Risk factors associated with the initial unplanned removal of orogastric tubes in NICU: A Single Center Study in China

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Abstract

**Background:** Newborns, in particular, are at higher risk for unplanned removal of orogastric tubes (UROGTs). Because there is a lack of studies identifying the incidence and risk factors for UROGTs in China, we designed this case–control study to investigate them.

**Method:** This study was conducted in China. A total of 111 neonates who received orogastric tubes between October 2022 and February 2023 were analyzed. Univariate and multivariate logistic models were used for risk factor analyses.

**Results:** The rate of UROGTs was 56.8%, and the incidence was 7.2 per 100 tube days. An increased risk of UROGTs was associated with higher agitation scores (OR=17.82, P=0.001), no oral feeding (OR=0.02, P=0.007), fixation tape loosening (OR=22.75, P=0.027) and tape wetting (OR=12.6, P=0.021).

**Conclusions:** The incidence of UROGTs was found to be significantly higher than that of endotracheal tube extubation. The risk factors were higher agitation scores, no oral feeding, fixation tape loosening and tape wetting.

**Background**

Orogastric tubes are used mainly in newborns and favored by most pediatricians in the neonatal intensive care unit (NICU) of China. They are commonly used for infusion of enteral nutrition (tube feeding), medication therapy, and gastric decompression [1]. In several prospective quality improvement (QI) studies involving adult ICU patients, researchers aimed to reduce the incidences of device displacement and unplanned device removal, which had a median rate of 7 per 100 patient days. The devices most commonly involved were nasogastric tubes, central catheters, and airway devices (tracheostomy tubes and endotracheal tubes) [2].

However, current studies have mostly focused on unplanned extubation (UE) in the NICU, which is characterized by accidental removal of the tracheal cannula. The UE rates in the NICU range from 0.72 to 5.36 extubations/100 ventilated days [3]. Risk factors associated with UE include infant agitation, tube manipulation, fixation tape loosening or tape getting wet and a high nurse-to-patient ratio [4].

In fact, feeding tubes are more often used than endotracheal tubes in the NICU. For preterm or critically ill infants, feeding tubes were used to deliver enteral nutrition [5]. Orogastric (OG) or nasogastric (NG) tubes are inserted through the mouth or nose into the stomach [6, 7]. As newborns have small nasal passages, feeding tubes squeezed through the nose cavity may cause partial nasal obstruction, increasing the incidence of apnea of prematurity, the amount of energy consumed for breathing and airway resistance [8]. Orogastric tubes were widely used prior to nasogastric tubes in the NICU of China.

Because the oral cavity allows easy movement, orogastric tube dislodgement occurs more frequently than nasogastric tube dislodgement [9]. Inadequate fixation may elicit unplanned removal to allow tube
reinsertion. Moreover, a previous study showed that feeding tubes in enteral feeding systems are susceptible to rapid microbial biofilm development and may therefore serve as reservoirs for pathogens, thus frequent reinsertion of the OG tube may increase the risk of infection or play an important role in necrotizing enterocolitis (NEC) development in infants [10, 11].

Unplanned removal of orogastric tubes (UROGTs) is defined as the unintentional removal or accidental displacement of the tube. The event is associated with feeding tube misplacement, thus increasing the burden on the healthcare system as a result of repeat insertions, prolonging the hospital stay and increasing the risk of infection [12]. In infants, repeated insertion as a result of UROGTs may increase the risk of radiation exposure and risk of injury to the esophagus and stomach [13].

Neonates, in particular, are at higher risk for UROGTs than other age groups. A previous study showed that in preterm newborns, the incidence of orogastric tube displacement was approximately 31.2% (15/48) and that the incidence of nasogastric tube displacement was 12% (6/50) [13]. Because infants have small faces, less tube in the stomach and require minimal sedatives, the technique for fixation is different and their risk of UROGTs is increased [8]. Moreover, there are no defined quality improvement indicators for use in China's NICUs because there is no defined rate of UROGTs and consensus on the risk factors for UROGTs.

Therefore, we conducted this prospective case–control study in a single NICU in China to investigate the incidence of UROGTs and to assess the risk factors associated with initial unplanned tube removal.

**Methods**

**Study Design**

This prospective case–control study was performed for 5 months, from October 2022 to February 2023, in China's NICU, which had a capacity of 120 beds. The research was approved by the institutional review board of our hospital. Patients with orogastric tubes were recruited and observed by nurses. Of 122 eligible patients initially enrolled in the study, 11 were excluded. Three participants underwent tube placement during surgery, another three were transferred to another hospital due to congestive heart diseases, and four newborns died in the unit (Figure 1).

Inclusion criteria: (1) infants with doctor-determined indications for orogastric tube insertion; (2) infants whose feeding tube was placed for more than 24 hours; and (3) infants with no gastrointestinal system malformations, such as clefts of the lip or palate, or congenital esophageal atresia. Exclusion criteria: (1) infants with a nasogastric tube; and (2) infants with a tube that was only used for single gastric lavage or medication administration.

The case group comprised participants who had experienced at least one UROGTs event. The control group comprised others who had never experienced an UROGTs event. Sample size was computed by PASS 2021 software. In our pilot study, we found that the expected rate of unplanned removal was 30%.
We assumed that the UROGTs rate was 0.30, the estimated lowest odds ratio was 8, the significance was 0.05, and the power was 0.8. We calculated that 100 newborns were needed for the study.

**Study setting**

**Tube insertion**

Orogastric tubes were inserted by the NICU registered nurses who had at least 5 years of clinical NICU experience. Before this research, they had been trained on the measurement method and the insertion procedure by the lead researchers to minimize potential biases and the risk of complications. The insertion depth was estimated by using the weight-based equation (length=3 × weight (kg) +12 cm) and verified by radiological examination. This equation was validated in a previous study conducted in our unit, and the results were submitted to another journal and are under review.

A pediatric disposable stomach tube kit (VERACON, Suzhou, Jiangsu, China) containing a silicone lumen tube with a diameter of F 6.0 or F8.0, a pack of sterile liquid paraffin and sterile gloves were used in the study. In our NICU, newborns who required an orogastric tube were not given routine sedatives or analgesics.

**Confirmation of the tube**

Immediately after insertion, the nurses gently pulled the plunder of the syringe back to obtain gastric contents. If the contents were not collected, the patient was placed in the other position, and a second aspiration was performed after 5 to 10 minutes. If the gastric contents were not collected after three attempts, the orogastric tube was closed and not used for feeding or gastric decompression, pending radiological verification.

According to our protocol, the gastric content pH test was performed immediately after aspiration using test strips. Its reading values range from 0.0-14.0 and are accurate to within 0.5 pH units (DFph0-14, GZJZ, China). The tube was correctly placed in the stomach, and the pH indicator strip showed a pH 5.5 or below within 10-15 seconds, indicating that the gastric contents were acidic. In contrast, if the pH reading was above 5.5, the tube was not allowed for use until verification by radiological examination [5].

**Tube fixation and maintenance**

The tube was fixed and secured using water resistant tape by attaching one end of the tape to the cheek, crossing over the tube, and then attaching the other end of the tape to the other cheek. The end of the tube was angled outward from the mouth, and maintenance care was recorded in the electric nursing record and the tube was checked before each feeding.

The nurses in our NICU worked 8-hour shifts, either the day shift (7:30 am-3:30 pm), evening shift (3:30 pm-11:30 pm) or night shift (11:30 pm-7:30 am). Therefore, the fixed tube was checked every 8 hours,
and if the tape became loosened or substantially wet, the tube was changed promptly. According to the manufacturer's instructions, the tubes typically need to be changed every week.

**Risk factor investigation tools**

The questionnaire tool used in this study consisted of five items based on a similar study on unplanned endotracheal extubation in newborns and our pilot study. One item was the dependent variable (the time of every unplanned tube removal), and the newborns' basic information (including sex, gestational age, birthday and birth weight), patient-related factors (position, ventilation support, agitation score and medical activities before removal), feeding-related factors (enteral feeding or oral feeding), and nursing-related factors (number of patients assigned, length of NICU careers were the independent variables).

A 6-point Likert scale, with scores for each item ranging from 0 (none) to 5 (most affected), was designed to objectively assess the nurse's perception of each baby's level of agitation [14].

Four NICU experts (two chief nurses with at least five years of work experience, one neonatologist, and one registered nurse) assessed the validity of the content obtained from the pilot study. A total of five preterm and five term newborns were selected in the pilot study to validate the content. The nurse needed 10 mins to answer all the questions.

**Data collection**

First, if the eligible newborns were recruited from within our NICU, the registered nurse completed the basic information of the questionnaire. Demographic characteristics such as gestational age, birth weight and days of life were collected from the medical records.

Second, the assigned nurses completed the questionnaire following the first occurrence of an UROGTs event, providing information on the occurrence time, tube fixation and length of NICU career, which was related to this event. Furthermore, if UROGTs recurred, the nurse recorded the time, instead of the risk factors.

If UROGTs did not occur during placement, the infants' condition improved, and the removal of the orogastric tube was decided by the doctor. This situation was defined as the planned removal of the orogastric tube. Before planned removal, the scores for the related factor items in the questionnaire were also collected by the registered nurses.

**Statistical analysis**

The rate of UROGTs was calculated by dividing the number of patients who had experienced this event by the total number of patients enrolled and then multiplying that number by 100. Moreover, the incidence was determined per 100 orogastric tube days, and the calculation was performed by dividing the number of UROGTs events by the number of orogastric tube days and multiplying the result by 100. Kaplan–Meier survival curves were generated for survival analysis. All risk factors were initially analyzed in the
univariate model, and the significant risk factors (P<0.10) were selected for the multivariable logistic regression model to obtain the independent risk factors.

We used SPSS Statistics 20.0 software (IBM Corp) to process all the data. Percentages and proportions were used to describe the categorical data. If the continuous variables fit a normal distribution, they are described as the mean ± standard deviation; otherwise, they are described as the median (interquartile range [IQR]).

**Result**

**Participant characteristics**

A total of 111 patients who underwent orogastric tube insertion were included in this study; 63 newborns were separated into the case group, and the other 48 individuals were matched as the control group. The mean gestational ages were 35.0± 3.6 weeks and 35.6 ± 3.5 weeks, and the birth weights were 2312.2±756.2 g and 2475.2±715.8 g in the case and control groups, respectively. The most common tube size for initial tube insertion was 6F in both groups (58, 92.1% vs. 46, 95.8%). The mean insertion length was 18.6±2.1 cm in the case group and 18.7±2.1 cm in the control group. The differences in all these factors were not significant between the two groups (P>0.05) (detailed in the Table1).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Case N=63</th>
<th>Control N=48</th>
<th>t/χ²*</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>41(65.1)</td>
<td>29(60.4)</td>
<td>0.25</td>
<td>0.614</td>
</tr>
<tr>
<td>Female</td>
<td>22(34.9)</td>
<td>19(39.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gestational age(weeks)</td>
<td>35.0±3.6</td>
<td>35.6±3.5</td>
<td>0.81</td>
<td>0.419</td>
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<tr>
<td>Birth weight(g)</td>
<td>2312.2±756.2</td>
<td>2475.2±715.8</td>
<td>1.15</td>
<td>0.252</td>
</tr>
<tr>
<td>Orogastric tube size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6F</td>
<td>58(92.1)</td>
<td>46(95.8)</td>
<td>0.66</td>
<td>0.418</td>
</tr>
<tr>
<td>8F</td>
<td>5(7.9)</td>
<td>2(4.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insertion length(cm)</td>
<td>18.6±2.1</td>
<td>18.7±2.1</td>
<td>0.19</td>
<td>0.849</td>
</tr>
</tbody>
</table>

*For categorical variables, chi-square (χ²) was used to test the differences between the two groups, and a t test was used for continuous variables.

**Incidence of UROGTs**
During the 5-month investigation period, the rate of UROGTs was 56.8% (63/111). One hundred twenty-three patients experienced unplanned removals during the study period: 63 (56.8%) infants experienced one unplanned removal, 15 (13.5%) infants experienced two unplanned removals, and 8 (7.2%) infants experienced three unplanned removals.

The total duration of orogastric tube placement was 1718.1 days; thus, the incidence of UROGTs was 7.2 per 100 tube days. The cumulative orogastric tube survival rate was 61.6% in the first week, 42.5% in the second week, 35.3% in the third week, 27.7% in the fourth week, 27.7% in the fifth week, 20.8% in the sixth week, and 0% in the seventh week after initial insertion. The survival rate of the orogastric tube group is shown in Figure 2.

**Univariate risk factor analysis**

The median age at the time of initial orogastric tube insertion was 1.65 days (IQR 0.55-6.47) in the case group and 0.86 hours (IQR 0.64-7.47) in the control group. The mean body weight before insertion was similar in both groups (2651.8±563.8 g vs. 2474.8±685.7).

Individuals in the case group received significantly more ventilator support (89.6% vs. 61.9%, P=0.017). The common ventilator mode in the case group was nIPPV (22.2%), whereas nIPPV and HF was used equally (4.2%, 4.2%) in the control group. The average patient’s agitation score before dislodgment in the case group (2.6±1.8) was higher than that in the control group (0.2±0.5) (P<0.001). Most newborns never experienced medical activity before removal (90.5% vs. 95.8%, P=0.280).

The proportion of patients receiving enteral feeding was not different between the two groups. In contrast, 95.2% of participants in the control group received oral feeding, which is a larger proportion than that in the control group (56.0%) (P<0.001).

In terms of fixation factors, the newborns in the case group were more likely to have experienced loose fixation, tape starting to lift, and tape getting wet (all P<0.001). In addition, the mean length of the NICU nursing career was 5.8±4.4 years in the case group and 3.1±2.4 years in the control group (P<0.001), as detailed in Table 2.

Table 2 Univariate factors for unplanned removal of the orogastric tube
<table>
<thead>
<tr>
<th>Category</th>
<th>Variables</th>
<th>Case (N=63)</th>
<th>Control (N=48)</th>
<th>t/χ²</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic factors</td>
<td>DOL when insertion*</td>
<td>1.65 (0.55-6.47)</td>
<td>0.86 (0.64-7.47)</td>
<td>0.363</td>
<td>0.717</td>
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<td></td>
<td>Weight when insertion</td>
<td>2651.8±563.8</td>
<td>2474.8±685.7</td>
<td>1.45</td>
<td>0.149</td>
</tr>
<tr>
<td>Ventilation</td>
<td>Ventilation support†</td>
<td></td>
<td></td>
<td>12.01</td>
<td>0.017</td>
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<tr>
<td></td>
<td>CMV</td>
<td>5(8)</td>
<td>1(2.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>nIPPV or CPAP</td>
<td>14(22.2)</td>
<td>2(4.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HF</td>
<td>5(7.9)</td>
<td>2(4.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>39(61.9)</td>
<td>43(89.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agitation</td>
<td>Agitation scores§</td>
<td>2.6±1.8</td>
<td>0.2±0.5</td>
<td>10.30</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Medical activity before removal‡</td>
<td></td>
<td></td>
<td>1.17</td>
<td>0.280</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>6(9.5)</td>
<td>2(4.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>57(90.5)</td>
<td>46(95.8)</td>
<td></td>
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</tr>
<tr>
<td>Feeding</td>
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<td></td>
<td></td>
<td>1.27</td>
<td>0.260</td>
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<td>Yes</td>
<td>50(79.4)</td>
<td>42(87.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>13(20.6)</td>
<td>6(12.5)</td>
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<td></td>
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<td>&lt;0.001</td>
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<tr>
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<td>Yes</td>
<td>28(56.0)</td>
<td>40(95.2)</td>
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<tr>
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<td>None</td>
<td>22(44.0)</td>
<td>2(4.8)</td>
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<tr>
<td>Fixation</td>
<td>Loose fixation</td>
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<td></td>
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<td></td>
<td>Yes</td>
<td>28(44.4)</td>
<td>2(4.2)</td>
<td></td>
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<td>35(55.6)</td>
<td>46(95.8)</td>
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</tr>
<tr>
<td></td>
<td>Tape starting to lift</td>
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<td></td>
<td>10.42</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>15(23.8)</td>
<td>1(2.1)</td>
<td></td>
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<tr>
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<td>None</td>
<td>48(76.2)</td>
<td>47(97.9)</td>
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</tr>
<tr>
<td></td>
<td>The proportion of tape getting wet</td>
<td></td>
<td></td>
<td>22.16</td>
<td>&lt;0.001</td>
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<tr>
<td></td>
<td>≥50%</td>
<td>12(19.0)</td>
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<tr>
<td></td>
<td>50%</td>
<td>23(36.5)</td>
<td>6(12.5)</td>
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<td></td>
<td>None</td>
<td>28(44.4)</td>
<td>42(87.5)</td>
<td>1.34</td>
<td>0.183</td>
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<td><strong>Workload</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of patients assigned</td>
<td>9.1±2.3</td>
<td>8.5±2.2</td>
<td>1.34</td>
<td>0.183</td>
<td></td>
</tr>
<tr>
<td>Number of critical patients assigned</td>
<td>7.4±2.8</td>
<td>7.0±2.1</td>
<td>0.85</td>
<td>0.395</td>
<td></td>
</tr>
<tr>
<td>Length of NICU nursing career (years)</td>
<td>5.8±4.4</td>
<td>3.1±2.4</td>
<td>3.82</td>
<td>&lt;0.001</td>
<td></td>
</tr>
</tbody>
</table>

*Days of life (DOL) is the difference between the time of initial orogastric tube insertion and the date of birth and is described as the median and interquartile range (IQR).

† CMV, controlled mechanical ventilation; nIPPV, nasal noninvasive positive pressure ventilation; CPAP, continuous positive airway pressure; HF, high flow.

‡ Medical activity including blood draw or puncture, bathing, transportation, weighing or radiology study.

§ Agitation scores ranged from 0 (none) to 5 (most agitation), which was assessed by the assigned nurse.

**Multivariable risk factor analysis**

Risk factors including ventilation support, agitation score, oral feeding, loose fixation of the tube, tape starting to lift, large proportion of the tape is wet, and short length of NICU nursing career were included in the multivariable logistics regression.

In the multivariable analysis, agitation scores, oral feeding, fixation tape loosening and tape getting wet were significantly associated with the incidence of unplanned removal of the orogastric tube. The risk of UROGTs increased by 17.82 times with one point greater in agitation score (OR=17.82, P=0.001, 95% CI = 3.01-105.38); the risk of UROGTs was 0.02 times lower in newborns who had begun oral feeding during placement (odds ratio [OR] = 0.02, P= 0.007, 95% CI =0.01-0.35) and 26.48 times higher in neonates whose fixation tape was loosened than in those whose tube was not loosened(OR= 22.75, P=0.027, 95% CI = 1.46-482.12). Wetting of the fixation tape was a predictive factor of UROGTs (OR=, P=0.021, 95% CI =1.47-108.45), as shown in Table 3.

Table 3 The results of logistic regression analysis for the risk factors for unplanned removal.
Variables | $B$ | Standard Error | $Wald \chi^2$ | P value | OR | 95% CI* for OR
--- | --- | --- | --- | --- | --- | ---
Ventilation support (Yes vs. None) | -1.00 | 1.34 | 0.55 | 0.458 | 0.37 | 0.03-5.16
Agitation scores (continuous variable) | 2.88 | 0.91 | 10.09 | 0.001 | 17.82 | 3.01-105.38
Oral feeding (Yes vs. None) | -3.81 | 1.40 | 7.37 | 0.007 | 0.02 | 0.01-0.35
Fixation tape loosening (Yes vs. None) | 3.28 | 1.48 | 4.90 | 0.027 | 26.48 | 1.46-482.12
Tape starting to lift (Yes vs. None) | 1.40 | 1.46 | 0.92 | 0.337 | 4.04 | 0.23-70.01
Tape getting wet (Yes vs. None) | 2.53 | 1.10 | 5.33 | 0.021 | 12.60 | 1.47-108.45
Length of NICU nursing career (years) | 0.28 | 0.16 | 3.14 | 0.066 | 1.33 | 0.97-1.84

*CI, confidence interval

**Discussion**

This study was conducted in a single center in China, and we found that the rate of UROGTs was 56.8% in the NICU, while the incidence was 7.2 per 100 tube days. In addition, factors including newborn agitation, oral feeding, fixation tape loosening and wetting significantly contributed to unplanned removal.

Tubes and catheters are the main appliances used in the NICU, providing daily health treatment for the administration of medicines and milk to critical newborns[15]. Patients who experienced unplanned removal of medical devices had more medical complications, such as bleeding, pulmonary, aspiration, and nosocomial infection[16]. According to a study involving adult ICU patients, nasogastric tubes, endotracheal tubes and central catheters are most commonly subjected to unplanned removal [16]. Reducing the incidence of and mitigating the risk factors for these events have been a major topic in the NICU.

Previous studies have mainly focused on strategies to reduce the incidence of unplanned extubation (UE) of the endotracheal tube (ETT). Unplanned extubation (UE) or accidental displacement of the ETT can cause common adverse effects in patients, including lung collapse, cardiovascular instability, trauma to the upper respiratory tract, ventilator-associated pneumonia, and so on [17]. A study including 182 neonates requiring mechanical ventilation in Australia showed that the UE rate in the neonatal population was 4.75 per 100 days of ventilation [18]. Similarly, a recent study from South Korea showed that 32.1% of newborns in the NICU had experienced UE, with an incidence of 6.56 per 100 ventilation days[19].

Although orogastric tubes are less important than ETTs, orogastric tubes are still valuable devices that can provide enteral nutrition and allow gastric decompression, especially for preterm babies[19]. In NICUs
in China, orogastric tubes are mainly used in newborns and favored by most pediatricians[20]. In contrast, there are few studies reporting the incidence of unplanned removal in our country. In this study, the reported incidence of UROGTs was 7.2 per 100 tube days, which was higher than that of UE in other studies. Therefore, neonatal units and medical teams in our country should begin to recognize UROGTs as a significant problem and strive to reduce this rate. Our results revealed an incidence of UROGTs, which can act as a baseline to understand the current situation. This will strongly support initiatives to improve the quality of care provide in the NICU in the future [21].

Another essential part of the quality improvement study is to determine the type of intervention needed based on the risk factors. Factors associated with UE in the NICU have been investigated in the published articles [18, 19, 22]. Patient agitation, poor fixation of the ETT, frequent suction, nurses working night shifts and/or overtime and a higher patient-to-nurse ratio were related to an increased number of unplanned extubation events in the NICU[19, 22]. Recent literature provides various strategies to help reduce UE rates. Strategies to proactively reduce agitation during ETT placement have been proven to be effective in decreasing the incidence of UEs [4]. In addition, standardized taping methods for securing ETTs can decrease the incidence of UEs [4]. Subsequently, the team implemented various interventions in the NICU to prevent unplanned removal, such as changing the ETT taping method, increasing the contact surface area of the adhesion, and avoiding loose securement. After implementation of quality improvement approaches, the incidence of UEs decreased dramatically while avoiding the need for sedation and restraints [23].

The methodology for reducing the incidence of UEs is not applicable for reducing the incidence of unplanned removal of the orogastric tube. Nurses are often aware of strategies to prevent UEs, but often lack knowledge about preventive measures for UROGTs. In this study, we found four risk factors for unplanned removal of tubes, including agitation scores, oral feeding, fixation tape loosening and getting wet. Newborns with the abovementioned risk factors were more prone to experience unplanned tube removal.

Among these four risk factors, our study found that the odds ratios of fixation factors, including tape loosening and wetness, were higher, indicating their pertinence as key risk factors for UROGTs. Therefore, improving fixation techniques and ensuring frequent observation of fixed tubes may reduce the incidence of unplanned tube removal. Such findings are consistent with those found in studies on UE, which showed that fixation tape loosening and wetness were main risk factors for UE in newborns [19]. Furthermore, John's quality improvement study also supported our results in that the main reason for UE was that the tape securing the tube became loose [24]. For future QI projects aiming to reduce the incidence of UROGTs, we recommend that loose tape be promptly reinforced and that any tape found to be “too wet” be promptly replaced.

In addition, we found that if the baby was very active, they could unintentionally pull out their own feeding tube, resulting in UROGTs. This unintentional removal event in the study on UE corresponded with the finding that infant agitation is the common factor associated with UE in the NICU [25, 26]. However,
these findings do not indicate that sedative-analgesic medications should be administered to calm agitated babies during orogastric tube placement. Jung's [19] study on the risk factors for UE in Korea showed that the administration of sedative-analgesic medications did not prevent UE in newborns. From the author's perspective, it is important to first design an easily applicable assessment to accurately assess infant agitation. Nonpharmacologic strategies for minor agitation include nonnutritive sucking, breastfeeding, and skin-to-skin contact to reduce the incidence of accidental dislodgment of various tubes in the NICU[27]. Recently, an infant-driven feeding (IDF) approach was introduced for oral feeding. Based on this strategy, feeding should always be initiated before crying occurs, which may dramatically reduce agitation [28, 29].

In our unit, when an infant was deemed physiologically stable, we began oral feeding at 32 to 34 weeks gestational age. Oral feeding was previously delayed for several days or weeks but most can start oral feeding much sooner. In this study, neonates who started oral feeding sooner were at lower risk for UROGTs. Therefore, our team recommends that infants, especially preterm babies, begin oral feeding as early as possible. Not only is it an effective way to decrease the risk of UROGTs, but it can also help shorten the time to full oral feedings and the length of hospital stay [28].

A few limitations should be mentioned in regard to this study. First, this study was a single-center study conducted in one women and children's hospital; therefore, selection bias is possible. Second, due to the lack of recent literature on UROGTs, we selected risk factors for unplanned extubation of endotracheal tubes that were previously studied in published articles. Therefore, some related factors may not be identified. Third, this study only included newborns with orogastric tubes. Since the guidelines for tube insertion and maintenance may differ from those for nasogastric tubes, our results may not be applicable to nasogastric tubes.

**Conclusion**

The rate of UROGTs was 56.8%, with an incidence of 7.2 per 100 tube days in Chinese neonates during the 5-month study period. Newborns with the following conditions were more likely to be at risk of UROGTs: higher agitation scores, no oral feeding, and fixation tape loosening and wetness. These results would be valuable for reducing the incidence of and preventing UROGTs in newborns.

**Abbreviations**

UROGTs: Unplanned Removal of Orogastric Tubes; NICU: Neonatal Intensive Care Unit; QI: Quality Improvement; UE: Unplanned Extubation; OG: Orogastric Tube; NG, Nasogastric Tube; NEC: Necrotizing Enterocolitis; IQR: Interquartile Range; CI: Confidence Interval; CMV: Controlled Mechanical Ventilation; nIPPV: nasal Noninvasive Positive Pressure Ventilation; CPAP: continuous Positive Airway Pressure; HF; High Flow; DOL: Days of Life; OR: odds ratio; ETT: endotracheal tube;

**Declarations**
Ethics approval and consent to participate

Ethical approval was obtained from the ethical board and the proposal number was FSFY-MEC-2022-10 approved by South Medical University Affiliated Maternal & Child Health Hospital of Foshan. For the study, we also obtained permission to conduct the research from the NICU department. All the activities were performed according to the rule of conduct and participants written consent was taken before the study. All methods were carried out in accordance with relevant guidelines and regulations. Written informed parental or guardian’s consent was obtained for each patient before investigation.

Consent for publication

Not applicable

Availability of data and materials

The data supporting this study’s findings are available from the corresponding author upon request.

Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Authors' contributions

JC and XLF were co-first author, they contributed equally to this essay from conceptualization, literature review, study design, questionnaire validation, data collection, funding acquisition and supervision. CMH leaded our team in data analysis, preparation of the manuscript, drafting and revision. YHD and LJL supported the clinical work including the project administration and training. All authors reviewed and approved the final version of the manuscript.

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Authors' information
References


Figures
Figure 1

The flow diagram of this study
Figure 2

Plot of Kaplan–Meier estimates against days following the first orogastric tube insertion.