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An original article entitled

The influence of preoperative vaginal cleansing on postoperative infectious morbidity in abdominal total hysterectomy for benign indications. A study from the Swedish national register for gynecological surgery.

by

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Running title: *Vaginal cleansing and postoperative infections*

Abstract

Objective: To evaluate whether vaginal cleansing reduces the risk of postoperative infection after abdominal total hysterectomy on benign indications and to analyze risk factors.

Design: Retrospective cohort study.

Setting: All clinics including patients in the Swedish National Register for Gynecological Surgery.

Population: All 7193 women who underwent abdominal total hysterectomy for benign indications during 2000 to 2007.

Methods: Information on clinic routines for preoperative vaginal cleansing was obtained retrospectively in a postal survey. Associations between routines for vaginal cleansing and structured data from the Register were analyzed by means of multivariate logistic regression models. The main effect variable was postoperative infections defined as infections treated with antibiotics within 6-8 weeks postoperatively, reported by the patient or the physician.

Main Outcome Measures: Prevalence and risk factors for postoperative infections.

Results: Prevalence of postoperative infections was 14.4%. The prevalence did not differ between those having had vaginal cleansing using chlorhexidine and those without vaginal cleansing, whereas using saline solution was encumbered with a significantly increased risk. Risk factors for postoperative infections were age > 60, obesity, smoking, weight of the uterus, duration of hospital stay, blood transfusion and peroperative injury of the urinary bladder or ureter.

Conclusion: Vaginal cleansing using chlorhexidine solution did not reduce the risk of postoperative infections, whereas vaginal cleansing using saline solution seemed to increase the risk. Some risk factors for postoperative infectious morbidity seem to be preventable.

Key words: hysterectomy; national register; postoperative infections; risk factor; vaginal cleansing

Introduction

Hysterectomy is encumbered with significant morbidity. Postoperative infections after hysterectomy are often reported (1,2) and arise primarily as ascending spread of microorganism from the upper vagina (3). In order to minimize this complication a strategy to reduce the bacteria pre- and peroperatively seems relevant. Prophylactic antibiotic use is considered to significantly reduce morbidity (4,5). However, other measures, such as preoperative vaginal cleansing, are practiced to reduce morbidity. Vaginal cleansing was not noted in the studies mentioned above and interpretation of the results may therefore be incorrect since vaginal cleansing may have been a confounding factor.

Information concerning the effect of vaginal cleansing on postoperative infectious morbidity is conflicting and large randomized controlled studies comparing vaginal disinfection with no vaginal preparation are lacking (6). Vaginal cleansing is not consistently used preoperatively in benign hysterectomy in all hospitals in Sweden and there seems to be a trend towards omitting it. It is therefore important to analyze whether preoperative vaginal disinfection is necessary or not in order to reduce postoperative morbidity before abandoning the practice.

By combining data from the Swedish National Register for Gynecological Surgery (7) and information from a survey on preoperative preparation routines among all clinics in Sweden conducting benign abdominal hysterectomies, we aimed to evaluate whether preoperative vaginal cleansing was associated with a reduced risk of postoperative infectious morbidity after benign abdominal total hysterectomy and to analyze associated risk factors.

Material and methods

This is a retrospective cohort study of women registered in the Swedish National Register of Gynecological Surgery during the period January 1, 2000 to December 31, 2007 who underwent abdominal total hysterectomy on benign indication. Forty clinics enrolled women in the national register during the time period. Information about vaginal cleansing routines, i.e. the exposure, was collected retrospectively. In May 2006 the clinics answered an e-mail survey concerning routines for preoperative vaginal preparation in benign abdominal total hysterectomy. In case the vaginal preparation had changed during the study period the clinic was required to give information about in which month and year the change had occurred. To cover the entire study period the e-mail survey was repeated in May 2008. In the first e-mail survey, the clinics were asked to report whether they used vaginal cleansing preoperatively during the period January 1, 2000 to December 31, 2005 and which disinfectant was used. In the second e-mail survey the questions were repeated and additional questions asked concerning change of routine in the period between the surveys.

A total of 7193 women were registered in the National Register as having undergone abdominal total hysterectomy on benign indication during the period and these women constituted the study group.

Data registration in the Swedish National Register of Gynecological Surgery has been carried out since 1996 and a detailed description of the register of hysterectomy on benign indications has been published previously (4). Briefly, data in the register are collected prospectively using doctors' forms and patient questionnaires. Patients are included in the register prior to surgery. Pre-, per- and postoperative data during the hospital stay comprise patient age, body mass index (BMI), smoking habits, date and duration of surgery, mode of skin incision, peroperative bleeding volume, occurrence of peroperative organ damage,

occurrence of concomitant bilateral salpingo-oophorectomy, weight of uterus, use of prophylactic antibiotics per-operatively, occurrence of blood transfusion, duration of hospital stay and occurrence of re-operation. At discharge data are registered about postoperative infectious morbidity and treatments during the hospital stay. The infections comprise *A*) febrile morbidity (temperature $>38^{\circ}\text{C}$ for > 2 days); *B*) abdominal wall wound infection; *C*) vaginal cuff infection; *D*) lower urinary tract infection (UTI); *E*) upper UTI; *F*) intraabdominal infection; and *G*) sepsis.

The clinics routinely sent postoperative questionnaires to patients approximately six weeks after the hysterectomy and the completed questionnaires were returned approximately eight weeks after surgery. The questionnaire contained the following questions about postoperative infections and treatment: Have you had *a*) temperature more than 38°C for more than 2 days; *b*) urinary tract infections; *c*) pelvic infection with purulent discharge; *d*) wound infection; *e*) pelvic abscess; *f*) sepsis; *g*) other infections; and *h*) no infection? For treatment of postoperative complications the options were: 1) no treatment; 2) follow-up visit and/or further investigations; 3) treatment with antibiotics; 4) treatment with analgesics; 5) wound bandaging and dressing; and 6) other treatment. The patient could indicate more than one alternative for these questions.

In this study only those with postoperative infections registered at discharge from the hospital or who indicated at least one of the alternatives *b* to *f* in the postal questionnaire and were treated with antibiotics according to the questionnaire or indicated by the physician in follow-up visits, were considered to have postoperative infectious morbidity. The postoperative infectious morbidity was categorized as postoperative infection (UTI not included), UTI, and no infection. Consequently, since an individual may have a postoperative infection (UTI excluded) concomitant with a UTI, overall postoperative infection was defined as a condition with either postoperative infection (UTI not included) or UTI.

The study was approved by the Regional Ethics Board of Linköping University.

Statistical analysis

Nominal data are presented as number and frequency, and continuous data as mean and standard deviation (SD). Univariate analyses were carried out with Student's-test (two-sided) for continuous data and Yates corrected chi-squared tests or Fishers exact test for nominal data. Level of significance was set at $p < 0.05$.

Multiple logistic regression analyses models were used to analyze associations between factors influencing occurrence of postoperative infectious morbidity. In these models, adjustments were carried out for known or potential confounding factors of postoperative infectious morbidity: age, BMI, smoking, per-operative bleeding volume, duration of hospital stay, occurrence of intestinal injury per-operatively and use of prophylactic antibiotics. These confounding factors were entered simultaneously in the models in the first step. Secondly, additional potential confounding factors were analyzed in the above mentioned models by testing them one by one in order to evaluate the predictive value of these factors in the occurrence of overall postoperative infectious morbidity treated with antibiotics.

The results are presented as odds ratios (ORs) with 95% confidence interval (CI). Statistical analyses were performed using Statview[®], version 5.01.

Results

Fig. 1 illustrates the flow chart of the population and relation to use and mode of vaginal cleansing. The information about routines of vaginal preparation revealed complete agreement between the two e-mail surveys. In the survey nine of the 40 clinics (22.5%) stated that they presently did not use preoperative vaginal cleansing for benign abdominal total hysterectomy. Two of these clinics changed method from vaginal cleansing (one from chlorhexidine and one from saline solution) to no vaginal cleansing during the period. Besides, one clinic changed method from chlorhexidine to saline solution. The median number of women enrolled in the register from each clinic was 147 (range 4 – 509).

The baseline demographics and clinical data are presented in Table I. Significant differences were observed in several aspects between the women who had vaginal cleansing preoperatively (chlorhexidine as well as saline) and those who did not, as shown in Table I.

The prevalence and associations of postoperative infectious morbidity treated with antibiotics registered at discharge from the hospital and in the questionnaire in relation to use and mode of vaginal cleansing are depicted in Tables II and III, respectively.

The multivariate analyses models showed that those who had vaginal cleansing using saline solution had a significantly increased risk of lower and upper UTI, vaginal cuff infection and overall infectious morbidity ($B - G$) registered at discharge from the hospital. Contrary, those who had vaginal cleansing using chlorhexidine had a significantly reduced risk of intra-abdominal infection at discharge.

The overall postoperative infection rate requiring antibiotic treatment within six weeks after abdominal total hysterectomy was 14.4% (893/6084). No significant associations were observed between postoperative infections and/or UTI within six weeks and vaginal cleansing

Table I. Demographic and clinical data from 7193 women with abdominal total hysterectomy on benign indications split up after mode of preoperative vaginal cleansing. Univariate analyses.

Characteristic		A	B	C	<i>p</i> -value A vs. B	<i>p</i> -value A vs. C	<i>p</i> -value B vs. C
		No vaginal cleansing (n = 790)	Vaginal cleansing using chlorhexidine (n = 6043)	Vaginal cleansing using saline (n = 360)			
Age (years)		49.6 ± 9.2	47.8 ± 7.8	47.7 ± 7.2	<0.0001	0.0005	0.7908
Age groups	< 40	85 (11%)	665 (11%)	34 (9%)	<0.0001*	0.0003*	0.5374*
	≥ 40 and < 50	358 (45%)	3215 (54%)	198 (55%)			
	≥ 50 and < 60	245 (31%)	1710 (28%)	109 (30%)			
	≥ 60	102 (13%)	393 (7%)	19 (6%)			
BMI (kg/m ²)		26.3 ± 13.1	25.8 ± 5.1	25.9 ± 4.4	0.0964	0.6346	0.7722
BMI groups	< 25	350 (49%)	2690 (49%)	165 (49%)	0.6044*	0.1465*	0.2792*
	≥25 and <30	259 (36%)	1934 (35%)	108 (32%)			
	≥ 30	100 (14%)	854 (16%)	62 (19%)			
Smoking	Yes	147 (20%)	1460 (25%)	95 (27%)	0.0010‡	0.0070‡	0.4718‡
	No	597 (80%)	4268 (75%)	252 (73%)			
Season of the year	Winter	177 (22%)	1550 (25%)	101 (28%)	0.1064*	0.1897*	0.2389*
	Spring	234 (30%)	1804 (30%)	94 (26%)			
	Summer	110 (14%)	708 (12%)	51 (14%)			
	Autumn	269 (34%)	1981 (33%)	114 (32%)			
Duration of surgery (minutes)		88 ± 34	88 ± 34	82 ± 29	0.5735	0.0029	0.0033
Bleeding volume (mL)		323 ± 405	347 ± 357	312 ± 425	0.0763	0.6944	0.0859
Skin incision	Midline	216 (32%)	1403 (29%)	70 (32%)	<0.0001*	0.0100*	0.5592*
	Pfannenstiel	316 (46%)	2654 (55%)	122 (55%)			
	Joel-Cohen	153 (22%)	736 (16%)	28 (13%)			
Concomitant BSOE	Yes	220 (28%)	1091 (18%)	55 (15%)	<0.0001‡	<0.0001‡	0.2062‡
	No	570 (72%)	4952 (82%)	305 (85%)			
Peroperative organ injury	Urinary bladder	6 (0.76%)	47 (0.78%)	4 (1.11%)	>0.9999†	>0.5142†	0.5319†
	Intestinal	3 (0.38%)	24 (0.40%)	1 (0.28%)	>0.9999†	>0.9999†	>0.9999†
	Ureter	4 (0.51%)	16 (0.26%)	0 (0%)	0.2791†	0.3157†	>0.9999†
Weight of uterus (g)		404 ± 424	460 ± 457	423 ± 390	0.0015	0.4882	0.1510
Use of antibiotic prophylaxis	Yes	762 (96.5%)	5026 (83%)	300 (83%)	<0.0001*	<0.0001*	0.9625*
	No	25 (3%)	778 (13%)	45 (12.5%)			
	No information	3 (0.4%)	239 (4%)	15 (4.5%)			
Blood transfusion (no. of patients)	Yes	56 (8%)	469 (9%)	10 (4%)	0.2271‡	0.0449‡	0.0046‡
	No	679 (92%)	4713 (91%)	254 (96%)			
Duration of hospital stay (days)		3.2 ± 2.2	3.5 ± 2.3	3.9 ± 2.6	0.0001	<0.0001	0.0015

Figures are mean ± 1 standard deviation (SD) or number and proportion. BMI body mass index; BSOE bilateral salpingoophorectomy. Information about characteristics is partially lacking for some patients. * Yates corrected Chi-square test; df = 3. † Yates corrected Chi-square test, df = 2. ‡ Yates corrected Chi-square test; df = 1. † Fishers exact test. Student's t-tests are used for comparing continuous variables between the groups.

Table II. Associations between mode of vaginal cleansing and postoperative infectious morbidity registered at discharge from hospital in 7046 women. Multivariate analyses.

	Infectious morbidity	Proportion registered as treated with antibiotics or penicillin at discharge	Mode of vaginal cleansing	No of women with the infectious morbidity (n and (%))	OR and (95% CI)*
<i>A</i>	Fever > 38° C >2 days	79% (80/101)	No vaginal cleansing	13 (1.67%)	1
			Chlorhexidine	82 (1.39%)	0.59 (0.31 – 1.10)
			Saline	6 (1.69%)	0.81 (0.29 – 2.24)
<i>B</i>	Lower UTI	81% (62/77)	No vaginal cleansing	10 (1.29%)	1
			Chlorhexidine	57 (0.96%)	0.79 (0.35 – 1.79)
			Saline	10 (2.82%)	2.66 (0.96 – 7.37)
<i>C</i>	Upper UTI	100% (2/2)	No vaginal cleansing	0 (0%)	NA
			Chlorhexidine	1 (0.02%)	1
			Saline	1 (0.28%)	19.85 (1.15 – 342.84)
<i>D</i>	Vaginal cuff infection	79% (15/19)	No vaginal cleansing	0 (0%)	NA
			Chlorhexidine	14 (0.24%)	1
			Saline	5 (1.41%)	5.79 (1.78 – 18.82)
<i>E</i>	Abdominal wound infection	81% (29/36)	No vaginal cleansing	3 (0.39%)	1
			Chlorhexidine	33 (0.56%)	1.83 (0.41 – 8.16)
			Saline	0 (0%)	NA
<i>F</i>	Intraabdominal infection	90% (9/10)	No vaginal cleansing	3 (0.39%)	1
			Chlorhexidine	6 (0.10%)	0.21 (0.04 – 0.99)
			Saline	1 (0.30%)	0.67 (0.06 – 7.54)
<i>G</i>	Sepsis	100% (2/2)	No vaginal cleansing	1 (0.13%)	NA
			Chlorhexidine	1 (0.02%)	NA
			Saline	0 (0%)	NA
<i>B-G</i>	Any infectious morbidity	81% (114/140)	No vaginal cleansing	16 (2.06%)	1
			Chlorhexidine	108 (1.83%)	0.94 (0.49 – 1.82)
			Saline	16 (4.52%)	2.55 (1.11 – 5.86)

CI = confidence interval. NA = not applicable. OR = odds ratio. UTI = urinary tract infection. *Adjusted for age, BMI, smoking, peroperative bleeding volume, duration of hospital stay, occurrence of intestinal injury peroperatively, and use of prophylactic antibiotics.

Table III. Associations between mode of vaginal cleansing and postoperative infectious morbidity treated with antibiotics registered by the physician at discharge from the hospital or at follow up visits, or by the patient in the postal questionnaire for 6084 women. Multivariate analyses.

Mode of vaginal cleansing	Postoperative infections (UTI not included)		UTI		Overall postoperative infection	
	Number of cases and (%)	OR and (95% CI)*	Number of cases and (%)	OR and (95% CI)*	Number of cases and (%)	OR and (95% CI)*
No vaginal cleansing (n=670)	71 (10.6%)	1	35 (5.2%)	1	96 (14.3%)	1
Chlorhexidine (n=5118)	564 (11.2%)	0.94 (0.70 – 1.25)	275 (5.4%)	1.11 (0.74 – 1.66)	734 (14.3%)	0.92 (0.72 – 1.19)
Saline solution (n=296)	45 (15.2%)	1.43 (0.92 – 2.22)	32 (10.8%)	2.36 (1.36 – 4.11)	63 (22.0%)	1.54 (1.05 – 2.27)

UTI = urinary tract infection.

Overall postoperative infection was defined as a condition with either postoperative infection (UTI not included) or UTI.

*Adjusted for age, BMI, smoking, peroperative bleeding volume, duration of hospital stay, occurrence of intestinal injury peroperatively, and use of prophylactic antibiotics.

using chlorhexidine compared with no vaginal cleansing as depicted in Table III. Contrarily, the use of saline solution was significantly associated with overall postoperative infection and UTI. For postoperative infection (UTI not included) the association was of borderline significance (OR 1.52; 95%CI 0.98 – 2.37; $p = 0.0606$).

Complete data concerning postoperative infectious morbidity in women treated with antibiotics at discharge and from the six weeks postoperative questionnaire or reported by the physician were available from 6,084 women (85%).

The predictive values of the factors in the multivariate analyses are shown in Table IV. Vaginal cleansing using saline solution, age under 60, obesity, smoking, injury of the urinary bladder or ureter per-operatively, blood transfusion and duration of hospital stay exceeding three days were all independent risk factors for postoperative infectious morbidity. Having a large uterus was significantly associated with less postoperative infectious morbidity. The calendar year and season of the year were not associated with postoperative infections (data not shown). In the multivariate analysis of the influence of the individual clinics on postoperative infectious morbidity only three of the 40 clinics demonstrated significant associations with overall postoperative infections. Two clinics revealed significantly lower prevalence of postoperative infectious morbidity and one clinic presented a significantly higher prevalence. Otherwise the prevalence of postoperative infections did not differ significantly between any of the remaining 37 clinics (data not shown).

The use of prophylactic antibiotics was not an independent prognostic factor for postoperative infectious morbidity.

Table IV. Predictive factors for postoperative infectious morbidity treated with antibiotics after abdominal total hysterectomy on benign indication. Multivariate analyses.

Predictive factor		OR and (95% CI)*	P-value	
Vaginal cleansing	Not done	1		
	Chlorhexidine solution	0.92 (0.72 – 1.19)	0.5299	
	Saline solution	1.54 (1.05 – 2.27)	0.0276	
Age groups	< 40	1		
	≥ 40 and < 50	0.79 (0.62 – 1.02)	0.0701	
	≥ 50 and < 60	0.77 (0.59 – 1.01)	0.0549	
	≥ 60	0.51 (0.33 – 0.78)	0.0017	
BMI groups	< 25	1		
	≥25 and <30	1.16 (0.97 – 1.38)	0.1019	
	≥ 30	1.59 (1.29 – 1.98)	< 0.0001	
Smoking	No	1		
	Yes	1.46 (1.23 – 1.74)	< 0.0001	
Duration of surgery (min)	< 60 minutes	1		
	≥ 60 and < 90 min	0.97 (0.76 – 1.22)	0.7661	
	≥ 90 and < 120 min	0.85 (0.66 – 1.10)	0.2169	
	≥ 120 min	1.12 (0.83 – 1.51)	0.4545	
Volume of bleeding	< 150 mL	1		
	≥ 150 and < 500 mL	1.05 (0.86 – 1.28)	0.6253	
	≥ 500 and < 1000 mL	1.09 (0.85 – 1.40)	0.5066	
	≥ 1000 mL	1.37 (0.95 – 1.09)	0.0914	
Skin incision	Midline	1		
	Pfannenstiel	1.15 (0.94 – 1.41)	0.1808	
	Joel-Cohen	1.03 (0.79 – 1.36)	0.8227	
Concomitant BSOE	Yes	1		
	No	0.94 (0.75 – 1.19)	0.6106	
Peroperative organ injury	Urinary bladder	No	1	
		Yes	2.17 (1.05 – 4.50)	0.0365
	Intestinal	No	1	
		Yes	1.53 (0.49 – 4.72)	0.4627
	Ureter	No	1	
		Yes	12.02 (2.26 – 64.38)	0.0035
Weight of uterus	< 100 g	1		
	≥ 100 and < 500 g	0.88 (0.67 – 1.15)	0.3519	
	≥ 500 g	0.69 (0.51 – 0.93)	0.0135	
Prophylactic antibiotics	No	1		
	Yes	0.86 (0.68 – 1.08)	0.1916	
Blood transfusion	No	1		
	Yes	1.52 (1.12 – 2.07)	0.0067	
Duration of hospital stay	≤ 3 days	1		
	4 – 7 days	2.18 (1.85 – 2.57)	< 0.0001	
	≥ 8 days	5.85 (3.89 – 8.79)	< 0.0001	

BMI body mass index; BSOE bilateral salpingo-oophorectomy.

*Adjusted for age, BMI, smoking, peroperative bleeding volume, duration of hospital stay, occurrence of intestinal injury peroperatively, use of prophylactic antibiotics and mode of vaginal cleansing.

Discussion

This study indicates that preoperative vaginal cleansing using chlorhexidine does not reduce the risk of postoperative infectious morbidity clinically or statistically significantly in the immediate as well as the long term postoperative period compared with no use of vaginal cleansing. In contrast, vaginal cleansing using saline solution seems to be a strong risk factor for postoperative infectious morbidity in the immediate as well as long-term postoperative period. After adjustment for other known confounding factors and vaginal cleansing, prophylactic antibiotic use was not found to be an independent risk-reducing factor for postoperative infections.

The large body of material in this study strengthens the importance of the results. The Swedish National Register of Gynecological Surgery is well described and the reliability of the patient questionnaires has been evaluated (5,7,8). We obtained information on the preoperative routines of vaginal cleansing retrospectively from all clinics, participating in the register. This may be a weak point in this study, since there is a risk of recall bias. However, we believe that this problem is minimal in this study since we asked about the vaginal preparation routines on two occasions with a 2-year interval and found complete agreement between the answers. The clinical data were obtained individually whereas information about vaginal cleansing was obtained from each clinic. The compliance to the clinical routine of vaginal cleansing is not known. Usually the operation room nurse performs the antiseptic routines, including vaginal cleansing, surgical cleansing and dressing before the start of surgery in Sweden. This may speak in favor of a high compliance to the clinical routine. The results of this study are based on the assumption that compliance was complete. Although lack of data was observed in the register, there was a high completion rate (85%) from the 6-8 week follow-up questionnaire. Consequently, we assume that the results may be generalized.

To the best of our knowledge no randomized trials comparing vaginal antiseptics using chlorhexidine with other antiseptics or placebo in abdominal total hysterectomy for benign conditions have been published. Sowapat et al. compared chlorhexidine with povidone iodine in a non-randomized study but found no significant difference in febrile morbidity between the two methods (9). In an open randomized trial comparing chlorhexidine and povidone iodine as antiseptics for vaginal hysterectomy Culligan et al. found that the chlorhexidine group had lower mean colony counts of bacteria in the upper vagina than the povidone iodine group for a longer time period after vaginal cleansing (10). Vaginal cleansing using povidone iodine has been shown to reduce postoperative infections significantly in abdominal hysterectomy (11,12). However, there is still a lack of knowledge about which antiseptic is most effective in abdominal total hysterectomy and the timing of the vaginal cleansing has not been investigated. Culligan et al. (13) found that the highest bacterial colony counts in the vagina were seen 30-90 minutes after vaginal cleansing, possible implicating this as the “weakest link” of standard infection prophylaxis protocol. In our study we have no detailed information of exactly when the vaginal cleansing was carried out in relation to start of surgery or what dilution of the chlorhexidine was used. These issues may be of importance.

Lower UTI is associated with transurethral indwelling catheter use (14,15). We were not able to adjust our results for catheter use since no information about catheter use or duration was available in the register. Usually a transurethral indwelling catheter is used in abdominal hysterectomy in Sweden. The result should therefore be interpreted with certain precaution.

The magnitude of bacterial contamination during abdominal hysterectomy is an important determinant in the development of postoperative infectious morbidity (16). Vaginal cleansing using saline solution has been suggested to reduce the quantity of bacteria by simple dilution (17). In our study vaginal cleansing using saline solution seemed to be a relatively

strong risk factor for postoperative infectious morbidity in the immediate postoperative course as well as in long-term. It is plausible that the possible immediate dilution effect of vaginal cleansing with saline solution on the quantity of bacteria may interfere with the recovery of the normal vaginal bacterial flora leading to a disturbed flora in the recovery period.

Surprisingly, we found that use of prophylactic antibiotics was not an independent risk factor for development of postoperative infections when adjusted for known and potential confounding factors and vaginal cleansing. Several studies have emphasized the importance of prophylactic antibiotics for reducing postoperative infectious morbidity in abdominal and vaginal hysterectomies (5,18,19,21). No adjustments were made for vaginal cleansing in these studies. The effect of prophylactic antibiotics may therefore have been overestimated. In our study we have no detailed information about type, timing, and mode of administration of the prophylactic antibiotics which may be important issues for development of postoperative infections (21,22). A misreport in the register of use of prophylactic antibiotics is also possible and cannot be ruled out. Our result concerning effect of antibiotic prophylaxis must consequently be interpreted with precaution.

We adjusted the results for factors known to be confounding factors for postoperative infectious morbidity after hysterectomy (5,21,23,24). Because of the obvious risk of postoperative infection with intra-abdominal intestinal bacterial contamination after intestinal injury, we also included per-operative bowel injury as an independent variable in the multivariate analyses. In accordance with other publications we found that postoperative infectious morbidity was strongly associated with age, BMI, smoking, obesity and length of the hospital stay (5,21,23,24). Injury to the urinary bladder or ureter per-operatively was also strongly associated with postoperative infectious morbidity. This may simply be explained by the prolonged use of catheter for bladder drainage during the healing time. Information about the association between excessive bleeding volume and postoperative infectious morbidity is

not unanimous (21,23). Our study showed in accordance with the finding of DiLuigi et al. (21) no significant association between bleeding volume and postoperative infectious morbidity. Blood transfusion was a risk factor for postoperative infection in our study. According to the meta-analysis by Vamvakas, information about this in the literature is ambiguous (25). In the present study a large uterus was a protective factor for postoperative infectious morbidity. This may be explained by the fact that the surgeons experience influences the risk of postoperative complications (26). Although there is no information about the experience of the surgeon in the register it may be reasonable to believe that hysterectomy of a large uterus may be surgically technically more demanding and therefore the hysterectomy is performed by surgeons with high experience. Previous studies about postoperative infections after benign abdominal total hysterectomy have not taken the size of the uterus into consideration (5,19,20,23).

It may be difficult to further reduce the incidence of postoperative infections significantly by means of improving preventive procedures such as antibiotics and disinfection. Instead, the prevention should be focused on other risk factors such as smoking habits, obesity and surgical techniques. Smoking cessation and weight reduction of obese women preoperatively could be a requirement before abdominal hysterectomy on benign indications in order to reduce the incidence of postoperative complications. Furthermore, improved surgical skills for minimizing the surgical trauma and per-operative bleeding could help to reduce the need of peri-operative blood transfusions.

In conclusion this study implies that vaginal cleansing using chlorhexidine solution does not reduce the risk of postoperative infectious morbidity significantly. On the contrary, vaginal cleansing using saline solution seems to be encumbered with a higher risk of postoperative infectious morbidity. Some risk factors for postoperative infectious morbidity seem to be preventable. To further reduce postoperative infectious morbidity after

hysterectomy large controlled randomized studies should be encouraged to determine the efficacy of prophylactic antibiotics combined with measures of reducing risk factors.

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Disclosure of interests

Mats Löfgren is chairman for the Swedish National Register of Gynecological Surgery. For Preben Kjølhede and Shefqet Halili no conflicts of interest are reported.

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