Automated reminders decrease postoperative nausea and vomiting incidence in a general surgical population

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Background. Guidelines to minimize the incidence of postoperative nausea and vomiting (PONV) have been implemented in many hospitals. In previous studies, we have demonstrated that guideline adherence is suboptimal and can be improved using decision support (DS). In this study, we investigate whether DS improves patient outcome through improving physician behaviour.

Methods. Medical information of surgical patients is routinely entered in our anaesthesia information management system (AIMS), which includes automated reminders for PONV management based on the simplified risk score by Apfel and colleagues. This study included consecutive adult patients undergoing general anaesthesia for elective non-cardiac surgery who were treated according to the normal clinical routine. The presence of PONV was recorded in the AIMS both during the recovery period and at 24 h. Two periods were studied: one without the use of DS (control period) and one with the use of DS (support period). DS consisted of reminders on PONV both in the preoperative screening clinic and at the time of anaesthesia.

Results. In the control period, 981 patients, of whom 378 (29%) were high-risk patients, received general anaesthesia. Overall, 264 (27%) patients experienced PONV within 24 h. In the support period, 1681 patients, of whom 525 (32%) had a high risk for PONV, received general anaesthesia. In this period, only 378 (23%) patients experienced PONV within 24 h after operation. This difference is statistically significant (P = 0.01).

Conclusion. Automated reminders can improve patient outcome by improving guideline adherence.

Keywords: decision support systems, clinical; postoperative nausea and vomiting; reminder systems

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information management system (AIMS) is available in all anaesthetic care locations and all patient data are stored primarily in the AIMS.

Based on the results of our previous studies, applying the same set of reminders, the IRB decided that this study was a natural extension of the previous studies and that no IRB review or informed consent was necessary.\textsuperscript{10, 18}

In this study, all adult patients (age $\geq$18 yr) undergoing elective non-cardiac surgery under general anaesthesia were included. Exclusion criteria were pregnancy, known allergies to anti-emetic drugs, anti-emetic therapy before surgery, and inability to communicate with the patient.

According to departmental guidelines, PONV risk was estimated at the preoperative clinic using Apfel's simplified risk score.\textsuperscript{1} Patients with three or more positive risk factors were considered at high risk to develop PONV.

Once identified as a high-risk patient, PONV prophylaxis was scheduled, consisting of dexamethasone after induction of general anaesthesia and granisetron upon awakening.

A decision support system (DSS) using patient-specific automated reminders was implemented, supporting the physicians in their decision to prescribe PONV prophylaxis in the preoperative screening clinic and reminding the anaesthesia team to administer PONV prophylaxis in the operating theatre. For a more extensive description of the DSS, we refer to our previous studies.\textsuperscript{10, 18}

This prospective study was set up as an on–off study to compare the 24 h incidence of PONV in a cohort of patients treated with decision support (DS) for PONV prophylaxis (DS period, June 29–October 8) to a cohort of patients treated without the use of the DSS (control period, October 9–December 20).

Based on the analysis of our previous data, we expected that we would find an increase in administration from 50% to 95% for dexamethasone and from 50% to 80% for granisetron.\textsuperscript{18} Based on a study by Apfel and colleagues, we assumed a maximal relative risk reduction of 26% for both drugs.\textsuperscript{2} Combined with the expected PONV incidence based on the risk profile and of our population, we expected an overall reduction in PONV incidence from 30% to 25%.\textsuperscript{10}

Power analysis using these figures ($\alpha=0.05$, $\beta=0.2$) suggested a sample size of 1250 patients per study period.

PONV outcome was recorded with a 24 h follow-up. In the post-anaesthesia care unit (PACU), the nurses were prompted by another reminder included in the AIMS to specifically ask for PONV every 2 h, and before discharge from the recovery room. Twenty-four hours after surgery, patients were interviewed in a standard way by dedicated study personnel; either at the clinical ward or by phone for day-case surgery patients. All patients were asked whether they had experienced PONV, and if so, at which time they did. Although the study personnel were not formally blinded, they were neither involved in nor informed about prophylactic or therapeutic anti-emetic medication given in the operating theatre and the PACU. The use of anti-emetic medication in the operating theatre and in the PACU was extracted from the AIMS. The anti-emetic use after PACU discharge was recorded by the study personnel. The primary outcome of this study was the incidence of PONV within the first 24 h after surgery. Secondary outcomes including incidence of early and late PONV were calculated. Early PONV was defined as PONV up to discharge from the recovery room and late PONV as any PONV thereafter up to 24 h. Anti-emetic drug usage was also analysed to identify an increase or decrease between the control and DS periods.

**Statistical analysis**

The primary comparisons were done between the intervention and control groups using a $\chi^2$-test for proportions and either a Student's t-test or a Mann–Whitney U-test, depending on distribution. We accepted a difference as statistically significant when the $P$-value of the statistical test was smaller than 0.05.

**Results**

Overall, 2662 patients (1681 in the intervention period and 981 in the control period) were included in this prospective study. Patient characteristics are summarized in Table 1.

Comparing the presence of risk factors in both groups, in the control period, less patients were expected to receive postoperative opioids (40%), in comparison with the intervention period (52%).

During the intervention period, the overall incidence of early or late PONV was 23% compared with 27% in the control period ($P=0.01$; Table 2). The incidence of early nausea (4% vs 5%), vomiting (1% and 1%), and late vomiting (8% vs 9%) was not significantly lower in the intervention period. In contrast, late nausea was significantly lower in the intervention period (21% vs 24%, $P=0.03$). The reduction in overall PONV incidence was exclusive in the high-risk patient group, where PONV incidence was reduced from 47% to 30% ($P<0.001$).

Figure 1 shows the incidence of PONV per responsible anaesthesiologist. The incidence decreased for every anaesthesiologist, although there was one anaesthesiologist with a slightly increased incidence of PONV (from 23% to 24%). Moreover, the range of incidences decreased with the incidence of PONV ranging between 18% and 36% in the control period and between 17% and 27% in the intervention period.

The overall use of dexamethasone, granisetron, and metoclopramide did not differ between the intervention and control periods. A reduction in the use of droperidol was observed in the control period when compared with the intervention period (2% vs 1%; Table 3).

The administration of PONV prophylaxis to high- and low-risk patients is also shown in Table 3 and Figure 2. The administration of prophylactic medication to high-risk patients significantly increased with the help of DS, from 82% to 91% for dexamethasone ($P<0.001$) and from 76% to 87% for granisetron ($P<0.001$). In contrast, low-risk patients received less PONV prophylaxis during the intervention period. Dexamethasone was given to 21% of low-risk
patients in the control period vs 14% in the intervention period ($P<0.001$). For granisetron, these percentages are 21% vs 15%, respectively ($P=0.002$).

**Discussion**

The most important finding of this study is that in routine daily practice, an automated patient-specific DSS is able to improve patient outcome—a decreased incidence of PONV—through improving guideline adherence.

The potential limitation of any guideline is the adherence to it by clinicians. Adherence to any guideline, such as hand hygiene or antibiotic prophylaxis, has been repeatedly proven to be difficult using conventional measures.$^{20,21}$ Several studies have demonstrated that patient-specific DS may be
was also illustrated in a recent pro–con discussion.26–28

universal prophylaxis approach remains to be defined. This (usually mild) side-effects.

In contrast, all patients are exposed to the potential do not experience PONV because of the prophylactic medica-

PONV regardless of the medication. Only 2.6% of the patients receive PONV prophylaxis and 7.4% will still experience will not experience PONV regardless of whether they 26% per prophylactic medicine given, 90% of the patients 212

calculated that in a population with a 10% baseline risk (i.e. no receiving universal PONV prophylaxis. It can however be calculated that in a population with a 10% baseline risk (i.e. no positive risk factors), assuming a relative risk reduction of one or more prophylactic drugs, regardless of the PONV risk. There is no evidence available to support such practice, nor is there any literature on PONV incidence in populations receiving universal PONV prophylaxis. It can however be calculated that in a population with a 10% baseline risk (i.e. no positive risk factors), assuming a relative risk reduction of 26% per prophylactic medicine given, 90% of the patients will not experience PONV regardless of whether they receive PONV prophylaxis and 7.4% will still experience PONV regardless of the medication. Only 2.6% of the patients do not experience PONV because of the prophylactic medication. In contrast, all patients are exposed to the potential (usually mild) side-effects.

The optimum between a risk score-based approach and a universal prophylaxis approach remains to be defined. This was also illustrated in a recent pro–con discussion.26–28

In the present study, we have shown that AIMS and DSSs can make a difference. In addition to the demonstrated increase in PONV prophylaxis administration to high-risk patients, DS decreased the inappropriate administration of PONV prophylaxis to low-risk patients. This suggests that automated reminders not only are effective in promoting correct actions, but may also prevent unnecessary prescription to other patients.

There were also several limitations to our study, the most important of which is that the calculated sample size of the control group was not achieved. Unfortunately, due to a change in hospital logistics, we were not able to continue gathering data for our study. Further, compared with other studies, PONV incidence in the control group was relatively low: 27%. This is probably due to a relatively high guideline adherence in the control group in the present study: even without DS, 83% and 77% of high-risk patients correctly received dexamethasone and granisetron, respectively. This may suggest a long-term (years) learning effect in our hospital. In a previous study, we have demonstrated the absence of such a learning effect over a shorter period of time (months).10 18 Performing several studies on PONV over the last few years may thus have increased the awareness among the anaesthesia care-givers that has not been demonstrated in a single study. This high adherence in the control group may have mitigated the effect of DS in the present study. It may also demonstrate that continued attention for PONV prevention is essential and in itself may eventually increase guideline adherence.

In addition, the greater proportion of high-risk patients in the intervention period, compared with the control period, may have reduced the measured effect of DS in the present study. Thus, the real effect of DS on the incidence of PONV may even be more pronounced than the estimate in our study.

In conclusion, we showed that implementation of DS for the selection of high-risk PONV patients, combined with automated reminders for the administration of PONV prophylaxis, significantly decreases the incidence of PONV in routine daily practice.

**Declaration of interest**

None declared.

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