* 2010; **210**: 575-82.
- [95] Spiegelman JIMD, Levine RHMDCM Abdominoplasty: A Comparison of Outpatient and Inpatient Procedures Shows That It Is a Safe and Effective Procedure for Outpatients in an Office-Based Surgery Clinic. *Plastic & Reconstructive Surgery* 2006; **118**: 517-22.
- [96] Stevens WG, Gear AJL, Stoker DA *et al.* Outpatient reduction mammoplasty: an eleven-year experience. *Aesthet Surg J* 2008; **28**: 171-9.
- [97] Tan LR, Guenther JM Outpatient definitive breast cancer surgery. *Am Surg* 1997; **63**: 865-7.
- [98] Trottier DC, Barron P, Moonje V, Tadros S Outpatient thyroid surgery: should patients be discharged on the day of their procedures? *Can J Surg* 2009; **52**: 182-6.

- [99] Usang UE, Sowande OA, Adejuyigbe O, Bakare TIB, Ademuyiwa OA Day case inguinal hernia surgery in Nigerian children: prospective study. *Afr J Paediatr Surg* 2008; **5**: 76-8.
- [100] Vallières E, Pagé A, Verdant A [Mediastinoscopy in ambulatory surgery: nine years' experience]. *Ann Chir* 1991; **45**: 778-82.
- [101] van Boxel GI, Hart M, Kiszely A, Appleton S Elective day-case laparoscopic cholecystectomy: a formal assessment of the need for outpatient follow-up. *Ann R Coll Surg Engl* 2013; **95**: e142-6.
- [102] Velhote CE, de Oliveira Velhote TF, Velhote MC, Moura DC Early discharge after appendicectomy in children. *Eur J Surg* 1999; **165**: 465-7.
- [103] Vilar-Compte D, Roldán R, Sandoval S *et al.* Surgical site infections in ambulatory surgery: A 5-year experience. *Am J Infect Control* 2001; **29**: 99-103.
- [104] Weltz CR, Greengrass RA, Lyerly HK Ambulatory surgical management of breast carcinoma using paravertebral block. *Ann Surg* 1995; **222**: 19-26.
- [105] Young MR, Humphries WG, Grainger DJ Local anaesthesia for inguinal herniorrhaphy--a neglected technique. *Ir J Med Sci* 1994; **163**: 287-9.
- [106] Zoutman D, Pearce P, McKenzie M, Taylor G Surgical wound infections occurring in day surgery patients. *Am J Infect Control* 1990; **18**: 277-82.
- [107] Goyal KS, Jain S, Buterbaugh GA, Imbriglia JE The Safety of Hand and Upper-Extremity Surgical Procedures at a Freestanding Ambulatory Surgery Center: A Review of 28,737 Cases. *J Bone Joint Surg Am* 2016; **98**: 700-4.
- [108] Holmes J, Readman R A study of wound infections following inguinal hernia repair. *J Hosp Infect* 1994; **28**: 153-6.
- [109] Chapter IV Factors Influencing the Incidence of Wound Infection. *Ann Surg* 1964; **160**: 32-81.

- [110] Altemeier WA, Culbertson WR, Hummel RP Surgical Considerations of Endogenous Infections — Sources, Types, and Methods of Control. *Surgical Clinics of North America* 1968; **48**: 227-40.
- [111] Ecdc. Surveillance of surgical site infections in Europe 2010–2011. 2013.
- [112] Rioux C, Grandbastien B, Astagneau P Impact of a six-year control programme on surgical site infections in France: results of the INCISO surveillance. *Journal of Hospital Infection* 2007; **66**: 217-23.
- [113] Haley RW, Culver DH, White JW *et al.* THE EFFICACY OF INFECTION SURVEILLANCE AND CONTROL PROGRAMS IN PREVENTING NOSOCOMIAL INFECTIONS IN US HOSPITALS. *Am J Epidemiol* 1985; **121**: 182-205.
- [114] Rücker G, Schoop R, Beyersmann J, Schumacher M, Zuschneid I Are KISS data representative of German intensive care units? Statistical issues. *Methods Inf Med* 2006; **45**: 424-9.
- [115] Andersen PK Modern Epidemiology. 2nd edn. Kenneth J. Rothman and Sander Greenland, Lippincott-Raven, U.S.A., 1998. No. of pages: 737. Price: \$74.50. ISBN 0-316-75780-2. *Statist Med* 2000; **19**: 881-2.
- [116] Lepelletier D, Ravaud P, Baron G, Lucet J-C Agreement among health care professionals in diagnosing case Vignette-based surgical site infections. *PLoS One* 2012; **7**: e35131.
- [117] Wilson APR, Gibbons C, Reeves BC *et al.* Surgical wound infection as a performance indicator: agreement of common definitions of wound infection in 4773 patients. *BMJ* 2004; **329**: 720.
- [118] Yokoe DS, Noskin GA, Cunningham SM *et al.* Enhanced Identification of Postoperative Infections among Inpatients. *Emerg Infect Dis* 2004; **10**: 1924-30.

- [119] Yokoe DS, Shapiro M, Simchen E, Platt R Use of Antibiotic Exposure to Detect Postoperative Infections. *Infection Control & Hospital Epidemiology* 1998; **19**: 317-22.

Table I. Description of variables presented in subgroup analyses

Subgroups	Number of studies (n=94)	Proportion (%)	Pooled prevalence (%) from subgroup analyses	95 % IC*	I ² between subgroups (p value)
Date of publication	94		1.36	1.10 – 1.60	0.00
1975	1	1.1	6.4	3.60 – 10.40	
1990	2	2.1	4.0	2.60 – 5.60	
1991	1	1.1	0.5	0.01 – 3.00	
1994	3	3.2	2.4	0.20 – 6.10	
1995	4	4.3	3.9	0.00 – 15.10	
1997	4	4.3	2.5	0.50 – 5.60	
1998	3	3.2	0.006	0.00 – 0.01	
1999	4	4.3	2.9	0.00 – 11.70	
2000	2	2.1	0.6	0.00 – 2.00	
2001	5	5.3	2.2	1.50 – 3.00	
2002	3	3.2	0.6	0.02 – 1.60	
2003	3	3.2	1.3	0.00 – 7.60	
2004	5	5.3	1.5	0.09 – 4.00	
2005	6	6.4	1.9	0.50 – 4.10	
2006	5	5.3	1.0	0.08 – 2.70	
2007	4	4.2	1.5	0.00 – 5.10	
2008	7	7.4	2.8	1.30 – 4.70	
2009	2	2.1	1.0	0.10 – 2.50	
2010	3	3.2	1.6	0.10 – 4.60	
2011	2	2.1	2.5	0.00 – 9.10	
2012	3	3.2	0.9	0.02 – 2.50	
2013	4	4.2	4.9	0.10 – 10.60	
2014	12	12.8	0.7	0.30 – 1.20	
2015	5	5.3	0.3	0.00 – 0.90	

2016	1	1.1	0.04	0.02 – 0.08	
Country of study					0.00
USA and Canada	33	35.11	0.6	0.4 – 0.80	
UK	17	18.09	4.3	2.2 – 6.80	
Europe	29	30.85	1.3	0.5 – 2.30	
Other countries	15	15.96	2.6	0.8 – 5.10	
Study design					0.04
RCT	5	5.32	2.8	1.1 – 5.18	
Observational studies	89	94.68	1.3	1.1 – 1.60	
Type of specialty					0.00
Digestive surgery	36	38.71	3.6	2.4 – 5.00	
Thyroid surgery	11	11.83	0.7	0.2 – 1.40	
Other surgical specialties	28	30.11	1.5	0.8 – 2.50	
Multiple specialties	18	19.35	0.9	0.5 – 1.30	
Specialty (grouped)					0.00
Digestive surgery	36	38.30	3.8	2.5 – 5.21	
Non-digestive surgery	58	61.70	0.87	0.6 – 1.15	
Class of contamination					0.00
Clean and clean-contaminated	69	74.19	1.0	0.8 – 1.30	
Contaminated and dirty	5	5.38	3.0	0.4 – 7.40	
Combined	19	20.43	2.0	0.9 – 3.40	
Status of the population					0.00
Children	82	87.23	2.6	1.3 – 4.30	
Adults	10	10.64	1.2	0.9 – 1.50	
Combined	2	2.13	7.3	4.5 – 10.60	
Duration of hospital care					
Less than 12 hours	8	8.5	**	**	
Less than 23 hours	25	26.6	**	**	
Not Available	61	64.9	**	**	

* CI: Confidence Interval ** Parameters could not be estimated because of the amount of missing data

***RCT: Randomized Clinical Trial

Table II. Time between day surgery and post-operative consultations in the study population sorted by year

Authors	Year	Population	Post-operative consultation 1 (Days)	Number of subjects 1	Post-operative consultation 2* (Weeks)	Number of subjects 2
Lewis et al [67]	1975	233	7	233	NA	NA
Zoutman et al [106]	1990	515	30	NA	NA	NA
Young et al [105]	1994	99	10	10	6 to 8	NA
Weltz et al [104]	1995	16	10	NA	NA	NA
Keulemans et al [61]	1998	37	7	NA	6	NA
Manian et al [21]	1998	3661	30	NA	NA	NA
Manian et al [21]	1998	3580	30	NA	NA	NA
Mezei et al [74]	1999	17638	30	NA	NA	NA
Velhote et al [102]	1999	124	2	NA	4 days	NA
Hollington et al [54]	1999	60	7	NA	NA	NA
Lau et al [66]	2000	265	1	NA	3 days	NA
Gabrielli et al [47]	2001	1000	3	NA	1	NA
Vilar-Compte et al [103]	2001	1350	30	NA	NA	NA
Grøgaard et al [50]	2001	642	7	4	4	18
Sewonou et al [91]	2002	5183	15	NA	3	NA
Minatti et al [75]	2002	223	13	NA	4	NA
Chok et al [37]	2004	64	1	NA	3 days	NA
Hashemi et al [52]	2004	1003	5	4	2	7
Kurzer et al [64]	2004	54	7	NA	2 to 6 years	NA
Mlangeni et al [76]	2005	16045	30	NA	NA	NA
Hirsemann et al [53]	2005	1095	46	NA	NA	NA
Lieng et al [68]	2005	41	1	NA	3 to 4	NA
Sahai et al [88]	2005	104	1	NA	NA	NA
Brebbia et al [34]	2006	226	7	NA	2	NA
Osuigwe et al [9]	2006	140	5	NA	NA	NA
Spiegelman et al [95]	2006	32	2 to 3	NA	2	NA

Engbaek et al [43]	2006	13907	60	NA	NA	NA
Bona et al [32]	2007	206	1	NA	2 days	NA
Proske et al [82]	2007	211	1	NA	1 to 2	NA
Dionigi et al [39]	2008	112	5	2	1	1
Usang et al [99]	2008	88	4	NA	2	NA
Obalum et al [78]	2008	72	7	NA	2 years	NA
Bergenfels et al [31]	2008	3660	7 to 42	NA	24	NA
Trottier et al [98]	2009	232	1	NA	2	NA
Jensen et al [59]	2009	113	2	NA	NA	NA
Snyder et al [94]	2010	1064	30	NA	NA	NA
Ilie et al [56]	2011	14	30	NA	NA	NA
Mattila et al [73]	2011	46	15	46	NA	NA
Alkhoury et al [25]	2012	126	14	NA	NA	NA
van Boxel et al [101]	2013	211	30	NA	NA	NA
Pugely et al [83]	2013	1652	30	NA	NA	NA
Martin-Ferrero et al [71]	2014	10032	2	NA	1	NA
Owens et al [22]	2014	284098	14	877	NA	NA
Owens et al [22]	2014	284098	30	1376	NA	NA
Jiang et al [60]	2014	14484	1	NA	3 days	NA
Putnam et al [23]	2014	42	14	NA	4	NA
Putnam et al [23]	2014	75	14	NA	4	NA
Putnam et al [23]	2014	195	14	NA	4	NA
Lim et al [69]	2014	6624	30	NA	NA	NA

*Time between post-operative consultation and day surgery is given in weeks; otherwise, the unit is detailed

**NA: Not Available

Table III. Univariate and multivariate meta-regressions of the prevalence of SSI following day surgery using the REML method to calculate Tau (n=94)

Variable	Univariate analysis			Multivariate analysis	
	Coefficient (95 CI %)	p value ^a	I ² (%)	Coefficient (95 CI %)	p value ^b
Date of publication^{a-b}	-0.001 (-0.0021 ; -0.0006)	0.037	45.41	-0.001 (-0.002 ; -0.00004)	0.04
Time of first follow up	0.0017 (-0.0022 ; 0.00556)	0.39			
Duration of hospital care					
Less than 12 hours	ref				
Less than 23 hours	0.0087 (-0.0336 ; 0.05089)	0.685			
Not available	0.0045 (-0.0341 ; 0.04317)	0.816			
Global test		0.89			
Country of study			40.42		
USA and Canada	-0.006 (-0.035 ; 0.023)	0.67			
UK	0.018 (-0.026 ; 0.063)	0.40			
Europe	0.002 (-0.027 ; 0.032)	0.86			
Other countries	ref				
Global test		0.46			0.86
Study design			46.67		0.92
Randomized Control Trials (RCT)	0.017 (-0.094 ; 0.128)	0.75			

Observational studies	ref			
Type of specialty		45.98		
Digestive surgery	ref			
Thyroid surgery	-0.034 (-0.073 ; 0.004)	0.074		
Other surgical specialties	-0.027 (-0.061 ; 0.007)	0.12		
Multiple specialties	-0.030 (-0.062 ; 0.002)	0.07		
Global test		0.29		0.27
Specialty (Grouped)^a				
Digestive surgery ^a	0.030 (-0.001 ; 0.062)	0.059	0.029 (-0.001 ; 0.061)	0.064
Non-digestive surgery	ref		ref	
Contamination class		45.03		
Clean and clean-contaminated	ref			
Contaminated and Dirty	0.014 (-0.046 ; 0.074)	0.64		
Combined	0.007 (-0.009 ; 0.023)	0.41		
Global test		0.65		0.96
Status of population included		46.74		
Children	-0.003 (-0.029 ; 0.023)	0.79		
Adults	ref			
Combined	0.06 (-0.054 ; 0.179)	0.29		

Global test

0.55

0.33

^a Significant p value < 0.25

^b Significant p value < 0.05

Figure 1.

Figure 2a

Figure 2b

Figure 3.

Legends for illustrations:

Figure.1. Flow-chart showing the study selection process.

Figure. 2a and 2b. Forest plot

Figure. 3. Funnel plot of the meta-analysis of the prevalence of SSI following day surgery.

Supplementary material online

Appendix A. Characteristics of each study included

Appendix B. Overall estimated prevalence of SSI using a Bayesian model

Appendix C. Cumulative meta-analysis including studies from the oldest to the most recent, using Sidik-Jonkman method to estimate Tau

Acknowledgements

We thank Philip Bastable for editing assistance.

Conflict of interest

No conflict of interest to disclose

Source of funding

No funding to disclose.

Disclosure

All authors have approved the final article