Postoperative Nausea and Vomiting in Laparoscopic Versus Open Cholecystectomy at two Major Hospitals in Jamaica

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ABSTRACT

Postoperative nausea and vomiting (PONV) is a distressing and potentially dangerous complication of general anaesthesia with volatile agents. The internationally reported average risk is 20 to 30%. It has been suggested that Jamaicans have a generally low risk of PONV and this is plausible since ethnic-based differences in response to emetogenic stimuli have been identified. It has also been suggested that laparoscopy, by stretching and irritation of the peritoneum during gas insufflation, may be a risk factor for PONV but it has become increasingly difficult to test this hypothesis as fewer comparable open abdominal operations are being performed. This retrospective cohort study of PONV after laparoscopic versus open cholecystectomy was designed to answer these two questions. Data were collected on 356 cases performed at two major hospitals in Jamaica. The risk of PONV after laparoscopic and open cholecystectomy was 28.7% and 28.6% respectively.

As these are at the upper end of the internationally reported average range, the impression that PONV risk is generally low in Jamaicans is not supported. The finding that 81.4% of cases of PONV occurred only after discharge from the recovery room may explain the misconception.

There was no significant difference between the risk of PONV after laparoscopic versus open cholecystectomy and the effect of laparoscopy remained insignificant after risk-adjustment in a generalized linear regression model. Laparoscopy is not a major risk factor for PONV in this study.

Náusea y Vómito Postoperatorio (NVPO) en la Colecistectomía Laparoscópica Frente a la Colecistectomía Abierta en dos Hospitales Principales de Jamaica

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RESUMEN

La náusea y vómito postoperatorio (NVPO) es una complicación alarmante y potencialmente peligrosa de la anestesia general con agentes volátiles. El riesgo promedio reportado intencionalmente es de 20 a 30%. Se ha sugerido que los jamaicanos poseen un bajo riesgo de NVPO, y esto es plausible ya que se han identificado diferencias de base étnica en respuesta a los estímulos emetogénicos. También se ha sugerido que la laparoscopia, al extender e irritar el peritoneo durante la insuflación del gas, puede ser un factor de riesgo para la NVPO. Sin embargo, resulta que se ha hecho cada vez más difícil probar esta hipótesis, ya que el número de operaciones abdominales abiertas comparables que se están realizando es menor. Este estudio retrospectivo de cohorte a propósito de la NVPO luego de una colecistectomía laparoscópica en comparación con una abierta, fue diseñado para responder estas dos preguntas. Se recopilaron datos sobre los 356 casos operados en dos hospitales principales de Jamaica. El riesgo de NVPO después de la colecistectomía laparoscópica y la abierta, fue 28.7% y 28.6% respectivamente. Como que estas cifras se hallan en el extremo superior del rango promedio reportado internacionalmente, la impresión de que el riesgo de NVPO es generalmente bajo en los jamaicanos carece de fundamento. El hallazgo de que el 81.4% de los casos de NVPO ocurrieron solamente luego que el paciente fuera dado de alta de la sala de recuperación, puede explicar esta concepción errónea. No hubo diferencia significativa entre el riesgo de NVPO después de la colecistectomía laparoscópica frente a la abierta, y el efecto de la laparoscopia permaneció insig-

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nificante tras el ajuste de riesgo en un modelo de regresión lineal generalizado. La laparoscopia no constituye un factor de riesgo principal de NVPO en este estudio.

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INTRODUCTION

Postoperative nausea and vomiting (PONV) after general anaesthesia with volatile anaesthetic agents occurs at an average risk of 20% to 30% (1). Prevention of PONV is important as it can be very distressing with some sufferers preferring pain (2). In addition, it can cause serious complications such as oesophageal rupture, pneumothorax, incisional hernia and upper airway and lung dysfunction from aspiration of vomitus. PONV may result in delayed discharge from hospital or re-admission after outpatient surgery, including laparoscopic cholecystectomy, thereby increasing cost (3).

Risk factors for PONV may be individual, anaesthetic, surgical and postoperative variables, including female gender (2, 4, 5), timing of surgery in relation to the menstrual cycle (6), increasing age (2, 5), history of previous PONV or motion sickness (2, 4, 5), anxiety (7), volatile inhalation anaesthetic agents (8), nitrous oxide (9), reversal of non-depolarizing relaxants with neostigmine [unless given with atropine] (10), opioid analgesics (4), longer duration of surgery (5), uncontrolled pain (11), hypovolaemia and dehydration (12) and early postoperative motion, including ambulation (2). Early feeding may be a precipitant for vomiting but is not a cause of PONV (13) and nasogastric drainage has either had no effect on PONV (14) or appears to increase the risk (15). Ameliorating factors include a history of smoking (2–5), use of non-opioid pre-medication and propofol for induction of anaesthesia (16).

The risk of PONV may also vary by surgical site and type of operation, appearing to be higher after breast augmentation, strabismus repair, ENT operations including tonsillectomy, gynaecologic surgery, orthopaedic surgery and laparoscopic procedures (2, 5, 8) but Apfel *et al* (17) were unable to confirm any such association after adjustment for major risk factors by multivariable regression. Laparoscopy *per se* was not a risk factor for PONV in that study but there may have been inadequate power to detect a significant effect (only 42 cases of laparoscopic surgery). Stretching and irritation of the peritoneum from insufflation of gas during laparoscopy may be a specific emetogenic stimulus (18) and laparoscopy has been associated with a relatively high absolute risk of PONV in several reports (18–24) [Table 1.], particularly in gynaecology. In a study by Iitomi *et al* (18), the only one encountered in which the risk of PONV was compared for the same operation performed by laparoscopic *versus* open approaches, the risk of PONV during the first 17 hours post laparoscopic cholecystectomy was 25.7% *versus* 18.8% for open cholecystectomy but this difference did not reach statistical significance ($p = 0.24$) for a sample size of 202 (and power of 62% to detect a difference of 15% as significant at the 5% level).

This considerable range of risk factors for PONV notwithstanding, Apfel *et al* (4) have demonstrated that the four factors most predictive of PONV after adjustment for all plausible confounders in a multiple regression model, and which they have included in a validated index, are female gender, history of motion sickness or PONV, non-smoking and the use of postoperative opioids. The opportunity to determine prospectively whether the laparoscopic approach *per se* is another major risk factor by performing direct comparisons between open and laparoscopic approaches may well have passed in most hospitals (including those in this study), as the laparoscopic approach increasingly becomes standard of care. At the Cornwall Regional Hospital (CRH) and to a lesser extent at the University Hospital of the West Indies (UHWI), open cholecystectomy continues to be performed electively by some surgeons concurrently with laparoscopic cholecystectomy by others. There is no evidence of patient selection among surgeons who offer either procedure, thereby allowing for a fair, retrospective comparison of the risk of PONV after either approach.

Another question is whether the risk of PONV among Jamaicans, in whom African ancestry predominates, is significantly different from the risk reported from predominantly Caucasian populations. The anecdotal experience of anaesthetists in Jamaica is that the risk of PONV is far lower than it is in the United Kingdom. Ethnic difference in response to

Table 1: Risk of PONV after laparoscopic procedures

Study	Laparoscopic procedure	Risk of PONV
Iitomi *et al* (18)	Cholecystectomy	25.7%
Bodner and White (19)	General abdominal (mainly gynaecologic)	92%
Bradshaw *et al* (20)	Foregut surgery	30.1% in recovery room 59.6% in nursing unit
Bailey *et al* (21)	Laparoscopy	62%
Ruiz *et al* (22)	Cholecystectomy	47%
Wang *et al* (23)	Cholecystectomy	63%
Tseng *et al* (24)	Gynecologic surgery	59%

emetogenic influences is theoretically plausible as racial differences have been identified in the activity of the P450 enzyme CYP2D6 (25) which metabolizes some opiates and CYP2E1 (26) which metabolizes some anaesthetic agents. In poor metabolizers, the vomiting centre would be exposed to higher concentrations of these emetogenic drugs. Additionally, racial differences in susceptibility to motion sickness (27) imply racial differences in the response of the vomiting centre to neural stimuli as well.

However, there is insufficient scientific evidence to support this impression of a lower incidence of PONV among Jamaicans. Although Scarlett *et al* (28), in the only Jamaican study of PONV identified, reported a low incidence after tonsillectomy (13%, *versus* 40–80% in the international literature (29)), others have reported an even lower risk of 5% (30) after introduction of specific anti-emesis strategies. Tonsillectomy may therefore not be a good candidate operation to test for the average risk of PONV among Jamaicans. Soyannwo *et al* (31) found a risk of PONV among Nigerians of 41.6% (nausea) and 19.6% (vomiting), not significantly different from the internationally reported risk.

In this retrospective cohort study, the risk of PONV was determined for elective laparoscopic and open cholecystectomy respectively at two major hospitals in Jamaica and the risks compared. The risk-adjusted effect of the laparoscopic approach on PONV occurrence after cholecystectomy was also calculated.

SUBJECTS AND METHODS

The study was approved by the Ethics Committees of the Western Regional Health Authority and the Faculty of Medical Sciences – University of the West Indies/University Hospital of the West Indies.

Assuming a risk of PONV after open cholecystectomy of 30%, the number of cases needed for the study to achieve 80% power to detect a risk of PONV after laparoscopic cholecystectomy of 45% as significant at the 5% level is 175 in each group (Epi Info Version 3.3.2.). Cases were all operations in which elective cholecystectomy (open or laparoscopic) was the primary operation and in which the primary disease being treated was cholelithiasis. Exclusions included all open cholecystectomy operations which would not usually be performed by the laparoscopic approach at either hospital, such as emergency cholecystectomy for cholecystitis or empyema of the gallbladder, operations in which cholecystectomy was incidental or secondary to another major operation such as common bile duct exploration and cholecystectomy done for disease other than cholelithiasis (*eg* gallbladder cancer or pancreatitis). Laparoscopic cholecystectomies converted to open surgery were also excluded.

Cases were identified from operations registers from May 2007, retrograde to dates selected to achieve the requisite number of cases (Table 2). The name, record code number and date of operation were extracted from the register for each case. Records were then retrieved and the relevant data extracted onto a pre-coded form. Variables chosen for extraction were predominantly those known, suspected or plausibly associated with the risk of PONV.

Variables extracted were age, gender, surgical firm/hospital, systemic illness, estimated body mass index, presence of nasogastric tube and when removed (recovery room or ward), pre-medication, PONV prophylaxis, anaesthetic agents, duration of anaesthesia, peri-operative antibiotic, total narcotic analgesia from pre-medication to 24 hours after end of anaesthesia, PONV on operating table or recovery room, PONV on ward, time in recovery room, PONV treatment, time to last episode of PONV, time to first tolerated feeding and time to discharge from hospital. A case of PONV was any patient manifesting retching or vomiting or reporting nausea within 24 hours of the end of general anaesthesia. Relevant information was found by perusing doctors' notes, anaesthetic and recovery room charts and nurses' notes. The coded data were entered directly into a STATA (Version 8) database for statistical analysis.

Summary statistics and analyses include frequency of PONV (with confidence intervals) in elective, uncomplicated open cholecystectomy and laparoscopic cholecystectomy at either and both hospitals combined as well as chi-squared test of difference between proportions affected by PONV in each group. The effect of all plausible independent variables on PONV risk was examined individually using t-test and chi-squared test as appropriate. Similarly, the effect of "surgical approach" on each of these variables was determined. Possible interaction between surgical approach and hospital in their effect on PONV risk was examined, first by stratification by hospital (with chi-squared test in each stratum) and then in a crude linear regression model involving only these 3 variables plus the interaction term. This was the only interaction examined and the sole purpose was to determine whether it was legitimate to pool the results from both

Table 2: Distribution of cases by hospital and calendar period

	CRH		UHWI	
	Number	**Calendar period**	**Number**	**Calendar period**
Open Cholecystectomy	150	May, 2002–May, 2007	25	Mar, 2001–May, 2007
Lap Cholecystectomy	122	Jan, 1997–May, 2007	59	Mar, 2001–May, 2007

hospitals. No interactions were examined in the final regression model.

Independent variables achieving statistical significance at a *p*-value of 0.15 or less on univariate testing against either PONV or surgical approach were eligible for inclusion in a multivariable regression model of effect on PONV risk. Log-binomial linear regression was used to model the risk of PONV. A stepwise variable selection procedure was used to determine statistical significance of included terms. Variables achieving statistical significance at a *p*-value of 0.15 or less were considered model confounders and were retained in the final model. All other variables were dropped from the model.

RESULTS

Data were collected for 175 cases of open cholecystectomy (150 from CRH and 25 from UHWI) and 181 cases of laparoscopic cholecystectomy (122 from CRH and 59 from UHWI) for a total of 356 cases. Table 2 shows the calendar period over which cases were identified at both institutions. These figures do not represent the total number of eligible cases done at either institution during the calendar periods indicated. At both institutions, a small number of records identified from the operations registers were unavailable at the time of data retrieval. As cases could only be accurately classified after perusal of the records (since the operations register often did not state specifically whether the case was urgent or not, or converted laparoscopic cholecystectomy), it is impossible to quantify the cases from among missing records that would have been eligible for inclusion. Nevertheless, the range of possible missing records is 0–4% (6/156) and 0–2% (2/124) for open and laparoscopic cholecystectomy respectively at CRH and 0–17% (5/30) and 0–12% (8/67) for open and laparoscopic cholecystectomy respectively at UHWI, the upper limit of each range being the total number of records unavailable. Since these case records appeared to be missing at random (either misplaced by filing clerks or sent off to clinics) and therefore unlikely to result in any systematic selection bias by their omission, no extraordinary attempt was made to locate them.

Table 3a illustrates the distribution of independent variables. The continuous variables age (coded as > or ? 50 years), duration of anaesthesia (coded as > or ? 1.5 hours) and total narcotic dosage (coded as > or ? 175 mg) were dichotomized to facilitate statistical analysis. Only two patients (both in the laparoscopic group at CRH) received PONV prophylaxis (with granisetron) in the true sense of the practice – these were combined in the table and analysis with the group receiving dimenhydrinate with each injection of narcotic. Table 3b illustrates the distribution of postoperative nausea and vomiting by operative approach and hospital.

Table 4 illustrates the crude risks of PONV after pooling of the results from both hospitals. Pooling by surgical approach was justified on the basis that (a) there was no statistically significant difference between the age structure of cases in each category of operation by hospital ($p = 0.75$ and 0.22 by t-test for open and laparoscopic cholecystectomy respectively) (b) indications for open and laparoscopic cholecystectomy were similar at both hospitals and cases did not appear to be selected for either operative approach (c) there was no evidence of interaction (effect modification) between hospital and surgical approach on PONV risk, either after stratification by hospital ($p = 0.34$, test of homogeneity) or testing the interaction parameter in an unadjusted log-binomial regression model ($p = 0.23$, Wald test), the level of significance being set at 10% in recognition of the reduced power engendered by interaction tests.

There was no difference between the crude risks of PONV for laparoscopic and elective, open cholecystectomy ($p = 0.97$, chi-squared test). Variables not associated with PONV nor type of operation (the main outcome and exposure variables) at $p < 0.15$ by simple bivariate analysis (chi-squared and t-test where appropriate) were excluded from the final regression model except for hospital, which was included despite absence of significant effect, a procedure recommended for analysis of multicentre trials by Fleiss (32). Variables thereby excluded were estimated body mass index, PONV prophylaxis (dimenhydrinate with each dose of narcotic) and type of relaxant.

The laparoscopic approach was not associated with PONV in the crude, univariate log-binomial regression analysis at the 5% level (risk ratio 1.01; CI, 0.72, 1.4; $p = 0.97$). Age, systemic illness, nasogastric tube, reversal, perioperative antibiotic, duration of anaesthesia and total narcotic dosage from premedication to 24 hours post-anaesthesia were all eliminated from the model after stepwise inclusion because of lack of effect at $p < 0.15$. Premedication and inhalation anaesthetic agent had effects at $p < 0.15$ (but not at $p < 0.05$) and were included in the final model. The only variables associated with PONV in the final regression model (Table 5) at the 5% level were female gender (risk ratio 5.28; CI 1.37, 20.36; $p = 0.02$) and induction with propofol (risk ratio 1.61; CI, 1.06, 2.45; $p = 0.03$). The effect of laparoscopy inverted to risk ratio 0.87 after adjustment for gender, induction agent, premedication, inhalation agent and hospital but remained insignificant [$p = 0.43$] (Table 5).

PONV occurred only after discharge from the recovery room (*ie*, only on the wards) in 81.4% (83/102; CI 72.4, 88.4%) of cases, in both recovery room and ward in 12.7% (13/102; CI, 7, 20.8%) and only in recovery room in the remaining 5.9% (6/102; CI 2.2, 12.4%). The mean time spent in the recovery room by patients with PONV was 1.5 hours (CI 1.3, 1.7).

PONV was treated in only 25.5% (26/102) of cases (with dimenhydrinate in 21, metoclopramide in 4 and granisetron in 1). Fourteen of the treated patients (54%) vomited after treatment. There was no difference in the time to last recorded episode of PONV between those treated and those

Table 3a: Distribution of independent variables by hospital and surgical approach

	Hospital			
	CRH		UHWI	
	Lap	Open	Lap	Open
Number of cases	122	150	59	25
Age – Mean (Range)	41.6 (19 – 89)	43.7 (20 – 78)	44.8 (21 – 89)	47 (20 – 81)
Sex – No (%) female	116 (95.1%)	136 (90.7%)	51 (86.4%)	21 (84%)
Systemic illness – No (%)	41 (33.6%)	65 (43.3%)	16 (27.1%)	12 (48%)
Estimated BMI – No obese (%)	56 (45.9%)	70 (46.7%)	25 (42.4%)	14 (56%)
NG Tube – No (%)	90 (73.8%)	113 (75.3%)	18 (30.5%)	5 (20%)
Premedication – No (%)	85 (69.7%)	129 (86%)	22 (37.3%)	9 (36%)
***PONV Proph** – No (%)	8 (6.6%)	23 (15.3%)	41 (69.5%)	24 (96%)
Induct. with Propofol – No (%)	18 (14.8%)	11(7.3%)	44 (74.6%)	18 (72%)
****Relaxant (Sux)** – No (%)	50 (41%)	52 (34.7%)	4 (6.8%)	0 (0%)
*****Halothane** – No (%)	119 (97.5%)	148 (98.7%)	48 (81.4%)	21 (84%)
!! Reversal – No (%)	96 (78.7%)	107 (71.3%)	46 (78%)	14 (56%)
Duration anesth – Mean(range)	1.7 (0.6 – 3.3)	1.47 (0.75 – 3.58)	2.1 (1 – 4.5)	1.8 1(0.92 – 2.92)
Antibiotic – No (%)	92 (75.4%)	135 (90%)	32 (54.2%)	17 (68%)
Total narcotic – Mean(range)	111 (0 – 275)	182 (50 – 400)	223 (0 – 590)	358 (175 – 610)
Time to first oral intake – Mean /(range)	19 (4 – 144)	24.95(7 – 68)	12(2 – 25)	23.6(3.75 – 47)
Time to discharge – Mean (range)	40 (16 – 500)	54 (15 – 216)	28 (7 – 240)	46 (24 – 72)
Time in recovery room – Mean (range)	1.3 (0.3 – 6)	1.4 (0.3 – 7.5)	2.1 (0.3 – 7.8)	2.5 (1.1 – 7.4)

*Ponv proph = PONV prophylaxis. Only 2 patients out of 356 had true PONV prophylaxis with granisetron. These 2, in the laparoscopic group at CRH, were combined with the group reported here which received dimenhydrinate 25–50mg with each dose of narcotic.

**All patients received a non-depolarizing muscle relaxant but the group referred to here also received a dose of the depolarizing relaxant succinylcholine.

***Most patients received the volatile inhalation agent halothane, as shown here. The others received isoflurane or sevoflurane.

!! Reversal was with neostigmine and atropine.

All times are in hours.

Total narcotic dosage from immediately preoperative to 24 hours postoperative is measured in pethidine equivalency units in milligrams, where fentanyl 100 ?gm = pethidine 100 mg = morphine 10 mg.

Table 3b: Distribution of postoperative nausea and vomiting by hospital and surgical approach

	Hospital			
	CRH		UHWI	
	Lap	Open	Lap	Open
Number of cases	122	150	59	25
PONV OR/Recov Rm – No. (%)	6 (4.9%)	8 (5.3%)	5 (8.5%)	0 (0%)
– 95% CI	1.8 – 10.4%	2.3 – 10.2%	2.8 – 18.7%	0 – 13.7%
PONV Ward – No. (%)	36 (29.5%)	41 (27.3%)	11 (18.6%)	8 (32%)
– 95% CI	21.6 – 38.4%	20.4 – 35.2%	9.7 – 30.9%	14.9 – 53.5%
PONV – No. (%)	39 (32%)	42 (28%)	13 (22%)	8 (32%)
– (95% CI)	23.8 – 41%	21 – 35.9%	12.3 – 34.7%	14.9 – 53.5%

For risk of PONV after laparoscopic compared to elective open cholecystectomy at CRH, $p = 0.48$ (chi-squared test).
For risk of PONV after laparoscopic compared to elective open cholecystectomy at UHWI, $p = 0.34$ (chi-squared test).
OR = Operating room

Table 4: Risk of PONV after cholecystectomy, by approach

Surgical approach	Risk	95% Confidence interval
Laparoscopic cholecystectomy	28.7%	22.3% –35.9%
Elective, open cholecystectomy	28.6%	22% –35.9%
Elective cholecystectomy by any approach (lap & open)	28.7%	24% –33.7%

For risk of PONV after laparoscopic compared to open cholecystectomy, $p = 0.97$ (chi-squared test)

Table 5: The final log-binomial multiple regression model for the effect of surgical approach on PONV risk

Variable	Risk ratio (RR)	P-Value	95% CI for RR
Surgical approach (laparoscopic)	0.87	0.43	0.61 to 1.23
Hospital (UHWI)	0.67	0.1	0.41 to 1.08
Female gender	5.28	0.02	1.37 to 20.36
Premedication	0.72	0.07	0.5 to 1.02
Induction with propofol	1.61	0.03	1.06 to 2.45
Inhalation anaesthetic (halothane)	2.22	0.14	0.76 to 6.48

The effect of laparoscopy on PONV risk has inverted from risk ratio 1.01 ($p = 0.97$) in the crude univariate, log-binomial analysis to 0.87 after adjustment for the variables shown, but remains insignificant ($p = 0.43$)

not treated ($p = 0.85$, t-test), nor in time to first tolerated feeding ($p = 0.53$, t-test), implying that treatment did not alter the course of PONV. Mean time to last recorded episode of PONV was 11 hours (range 0.08, 44; CI 9.4, 12.5).

In patients who had laparoscopic cholecystectomy, mean time to first tolerated feeding was significantly prolonged for patients who had PONV (20.4 hours; CI 15.2, 25.6) compared to those who did not (14.9 hours; CI 13.6, 16.3, $p = 0.006$, t-test). However the mean time to discharge was not significantly different for each group ($p = 0.16$, t-test), being 43.3 hours (CI 23.9, 62.7) for those with PONV and 33.3 hours (CI, 28.8, 37.8) for those without.

In the case of patients who had elective, open cholecystectomy, there was no difference in mean time to first tolerated feeding ($p = 0.17$, t-test) between those who had PONV (26.4 hours; CI, 23.6, 29.1) and those who did not (24.1 hours; CI 22.3, 25.9) nor was there any difference in mean time to discharge from hospital ($p = 0.59$, t-test) between those who had PONV (54.6 hours; CI 47.7,61.6) and those who did not (52.4 hours; CI 48.1,56.8).

DISCUSSION

The risks of PONV in this study after elective laparoscopic cholecystectomy (28.7%; CI 22.3, 35.9%), elective, uncomplicated open cholecystectomy (28.6%; CI 22, 35.9%) and cholecystectomy by any approach (28.7%; CI 24, 33.7%) are at the higher end of the average internationally reported range of 20–30% (1). The preponderant occurrence of PONV only after discharge from the recovery room (81.4%; 83/102; CI, 72.4, 88.4%) may explain this misconception. Others reporting the changing risk over time after anaesthesia have not reported such a dramatic difference between early (2 hours) and later postoperative risk [2–24 hours] (33).

There was no difference between the crude risk of PONV after laparoscopic cholecystectomy (28.7%) compared to elective, uncomplicated open cholecystectomy (28.6%) ($p = 0.97$, chi-squared test) which means that laparoscopy *per se* is not a risk factor for PONV in this study. Indeed, after adjustment for confounders in a multivariable log-binomial linear regression model, the effect of laparoscopy on PONV risk was inverted from the crude risk ratio of 1.01 to 0.87, suggesting a protective effect, but remained insignificant at the 5% level ($p = 0.43$, Wald test). Unfortunately, it was not possible to adjust the risk of PONV for history of smoking (which has an ameliorative effect) and previous PONV or motion sickness, two established major risk factors (4), because these variables were not consistently recorded in the patients' notes. However, there is no reason to suspect differential distribution of these two variables between the main comparison groups and therefore to have expected any significant confounding of the effect of surgical approach on PONV risk, although smoking behaviour would be expected to confound the effect of gender on PONV risk, the prevalence being higher among Jamaican males than among women. Iitomi *et al* (18) also found no significant difference ($p = 0.24$) in the crude risk of PONV at 17 hours postoperatively between laparoscopic cholecystectomy (25.7%) and open cholecystectomy (18.8%) but that was a smaller sample (202).

The retrospective design almost certainly underestimates the true risk of PONV in this study. It is unlikely that many instances of vomiting were missed, since recovery room charts have a section specifically for recording occurrence of PONV and since ward nurses meticulously record episodes of vomiting and retching as well as patients' complaints. However, several patients who did not vomit or complain of nausea refused early feeding and did not state the reason. Other reasons for refusing food include anorexia (from stomach distension) or dysphoria but some of these patients could have been experiencing nausea and did not specifically report it to the nurses as such. Any such reporting bias would likely affect both comparison groups equally**.** A prospective study with more focussed observation and a patient interview component (17) would have detected these cases, but early, post-anaesthesia interview-based protocols seem likely to have the disadvantage of inflating estimates of risk by unearthing clinically inconsequential nausea or misclassifying other types of dysphoric symptomatology.

The period extending from January 1997 to March 2001 during which data were collected for laparoscopic cholecystectomy at CRH but not at UHWI could be considered a weakness of the study. It is theoretically possible

that patients or the disease might have changed in some way during that period and such a change would introduce error. However, it does not seem plausible that any such change occurred and the authors do not believe that it would have been productive to test the effect of calendar period as an independent variable. Any changes in anaesthetic technique would have been adjusted for in the multivariable regression model**.**

Any error resulting from unavailable records should not be significant. The percentage of unavailable records was low at both hospitals and a significant proportion of those missing are likely to have been ineligible for inclusion in this study anyway. Caution should be exercised in assuming that any error resulting from missing records is likely to be similar to error resulting from withdrawal of patients in prospective experimental trials. In the latter case, error occurs because patients may well have withdrawn as a result of factors related to the intervention (explanatory variable) or outcome being studied. It is not plausible that records were missing for any reason related either to the main explanatory variable (surgical approach, there being no evidence of greater complication rate for either approach at either hospital, which would require more intensive clinic follow-up) or outcome (PONV, a transient phenomenon not requiring clinic follow up).

Log-binomial regression (a generalized linear regression model of risks) was used rather than logistic regression because of the widening difference between risk ratio and odds ratio as risk exceeds 10%, which it does in both comparison groups in this study. The authors agree with those who feel that multivariable risk modelling is a more accurate model of effect than odds modelling (logistic regression) when risk exceeds 10% (34,35), but concede that a logistic regression model would have been acceptable in this study. Indeed, some statisticians contend that odds modelling should usually be favoured as it has better mathematical properties than risk modelling (36), and therefore, for example, does not allow impossible values such as probabilities greater than 1. None of the *p*-values for variables fitted to our regression model exceeded 1.

Absence of association of PONV with age over 50 years, obesity, nasogastric tube and duration of anaesthesia was supported by this study. Dimenhydrinate and metoclopramide appeared to be of at best incomplete efficacy in treatment of PONV, neither preventing at least one subsequent episode of PONV in the majority (54%) of those treated, nor decreasing the time to last recorded episode of PONV nor first tolerated feeding in those treated compared to patients not treated. This relative refractoriness of PONV to treatment, even with agents more effective than metoclopramide and dimenhydrinate, has been noted by others (37) and continues to be the major justification driving the quest for effective prophylaxis. The practice of administering dimenhydrinate with injections of opioid analgesia, prevalent at UHWI (77.4% of all patients compared to 10.7% at CRH) had no significant effect in preventing PONV either for laparoscopic (p = 0.98, chi-squared test) or open cholecystectomy (p = 0.83, chi-squared test).

After laparoscopic cholecystectomy, PONV caused a significant increase in the mean time to first tolerated feeding (p = 0.0057) but there was no difference in the time to discharge (p = 0.16) reflecting a general reluctance to discharge patients before the following day during the introductory phase of this new technology.

In summary, the risk of postoperative nausea and vomiting in 356 patients undergoing cholecystectomy at two major hospitals in Jamaica was found to be 28.7% for laparoscopic cholecystectomy and 28.6% for elective, uncomplicated open cholecystectomy. Laparoscopy is not a risk factor for postoperative nausea and vomiting in this study, there being no significant difference between the risk after laparoscopic cholecystectomy and the risk after elective, uncomplicated, open cholecystectomy, after adjustment for possible confounders.

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