Implementation of safety strategies decreased incidence of human errors in the clinical practice of intravenous patient-controlled analgesia in postoperative patients: a retrospective study.

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Background:

Intravenous patient-controlled analgesia (IVPCA) offers meaningful advantages over traditional analgesia for postoperative pain. Strategies for decreasing human errors are important because IVPCA errors can be catastrophic. We aimed to examine whether the incidence of human errors decreased after implementing a 4-point safety strategy in clinical IVPCA practice.

Materials and Methods:

The acute pain service team including anesthesiologists, pain nurses and pharmacists provides IVPCA services. A 4-point safety strategy has been implemented since Nov. 2006.

- (1)The use of a single, standard concentration for each IVPCA formula.

Table 1. Drug ingredients for each IVPCA formula.

Formulae	Drug ingredients
Formula 1	Morphine 1 mg/ml
Formula 2	(Morphine 0.5 mg and Ketorolac 1 mg)/ml
Formula 3	Fentanyl 20 ug/ml
Formula 4	(Fentanyl 5 ug and Ketorolac 1.2 mg)/ml

- (2)The use of prefilled IVPCA bags- to centralize, dispense and label IVPCA bags with computer-generated labels appropriately.
- (3)The use of level-based standard IVPCA prescriptions and pump programming.

Table 2. Four-level IVPCA prescriptions and pump programming.

Pump programming	Level I	Level II	Level III	Level IV
Loading dose	5 ml	3 ml	3 ml	2 ml
Bolus dose	2 ml	1.5 ml	1 ml	0.5 ml
Mode	Bolus alone	Bolus alone	Bolus alone	Bolus alone
Lockout interval	5 min	5 min	10 min	10 min

- (4)The implementation of double-checks for all IVPCA procedures by two nurses.

Pain severity at rest/on movement and side effects of IVPCA during the first three postoperative days were assessed and recorded by acute pain service team members in every visit for each patient. An 11-point numeric rating pain scale (NRS) was used for assessing pain severity. An 11-point NRS score >3 is considered inadequately treated pain. Patient satisfaction was determined using the 5-point Likert scale after the termination of IVPCA.

Outcome measures:

Primary outcomes were the incidence of human errors before- and after-the 4-point safety strategy. Secondary outcomes included the rates of inadequately treated pain, the rates of side effects of IV-PCA and patient satisfaction.

Statistical analysis:

Fisher exact test was calculated to compare the incidence of human errors between before- and after- groups. Categorical characteristics of patients between groups were assessed by chi-square test and continuous variables were assessed by student's t-test. A p value of < 0.05 was considered significant.

Results:

A total of 13,508 IVPCA patients were enrolled in this retrospective study from 2005 to 2012.

Table 3. Comparisons of the incidence of human errors between groups.

Potential error	Before group (N=1,505)	After group (N=12,003)	p
1.Wrong concentrations	3	1	0.001
2.Wrong drug	0	0	NC
3.Error in drugs prescribed by physicians	0	0	NC
4.Error in PCA pump programming	3	2	0.006
5.PCA tubing incorrectly connected to the pump or patient	2	0	0.012

NC: non-calculated

There were no significant differences in the rates of inadequately treated pain, the rates of side effects of IVPCA and patients' satisfaction between groups. Overall, the results revealed that the 4-point safety strategy reduced human errors effectively.

Conclusion:

Implementation of the 4-point safety strategy for clinical IVPCA practice minimized human error effectively. The standardization of physicians' prescriptions by using level-based standard IVPCA prescription and pump programming did not affect the efficacy of pain relief and patients' satisfaction. The overall effectiveness of IVPCA increased.