

# Association of a Liberal Fasting Policy of Clear Fluids Before Surgery With Fasting Duration and Patient Well-being and Safety

6

Marije Marsman, MD; Teus H. Kappen, MD, PhD; Lisette M. Vernooij, PhD; Evelien C. van der Hout, MD; Judith A. van Waes, MD, PhD; Wilton A. van Klei, MD, PhD

 Supplemental content

**IMPORTANCE** Current fasting guidelines for procedures under anesthesia are poorly implemented, leading to negative metabolic sequelae. Recent studies in children showed support of liberal clear fluid intake; adult physiology can support clear fluid intake, but implementation studies are lacking.

**OBJECTIVE** To evaluate the successfulness of implementation of a liberal clear fluid policy with regard to fasting duration, well-being, and safety in adults scheduled for anesthesia.

**DESIGN, SETTING, AND PARTICIPANTS** This was a quality improvement study conducted from January 2016 to July 2021 at a tertiary referral hospital in the Netherlands. Adults scheduled for nonemergency procedures under anesthesia were included in the study. Patients undergoing obstetrics procedures or those who were intubated preoperatively were excluded.

**INTERVENTIONS** Stepwise introduction of a liberal fluid fasting policy, allowing for ingestion of clear fluids until arrival at the operating room.

**MAIN OUTCOMES AND MEASURES** The primary outcome was change in fasting duration. Secondary outcomes were patient well-being, measured as preoperative thirst, amount of fluid ingested, postoperative nausea and vomiting (PONV), and administration of antiemetics. Safety was measured as incidence of regurgitation and aspiration (pneumonia).

**RESULTS** Of the 76 451 patients (mean [SD] age, 56 [17] years; 39 530 male individuals [52%] 36 921) included in the study, 59 036 (78%) followed the standard policy, and 16 815 (22%) followed the liberal policy. Time series analysis showed an estimated fasting duration decrease of 3:07 hours (IQR, 1:36-7:22;  $P < .001$ ) after implementation of the liberal policy. Postimplementation median (IQR) fasting duration was 1:20 (0:48-2:24) hours. The incidence of regurgitation changed from 18 (95% CI, 14-21) to 24 (95% CI, 17-32) in 10 000 patients, and the incidence of aspiration changed from 1.7 (95% CI, 0.6-2.7) to 2.4 (95% CI, 0.5-4.7) in 10 000 patients. In the liberal policy, thirst feelings decreased (37% [4982 of 8615] vs 46% [3373 of 7362];  $P < .001$ ). PONV incidence decreased from 10.6% (6339 of 59 636) to 9.4% (1587 of 16 815;  $P < .001$ ) and antiemetic administration decreased from 11.0% (6538 of 59 636) to 9.5% (1592 of 16 815;  $P < .001$ ).

**CONCLUSIONS AND RELEVANCE** Results of this quality improvement study suggest that a liberal fasting policy was associated with a clinically relevant reduction in fasting duration and improved patient well-being with regard to preoperative thirst and PONV. Although a slightly higher incidence of regurgitation could not be ruled out, wider implementation of such a policy may be advocated as results are still within the clinically accepted risks margins. Results suggest that surgical procedures in patients who drink clear fluids within 2 hours before anticipated anesthesia should not be postponed or canceled.

JAMA Surg. 2023;158(3):254-263. doi:10.1001/jamasurg.2022.5867  
Published online January 4, 2023.

**Author Affiliations:** Author affiliations are listed at the end of this article.

**Corresponding Author:** Marije Marsman, MD, Department of Anesthesiology and Intensive Care Medicine, University Medical Center Utrecht, Local Mail Q04.2.313, PO Box 58800, 3508 GA Utrecht, the Netherlands ([m.marsman-2@umcutrecht.nl](mailto:m.marsman-2@umcutrecht.nl)).

**P**reoperative fasting is commonly implemented to minimize the risk of aspiration in patients undergoing elective procedures under anesthesia. In adults, guidelines advise withholding solids for 6 hours and clear fluids for 2 hours before anesthesia.<sup>1-3</sup> Studies have shown that guideline implementation is suboptimal: in many hospitals, patients still fast 5 to 6 hours for clear fluids, leading to negative metabolic sequelae.<sup>2,4-10</sup> Inadequate implementation is, among other things, caused by fear of aspiration, anxiety, and loose flexibility in operating room scheduling.<sup>7</sup> Although aspiration can lead to aspiration pneumonia and even death, its reported incidences are between 1 and 10 in 10 000 elective procedures.<sup>11-13</sup> Recent studies, mainly in children, have shown that reducing fluid fasting times results in flexible operating room scheduling, reduced postoperative nausea and vomiting (PONV) and better patient well-being, without increasing aspiration risk.<sup>14-19</sup>

In response to these studies, European pediatric fasting guidelines relaxed their recommendations to allow intake of clear fluids until 1 hour before anesthesia.<sup>20-22</sup> An international consensus statement on procedural sedation advises liberal clear fluid intake in adults considered at low risk for regurgitation.<sup>23,24</sup> For adults scheduled for anesthesia, guidelines were not relaxed further, as there is limited supportive evidence available. However, because the physiology of gastric emptying in children and adults is comparable, a liberal fluid fasting policy in adults would likely not be accompanied by an increased risk of aspiration.<sup>18,25-28</sup> Accordingly, recent editorials propose a liberal fasting policy for clear fluids for adults, and some hospitals have started implementation.<sup>29-33</sup>

Based on these considerations, we implemented a liberal fasting policy for clear fluids in adults scheduled for procedures under anesthesia. This prospective study evaluated the implementation of this liberal policy, by studying the change in fasting duration. We also aimed to assess the safety of this liberal fasting policy with regard to regurgitation and aspiration. Finally, we studied if fasting duration was related to patient well-being (thirst and PONV).

## Methods

### Patient Selection and Fasting Policy

This was a prospective quality improvement study conducted between January 2016 and July 2021 that included patients aged 18 years and older who were scheduled for elective or urgent procedures under anesthesia at the University Medical Center Utrecht, a tertiary referral hospital in the Netherlands. We excluded patients scheduled for emergency surgery requiring intervention within 8 hours, those with preoperative intubation, and patients undergoing obstetric procedures. Race and ethnicity are not part of the standard anesthesiology health record and were therefore not available for this study. The University Medical Center Utrecht Medical Research Ethics Committee waived the need for informed consent because of the noninterventional nature of the study. This study followed the Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

### Key Points

**Question** Is the implementation of a liberal fasting policy of clear fluids before surgery associated with reduced fasting duration and improved patient well-being and safety?

**Findings** This quality improvement study included 76 451 patients. After implementation of the liberal fasting policy, fasting duration decreased.

**Meaning** Results suggest that a liberal fluid fasting policy was successfully implemented.

In the standard fasting policy, clear fluids were allowed until 2 hours before the start of anesthesia. Between 15 and 60 minutes before anesthesia, patients received 1 g of acetaminophen with sips of water. In the implemented liberal policy, intake of clear fluids was permitted until arrival in the operating room, with a maximum of 1 glass per hour, and it was advised that the acetaminophen be ingested with 1 glass of fluid. In patients with a policy of nothing by mouth, no additional fasting policy was advised. Even after implementation of the liberal policy, by protocol, we advised patients with a proven gastroparesis or previous aspiration to follow the prior, standard protocol. In both fasting policies, patients were instructed to fast for solids for 6 hours.

### Implementation of the Liberal Fasting Policy

Implementation of a new policy can be difficult.<sup>6,8</sup> We therefore used a stepwise plan at 4 different locations in our hospital where implementation of a new fasting policy was considered increasingly difficult (eMethods and eTable 1 in the [Supplement](#)). In June 2019, the liberal policy was implemented in the first location and other patients in the hospital still followed the old policy. Subsequent locations started implementation in November 2019, June 2020, and September 2020. After September 2020, all patients followed the liberal fasting policy.

### Data Collection

All data were documented as part of standard care and obtained from electronic medical records. Registration of thirst and amount of fluid intake was implemented in June 2019. Data regarding baseline characteristics, fasting duration, thirst, and fluid ingestion were collected from the hospital medical records (ChipSoft). Perioperative data regarding the occurrence of regurgitation, aspiration, PONV, and antiemetics administration were obtained from an Anesthesia Information Management System (AIMS) (Anstat [Carepoint]). The AIMS allows entering of free text, and also contains a critical incident reporting system to be filled out at the end of each case, when a pop-up offers several choices from a standardized computerized audit form, including aspiration as well as a free-text box.<sup>34</sup> If the pop-up is ignored, a reminder email is sent. This consistently results in a 95% completion rate for incident reporting.<sup>34</sup> Incident reports were searched for both the standardized category aspiration as well as by a free-text search for aspiration and regurgitation. Additionally, free-text records within the AIMS were systematically searched for the keywords aspiration, regurgitation, vomiting, bile, and food. Subsequently, 2 authors (M.M. and T.H.K.) assessed the medical

records of the patients with suspected regurgitation or aspiration, to confirm the diagnosis of regurgitation or aspiration. If the diagnosis of regurgitation was unclear, this was discussed until agreement. The medical records of patients with suspected aspiration pneumonia were also assessed by an independent pulmonologist (E.C.H.) to adjudicate the diagnosis pneumonia.

### Outcomes

The primary outcome was the fasting duration for clear fluids, which was defined as the time between the last intake of fluids (at least one-half glass or 75 mL) and the start of anesthesia. Secondary outcomes were the incidence of regurgitation, aspiration, aspiration pneumonia, preoperative thirst, the amount of fluid ingested, the incidence of PONV, and administration of antiemetics in the recovery room. eTable 2 in the [Supplement](#) describes the definitions of the outcomes of regurgitation, aspiration, and aspiration pneumonia. Thirst was defined by a 3-point numeric rating scale (no, intermediate, very thirsty). The amount of ingested fluid was defined as less than or equal to one-half glass, 1 glass, or 2 or more glasses. One glass contained approximately 150 mL.

### Sample Size

Ideally in studying implementation of an intervention with a risk for potential harm, a noninferiority analysis on the safety outcome would be preferred, in this case, this would include regurgitation and aspiration. However, because the incidence of these safety outcomes is rare, the number of patients that would have had to be evaluated to test the noninferiority with regard to safety was considered not feasible in terms of time and costs. Because the historical estimated incidence of regurgitation among patients scheduled in our hospital between 2013 and 2017 was 7 in 10 000, a noninferiority study taking this incidence into account would require inclusion of more than 50 000 patients in the liberal policy and would take a total of 5 years. We considered an implementation and evaluation cycle of 2 years to be optimal for successful implementation, and this would include an estimated 15 000 patients in the liberal fluid policy. This would provide sufficient numbers for evaluation of the primary outcome, the change in fasting time, and the secondary well-being outcomes. It would also result in multiple cases of regurgitation, allowing a reasonable estimate of the incidence of safety outcomes.

### Statistical Analysis

Baseline characteristics are presented as means, medians, or percentages, where appropriate. Patients in the standard policy group were compared with those in the new policy group, regardless of the implementation location. Normality for continuous variables was checked by visualization of quantile-quantile plots and histograms. Fasting duration was not normally distributed, and these data were presented as medians. The  $\chi^2$  test for categorical variables and the *t* test or Mann-Whitney *U* test for continuous variables were used to compare groups where appropriate.

Multiple variables showed missing data, with 26% of the data on fasting duration missing. Missing data were handled using multiple imputation using the mice library in R (R Foundation for Statistical Computing), creating 20 imputed data sets. All analyses were conducted in the imputed data sets and subsequently, estimates were pooled using the Rubin rule (eTable 3 in the [Supplement](#)). Missing data on registration of thirst and ingested fluids were not imputed as collection of these data started only after June 2019, resulting in missing data of 23% (thirst) and 20% (ingested fluids) after June 2019 and of 100% before June 2019. As kidney function was only measured for strict indications preoperatively, patients with missing preoperative glomerular filtration rate were assumed to be within normal ranges.

The association of the implementation of the liberal fasting policy on median monthly fasting duration was analyzed using an interrupted time series analysis. For this purpose, autoregressive integrated moving average (ARIMA) models were created, with the different implementation dates as possible outcome predictors.<sup>35</sup> Based on visualization of the observed and fitted models, 2 extra predictors were added that explained abrupt changes in fasting duration due to implementation of new registration forms in June 2016 and February 2017 (eMethods in the [Supplement](#)). ARIMA (0, 0, 0) models were tested, and the accuracies of the fitted models were checked by visual inspection of the (partial) autocorrelation function plots and were considered a good fit using the Ljung-Box *Q* test (test for autocorrelation applied to the residuals of the fitted model) and stationary *R*<sup>2</sup>. In addition to the ARIMA model fitted on the full data set of combined locations, separate models were created for the different locations, as it was expected that the success of implementation would differ across locations.

Similar ARIMA models were constructed to assess the association of the implementation of the liberal policy with the secondary well-being outcomes. The incidences of regurgitation, aspiration, and aspiration pneumonia were determined for both periods after either the standard or the liberal policy, and CIs were calculated using the 1-way analysis of variance test. Adjusted analyses were not performed for the safety outcomes, as the incidences of regurgitation and aspiration were too low to make accurate ARIMA models or to make clinically accurate risk estimations.

Further, a post hoc analysis was performed for the primary and secondary outcomes, excluding patients who underwent urgent surgery or endoscopic procedures as these procedures were associated with a higher risk for regurgitation. All *P* values were 2-sided, and statistical significance was set as *P* < .05. The imputation model was constructed in R, version 4.0.3 (R Core Team), and statistical analyses were performed with SPSS, version 26.0 (IBM Corp).

## Results

### Primary Outcome

Of the 76 451 patients (mean [SD] age, 56 [17] years; 39 530 male individuals [52%]; 36 921 female individuals [48%])

**Table 1. Baseline Characteristics Comparing Standard and Liberal Fluid Policy**

Characteristic	Policy, patients, No. (%)	
	Standard	Liberal
No.	59 636	16 815
Age, mean (SD), y	57 (17)	56 (18)
Sex		
Female	28 449 (48)	8472 (51)
Male	31 187 (52)	8343 (49)
BMI, mean (SD) <sup>a</sup>	26 (5.0)	26 (5.1)
Obesity <sup>b</sup>	11 103 (19)	2082 (18)
Smoking <sup>c</sup>	11 778 (20)	3143 (19)
Alcohol use <sup>d</sup>	33 018 (55)	9022 (54)
History		
Diabetes <sup>e</sup>	7407 (12)	2139 (13)
Kidney failure <sup>f</sup>	1336 (2.2)	323 (0.22)
GFR, mean (SD), mL/min	84 (26)	88 (27)
ASA classification <sup>g</sup>		
1	9693 (16)	2395 (14)
2	29 088 (49)	7810 (46)
≥3	20 855 (35)	6610 (40)
Urgent surgery <sup>h</sup>	3699 (6.2)	1009 (6.0)
Motion sickness/previous PONV	12 618 (21)	3253 (19)
Apfel criteria (0-3) <sup>i</sup>		
0	21 986 (37)	6003 (36)
1	23 995 (40)	7108 (42)
2	12 115 (20)	3350 (20)
3	1540 (2.6)	354 (2.1)
No. of anti-emetics administered intraoperatively <sup>j</sup>		16815
0	18584 (31)	3660 (22)
1	29 496 (49)	7998 (47)
2	9101 (15)	3817 (23)
≥	2488 (4.1)	1340 (8.0)
Anesthesia technique		
General	39 769 (67)	12 299 (73)
General + locoregional	2600 (4.4)	664 (3.9)
Locoregional anesthesia only	3224 (5.4)	841 (5.0)
Procedural sedation	13 387 (22)	2862 (17)
Monitored awake anesthesia care	656 (1.1)	150 (0.9)
Anesthesia depth		
General	42 369 (71)	12 962 (77)
Procedural sedation	13 387 (22)	2862 (17)
Awake procedure	3880 (6.5)	991 (5.9)

(continued)

included in the study, 59 036 (78%) followed the standard fasting policy, and 16 815 (22%) followed the liberal policy (Table 1). After implementation of the liberal fasting policy, overall median (IQR) fasting time decreased significantly from 3:07 (1:36-7:22) hours to 1:20 (0:48-2:24) hours ( $P < .001$ ). The 75th percentile decreased from 7:22 hours to 2:24 hours. Implementation was most successful in ambulatory surgery patients, leading to median (IQR) fasting times of 44:00 (29:00-135:00) minutes, whereas implementation

**Table 1. Baseline Characteristics Comparing Standard and Liberal Fluid Policy (continued)**

Characteristic	Policy, patients, No. (%)	
	Standard	Liberal
Surgical specialty <sup>k</sup>		
Group 1: airway manipulation without digestive tract involvement	7621 (13)	2529 (15)
Group 2: minor procedures without airway or digestive tract involvement	8617 (14)	2073 (12)
Group 3: major procedures without airway or digestive tract involvement	15 100 (25)	4935 (29)
Group 4: major procedures with digestive tract involvement	20 567 (35)	5803 (35)
Group 5: endoscopy of digestive tract	7731 (13)	1475 (8.8)

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; GFR, glomerular filtration rate; PONV, postoperative nausea and vomiting.

<sup>a</sup> Calculated as weight in kilograms divided by height in meters squared.

<sup>b</sup> Obesity was defined as a BMI of 30 or greater.

<sup>c</sup> Smoking was defined as currently smoking.

<sup>d</sup> Alcohol use was defined as drinking any alcohol daily.

<sup>e</sup> Diabetes included patients with oral antidiabetics and/or insulin.

<sup>f</sup> Kidney failure is defined as a GFR less than 30 mL/min.

<sup>g</sup> ASA classification is physical status according to American Society of Anesthesiology.

<sup>h</sup> Urgent surgery was defined as needing surgery between 8 and 24 hours.

<sup>i</sup> The Apfel criteria: patients got 1 point for a positive score on each of the following items: female sex, smoking, previous motion sickness/PONV; possible score 0 to 3.

<sup>j</sup> Included antiemetics are ondansetron, droperidol, dexamethasone, continuous propofol infusion.

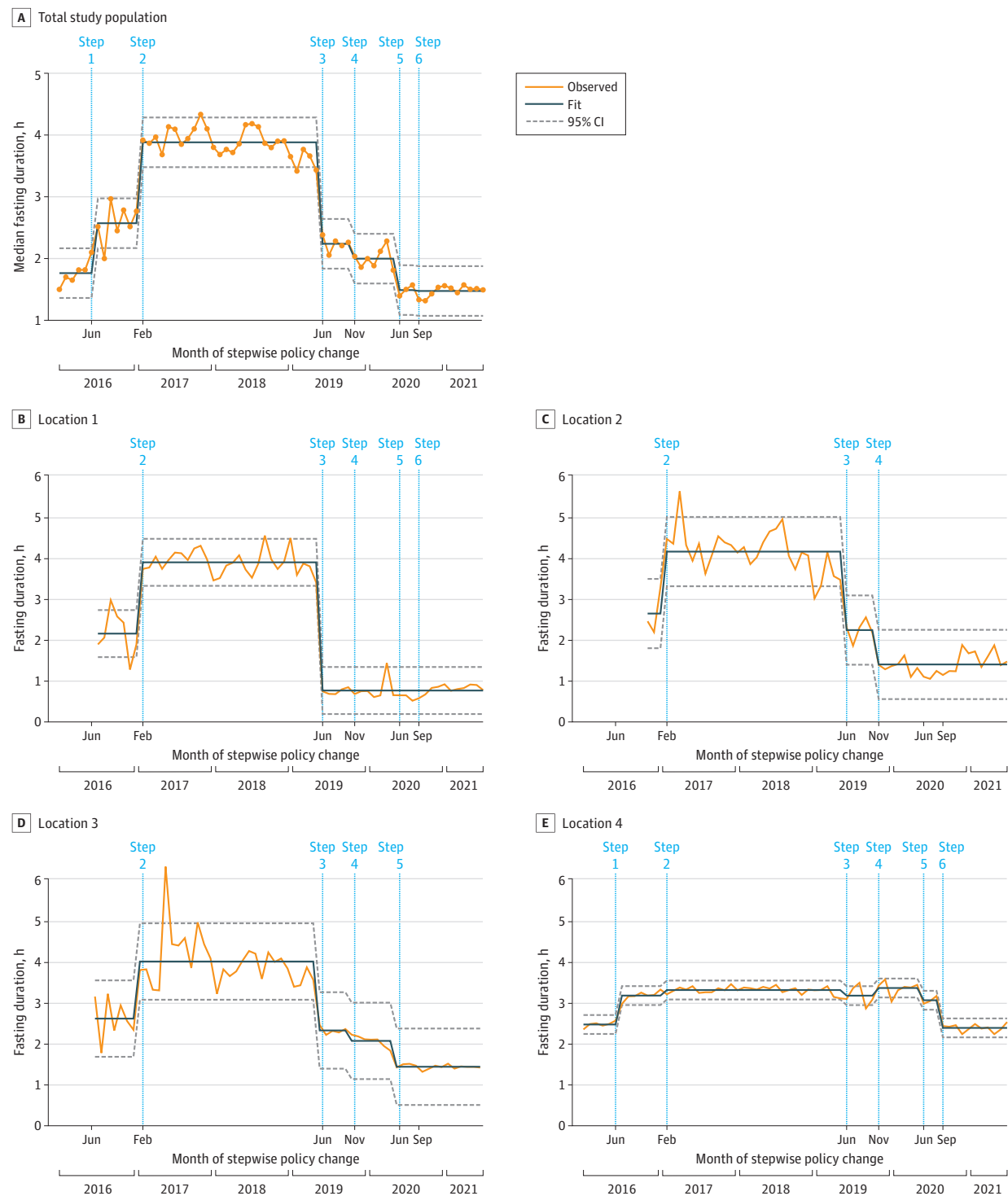
<sup>k</sup> Surgical specialties were grouped based on potential for airway manipulation by the surgeon, potential for involvement of the digestive tract, and classification as minor vs major surgery (group 1, otorhinolaryngology, maxillary surgery, bronchoscopy by pulmonologists; group 2, interventional cardiology, complex pain procedures, interventional radiology, electroconvulsive therapy; group 3, neurosurgery, orthopedics, plastic and reconstructive surgery, ophthalmology; group 4, cardiothoracic surgery, general surgery, gynecology, urology, vascular surgery; group 5, endoscopic procedures of the digestive tract).

was less successful in patients undergoing procedures at remote locations, with postimplementation median (IQR) fasting times of 2:24 (1:16-4:49) hours (Figure 1). The ARIMA models showed that implementation of the new fasting policy across the different locations explained the overall decrease in fasting duration (estimated change of 2:24 hours;  $P < .001$ ; stationary  $R^2 = 0.996$ ; Ljung-Box  $Q = 0.692$ ) (Figure 1). Analysis per location showed that the implementation outcome was largest in ambulatory care (estimated change 3:08 hours;  $P < .001$ ) and smallest at remote locations (estimated change of 0:41 hours;  $P < .001$ ) (Figure 1). Implementation of the liberal fasting policy at the ambulatory location already reduced fasting duration at the inpatient care locations before it was implemented there.

### Safety Outcome

In total, 146 patients (0.2%) regurgitated (Figure 2). The incidence of regurgitation was 24 (95% CI, 17-32) in 10 000 patients in the liberal policy group, compared with 18 (95% CI, 14-21) in 10 000 patients in the standard policy group (Table 2).

Figure 1. Autoregressive Integrated Moving Average Models for Observed and Fitted Median Fasting Duration Over Time



The vertical lines denote changes in policy or registration, and these moments were used as predictors. Step 1 (June 2016) is the change in registration forms in the remote locations, leading to better registration of glasses of fluid ingested. Step 2 (February 2017) is the change in registration forms in the operating rooms, leading to better registration of glasses of fluid ingested. Step 3 (June 2019) denotes implementation of the liberal fluid policy in ambulatory surgery (location 1). Step 4 (November 2019) denotes implementation of the

liberal fluid policy in the inpatient minor surgery area (location 2). Step 5 (June 2020) denotes implementation of the liberal fluid policy in the inpatient major surgery area (location 3). Step 6 (September 2020) denotes implementation of the liberal fluid policy in the remote locations (location 4). The change in fasting duration over time is shown for total study population (A), location 1 (B), location 2 (C), location 3 (D), and location 4 (E).



Figure 2. Flowchart With Incidences of Regurgitation, Aspiration, and Aspiration Pneumonia

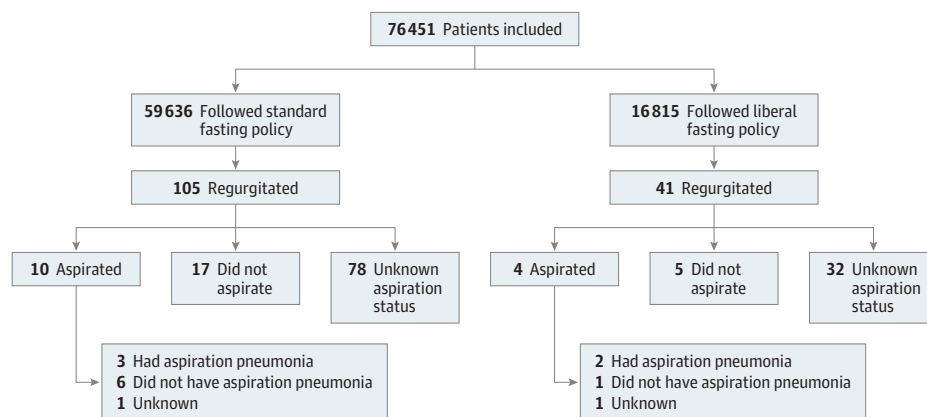


Table 2. Primary and Secondary Outcomes as Compared Between the Standard and Liberal Fasting Policy

Outcome	Policy, patient, No. (%)		P value
	Standard	Liberal	
No.	59 636	16 815	
Fasting duration, median (IQR), h:min	3:07 (1:36-7:22)	1:14 (0:48-2:24)	<.001
Incidence			
Of regurgitation	105 (0.18)	41 (0.24)	.09
Of aspiration			
Yes	10 (0.017)	4 (0.024)	
Unknown	78 (0.13)	32 (0.19)	.17
No	59 548 (99.9)	16 779 (99.8)	
Incidence of aspiration pneumonia	4 (0.007)	3 (0.018)	.18
Phase of anesthesia during regurgitation <sup>a</sup>			
Induction	27/105 (26)	12/41 (29)	
Maintenance	61/105 (58)	23/41 (56)	.82
Emergence	17/105 (16)	6/41 (15)	
Postoperative nausea and vomiting	6339 (10.6)	1587 (9.4)	<.001
Use of antiemetics	6538 (11.0)	1592 (9.5)	<.001
Ingestion of ≥1 glass <sup>b</sup>	3915/7888 (50)	10 010/14 018 (71)	<.001
Preoperative thirst <sup>c</sup>	3373/7362 (46)	4982/8615 (37)	<.001

<sup>a</sup> Percentages calculated based on number of patients who regurgitated in the standard (n = 105) and liberal policy (n = 41).

<sup>b</sup> A glass contains approximately 150 mL of clear fluids.

<sup>c</sup> Data registration was available only for patients scheduled after June 2019, and percentages were calculated based on available number of patients.

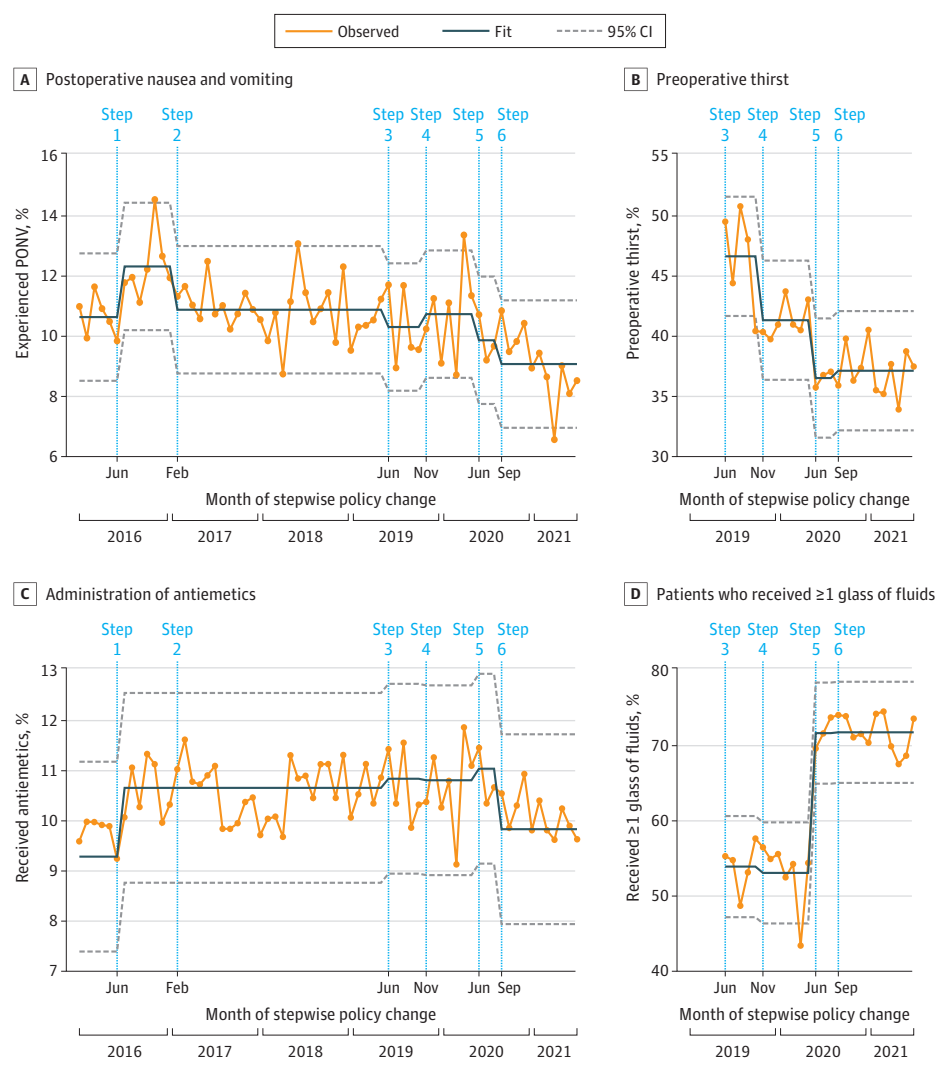
Patients who regurgitated were more frequently obese and more often underwent urgent surgery or endoscopy, and the majority regurgitated during maintenance of anesthesia (eTable 4 in the Supplement). Of the 146 patients who regurgitated, 14 (9.6%) had a proven aspiration, 22 (15%) did not aspirate, and in 110 (75%), it was unknown if they had aspirated (Figure 2). The incidence of aspiration in the liberal policy group was 2.4 (95% CI, 0.5-4.7) in 10 000 patients as compared with 1.7 (95% CI, 0.6-2.7) in 10 000 patients in the standard policy group (Table 2). Five of the 14 aspirating patients (36%) developed an aspiration pneumonia as adjudicated by pulmonologist E.C.H., and in 2 patients, this diagnosis was uncertain, but the patients were classified as having an aspiration pneumonia. Of these 7 patients with aspiration pneumonia, 3 followed the liberal policy, and 4 followed the standard policy resulting in an incidence of aspiration pneumonia of 1.8 (95% CI, 0.23-3.8) and 0.7 (95% CI, 0.01-1.3) in 10 000 patients, respectively. The pneumonia contributed to a longer hospital stay in

4 patients and may have contributed to death in 2 (eTable 5 in the Supplement).

### Well-being Outcome

The reported PONV incidence was lower in the liberal policy group, 9.4% (1587 of 16 815) vs 10.6% (6339 of 59 636;  $P < .001$ ), and patients received significantly less antiemetics in the liberal policy group (9.5% [1592 of 16 815] vs 11.0% [6538 of 59 636];  $P < .001$ ) (Table 2). The ARIMA models for PONV and administration of antiemetics were less accurate (stationary  $R^2$  of 0.235 and 0.43 respectively, with LJung-Box Q tests of 0.492 and 0.775), and implementation of the liberal policy did not explain decrease in PONV incidence and antiemetics administration (Figure 3). Analysis per location showed that implementation of the liberal fasting policy decreased antiemetic use in the ambulatory care location (estimated decrease 2.0%;  $P = 0.02$ ). PONV incidence and antiemetics administration decreased in the inpatient care location with

Figure 3. Autoregressive Integrated Moving Average Model of Observed and Fitted Values for Secondary Outcomes of Well-being



The vertical lines denote changes in policy or registration and these moments were used as predictors. Step 1 (June 2016) is the change in registration forms in the remote locations, leading to better registration of glasses of fluid ingested. Step 2 (February 2017) is the change in registration forms in the operating rooms, leading to better registration of glasses of fluid ingested. Step 3 (June 2019) denotes implementation of the liberal fluid policy in ambulatory surgery (location 1). Step 4 (November 2019) denotes implementation of the liberal fluid policy in the inpatient minor surgery area (location 2). Step 5 (June 2020) denotes implementation of the liberal fluid policy in the inpatient major surgery area (location 3). Step 6 (September 2020) denotes implementation of the liberal fluid policy in the remote locations (location 4). Depicted over time are the change in postoperative nausea and vomiting (PONV) in the recovery room (A), the change in administration of antiemetics in the recovery room (B), the change in preoperative thirst (C), and the change in percentages of patients who received 1 or more glasses of fluid preoperatively (D).

minor surgery (estimated decrease 2.4%;  $P = .01$  and 2.7%;  $P = .02$  respectively) but not in other locations.

Registration of thirst and amount of fluid intake started after June 2019 ( $n = 27\,284$ ). In the liberal policy group, 71% of patients (10 010 of 14 018) drank 1 or more glasses of clear fluids, and 37% (4982 of 8615) felt thirsty before surgery as compared with 50% (3915 of 7888) and 46% (3373 of 7362), respectively, in the standard policy group ( $P < .001$ ) (Table 2). The ARIMA models for thirst and fluid intake were accurate (stationary  $R^2$  of 0.741 and 0.904, respectively, with Ljung-Box Q tests of 0.001 and 0.938), and implementation of the fasting policy could explain the decrease in thirst and increase in fluid intake (Figure 3).

### Post hoc Analyses

After excluding patients scheduled for endoscopy or undergoing urgent procedures, 14 334 of the 62 561 remaining patients (23%) followed the liberal policy (eTable 6 in the Supplement). Median (IQR) fasting time in the liberal policy group was

1:14 (0:45-2:11) hours, compared with 2:54 (1:29-6:21) hours in the standard policy group and, based on the ARIMA analyses, could be explained by the stepwise implementation (eFigure in the Supplement). eTable 6 in the Supplement describes secondary outcomes with regard to well-being and safety. In both policies, the incidences of regurgitation, aspiration, and aspiration pneumonia were lower than in the total population. The beneficial association of the liberal policy with well-being was comparable to that of the total population.

### Discussion

This was a quality improvement study of the implementation of a liberal fasting policy that allowed adults scheduled for procedures under anesthesia to drink clear fluids until arrival in the operating room. Time series analysis showed an associated estimated decrease in fasting duration of 3:07 hours to a median postimplementation duration of 1:10 hours, and 75%

of patients had a fasting duration of 2:24 hours or shorter, suggesting implementation success. The liberal policy was associated with improved patient well-being as patients felt less thirsty. We also found a small decrease in PONV and antiemetics administration in minor surgery. The incidence of regurgitation was 24 (95% CI, 17-32) in 10 000 patients after implementation, compared with 18 (95% CI, 14-21) in 10 000 patients before implementation. Inferiority of the liberal policy with regard to safety could not be ruled out.

### Implication for Current Practices and Future Research

Current fasting policies advocated in guidelines are poorly implemented in clinical practice.<sup>4,10</sup> This study offers a strategy on the successful implementation of a preoperative fasting policy (eMethods in the [Supplement](#)). In addition, our results add to the available literature that a liberal fluid policy is associated with improved patient well-being. Furthermore, it suggests that the risk of regurgitation and aspiration is likely to be within clinically acceptable limits. At the very least, results suggest that surgery in patients who (accidentally) drink clear fluids within 2 hours before anticipated anesthesia induction in a standard fasting policy should no longer have their procedures be postponed or canceled. Finally, as conducting a randomized clinical trial comparing incidences of aspiration between a standard and a liberal fasting fluid policy is challenging, we call for wider implementation of a liberal fluid policy. If fasting duration, regurgitation, and aspiration are monitored adequately and the results are shared, this may result in more accurate estimates of the incidence of aspiration and regurgitation.

### Regurgitation

Both in the standard and liberal policy, the incidence of regurgitation was higher than anticipated. The higher incidence could be explained by better registration due to a Hawthorne effect. Another contributing factor could be an increase in the number of more complex procedures under procedural sedation at the endoscopy department in our hospital. Because such procedures may be painful and require higher doses of opioids, these relatively often result in nausea with subsequent regurgitation, which was suggested by our results showing a higher incidence of regurgitation in endoscopic procedures. Although higher than anticipated, our current incidence of regurgitation matches the recent literature.<sup>12,17</sup>

The German prospective multicenter observational (NIKS) study of 12 093 children evaluated the safety of a liberal fluid policy.<sup>17</sup> For children undergoing elective procedures after a fasting duration of 2.3 hours, the reported incidence of regurgitation was 32 per 10 000 patients, which is higher than in our study. No significantly higher incidence was observed in children with a fasting duration of 1 to 2 hours. A recent retrospective record study in 155 830 adults evaluated the standard 2 hours of fasting for clear fluids and reported an incidence of regurgitation in elective anesthesia of 0.6 per 10 000 patients.<sup>12</sup>

This incidence is lower than in our population and likely to be attributed to the retrospective study design. The authors noticed that some anesthesiologists considered regurgitation without aspiration relatively innocent and were inclined not to record this, leading to an underestimation. We used regurgitation as an outcome to evaluate the safety of our liberal policy because its incidence is higher than aspiration and aspiration pneumonia, making the safety estimates more reliable.

### Aspiration

Previously, the estimated incidence of aspiration was reportedly between 1 and 10 per 10 000 patients, which was considered to be an acceptable risk.<sup>13</sup> In our study, the overall incidence of aspiration was 1.8 per 10 000. The incidence of aspiration was slightly higher in the liberal group compared with the standard group. More recent studies also investigated the incidence of aspiration, both in standard and liberal fasting policies. In the prospective multicenter Anesthesia Practice in Children Observational Trial (APRICOT) in children, including elective and emergency procedures, the incidence of aspiration was 9 per 10 000 patients.<sup>36</sup> In the NIKS study, the incidence of (suspected) aspiration in elective procedures was 8 per 10 000 patients, which is higher than in our study. In a prospective study by McCracken and Montgomery evaluating a liberal fasting policy in elective ambulatory surgery in adults, the incidence of aspiration was 0.7 per 10 000.<sup>24</sup>

### Strengths and Limitations

The major strength of this study was the successful implementation of a liberal fasting policy and adequate recording of fasting duration, regurgitation, and aspiration. In addition, to our best knowledge, this was the largest study evaluating a liberal fluid policy in adults. Our study also has some limitations. It was underpowered to conclude on safety of the liberal fasting protocol with regard to regurgitation and aspiration. In addition, because of the observational design, residual confounding could not be ruled out.

## Conclusions

Results of this quality improvement study suggest that a liberal fasting policy was associated with a clinically relevant reduction in fasting duration and improved patient well-being with regard to preoperative thirst and PONV. Although a slightly higher incidence of regurgitation could not be ruled out, wider implementation of such a policy may be advocated, as results are still within the clinically accepted risks margins. Results suggest that surgical procedures in patients who drink clear fluids within 2 hours before anticipated anesthesia should not be postponed or canceled. To obtain definitive estimates on safety outcomes, there is need for collaborative multicenter studies evaluating a liberal fluid fasting policy.

### ARTICLE INFORMATION

Accepted for Publication: September 16, 2022.

Published Online: January 4, 2023.  
doi:10.1001/jamasurg.2022.5867

Author Affiliations: Department of Anesthesiology and Intensive Care Medicine, University Medical Center Utrecht, Utrecht, the Netherlands



(Marsman, Kappen, Vernooij, van Waes, van Klei); Department of Information Technology, University Medical Center Utrecht, Utrecht, the Netherlands (Kappen); Department of Pulmonology, University Medical Center Utrecht, Utrecht, the Netherlands (van der Hout); Department of Anesthesia and Pain Management, Toronto General Hospital, University Health Network Toronto, Ontario, Canada (van Klei); Department of Anesthesiology and Pain Medicine, Temerty Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada (van Klei); Toronto General Hospital Research Institute, Toronto, Ontario, Canada (van Klei).

**Author Contributions:** Dr Marsman had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**Concept and design:** Marsman, Kappen, van Klei.  
**Acquisition, analysis, or interpretation of data:** All authors.

**Drafting of the manuscript:** Marsman, Kappen, van Klei.

**Critical revision of the manuscript for important intellectual content:** All authors.

**Statistical analysis:** Marsman, Kappen, Vernooij.  
**Obtained funding:** van Klei.

**Administrative, technical, or material support:** van Klei.

**Supervision:** Kappen, van Waes, van Klei.

**Conflict of Interest Disclosures:** None reported.

**Funding/Support:** This research was supported by the department of anesthesiology of the University Medical Center Utrecht, the Netherlands, and the Heinz Company, which gave material support by offering 400 bottles of lemonade to the department of anesthesiology and intensive care medicine to promote implementation of the liberal fasting protocol.

**Role of the Funder/Sponsor:** The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

## REFERENCES

- Smith I, Kranke P, Murat I, et al; European Society of Anaesthesiology. Perioperative fasting in adults and children: guidelines from the European Society of Anaesthesiology. *Eur J Anaesthesiol*. 2011;28(8):556-569. doi:10.1097/EJA.0b013e3283495ba1
- Brady M, Kinn S, Stuart P. Preoperative fasting for adults to prevent perioperative complications. *Cochrane Database Syst Rev*. 2003;(4):CD004423. doi:10.1002/14651858.CD004423
- American Society of Anesthesiologists Committee. Practice guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures: an updated report by the American Society of Anesthesiologists Committee on Standards and Practice Parameters. *Anesthesiology*. 2011;114(3):495-511. doi:10.1097/ALN.0b013e32818fcbfd9
- Davies A, Pang WS, Fowler T, Dewi F, Wright T. Preoperative fasting in the department of plastic surgery. *BMJ Open Qual*. 2018;7(4):e000161. doi:10.1136/bmjopen-2017-000161
- El-Sharkawy AM, Daliya P, Lewis-Lloyd C, et al; FaST Audit Group; East Midlands Surgical Academic Network (EMSAN). Fasting and surgery timing (FaST) audit. *Clin Nutr*. 2021;40(3):1405-1412. doi:10.1016/j.clnu.2020.08.033
- Hertzum M, Simonsen J. How come nothing changed? reflections on the fasting-time project. *Stud Health Technol Inform*. 2020;270:971-975. doi:10.3233/SHTI200306
- Merchant RN, Chima N, Ljungqvist O, Kok JNJ. Preoperative fasting practices across 3 anesthesia societies: survey of practitioners. *JMIR Perioper Med*. 2020;3(1):e15905. doi:10.2196/15905
- Newton RJG, Stuart GM, Willdridge DJ, Thomas M. Using quality improvement methods to reduce clear fluid fasting times in children on a preoperative ward. *Paediatr Anaesth*. 2017;27(8):793-800. doi:10.1111/pan.13174
- Zia F, Cosic L, Wong A, et al. Effects of a short message service (SMS) by cellular phone to improve compliance with fasting guidelines in patients undergoing elective surgery: a retrospective observational study. *BMC Health Serv Res*. 2021;21(1):27. doi:10.1186/s12913-020-06039-y
- Zhu Q, Li Y, Deng Y, et al. Preoperative fasting guidelines: where are we now? findings from current practices in a tertiary hospital. *J Perianesth Nurs*. 2021;36(4):388-392. doi:10.1016/j.jopan.2020.09.002
- Sakai T, Planinsic RM, Quinlan JJ, Handley LJ, Kim TY, Hilmi IA. The incidence and outcome of perioperative pulmonary aspiration in a university hospital: a 4-year retrospective analysis. *Anesth Analg*. 2006;103(4):941-947. doi:10.1213/01.ane.0000237296.57941.e7
- Sun J, Wei G, Hu L, Liu C, Ding Z. Perioperative pulmonary aspiration and regurgitation without aspiration in adults: a retrospective observational study of 166,491 anesthesia records. *Ann Palliat Med*. 2021;10(4):4037-4046. doi:10.21037/apm-20-2382
- Ng A, Smith G. Gastroesophageal reflux and aspiration of gastric contents in anesthetic practice. *Anesth Analg*. 2001;93(2):494-513. doi:10.1213/00000539-200108000-00050
- McCracken GC, Smith AF. Breaking the fast for procedural sedation: changing risk or risking change? *Anaesthesia*. 2020;75(8):1010-1013. doi:10.1111/anae.15018
- Disma N, Frykholm P, Cook-Sather SD, Lerman J. Pro-con debate: 1- vs 2-hour fast for clear liquids before anesthesia in children. *Anesth Analg*. 2021;133(3):581-591. doi:10.1213/ANE.0000000000005589
- Andersson H, Zarén B, Frykholm P. Low incidence of pulmonary aspiration in children allowed intake of clear fluids until called to the operating suite. *Paediatr Anaesth*. 2015;25(8):770-777. doi:10.1111/pan.12667
- Beck CE, Rudolph D, Mahn C, et al. Impact of clear fluid fasting on pulmonary aspiration in children undergoing general anesthesia: results of the German prospective multicenter observational (NIKS) study. *Paediatr Anaesth*. 2020;30(8):892-899. doi:10.1111/pan.13948
- Schmidt AR, Buehler KP, Both C, et al. Liberal fluid fasting: impact on gastric pH and residual volume in healthy children undergoing general anesthesia for elective surgery. *Br J Anaesth*. 2018;121(3):647-655. doi:10.1016/j.bja.2018.02.065
- Cook TM, Woodall N, Frerk C; Fourth National Audit Project. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. part 1: anaesthesia. *Br J Anaesth*. 2011;106(5):617-631. doi:10.1093/bja/aer058
- Linscott D. SPANZA endorses 1-hour clear fluid fasting consensus statement. *Paediatr Anaesth*. 2019;29(3):292. doi:10.1111/pan.13585
- Rosen D, Gamble J, Matava C; Canadian Pediatric Anesthesia Society Fasting Guidelines Working Group. Canadian Pediatric Anesthesia Society statement on clear fluid fasting for elective pediatric anesthesia. *Can J Anaesth*. 2019;66(8):991-992. doi:10.1007/s12630-019-01382-z
- Frykholm P, Disma N, Andersson H, et al. Preoperative fasting in children: a guideline from the European Society of Anaesthesiology and Intensive Care. *Eur J Anaesthesiol*. 2022;39(1):4-25. doi:10.1097/EJA.0000000000001599
- Green SM, Leroy PL, Roback MG, et al; International Committee for the Advancement of Procedural Sedation. An international multidisciplinary consensus statement on fasting before procedural sedation in adults and children. *Anaesthesia*. 2020;75(3):374-385. doi:10.1111/anae.14892
- McCracken GC, Montgomery J. Postoperative nausea and vomiting after unrestricted clear fluids before day surgery: a retrospective analysis. *Eur J Anaesthesiol*. 2018;35(5):337-342. doi:10.1097/EJA.0000000000000760
- Grimm M, Koziolok M, Kühn JP, Weitschies W. Interindividual and intraindividual variability of fasted state gastric fluid volume and gastric emptying of water. *Eur J Pharm Biopharm*. 2018;127:309-317. doi:10.1016/j.ejpb.2018.03.002
- Beck CE, Chandrakumar T, Sümpelmann R, et al. Ultrasound assessment of gastric emptying time after intake of clear fluids in children scheduled for general anesthesia—a prospective observational study. *Paediatr Anaesth*. 2020;30(12):1384-1389. doi:10.1111/pan.14029
- Marsman M, Pouw N, Moons LMG, van Klei WA, Kappen TH. Gastric fluid volume in adults after implementation of a liberal fasting policy: a prospective cohort study. *Br J Anaesth*. 2021;127(3):e85-e87. doi:10.1016/j.bja.2021.06.006
- Van de Putte P, Perlas A. Ultrasound assessment of gastric content and volume. *Br J Anaesth*. 2014;113(1):12-22. doi:10.1093/bja/aeu151
- Søreide E, Eriksson LI, Hirlekar G, et al; Task Force on Scandinavian Pre-operative Fasting Guidelines, Clinical Practice Committee Scandinavian Society of Anaesthesiology and Intensive Care Medicine. Preoperative fasting guidelines: an update. *Acta Anaesthesiol Scand*. 2005;49(8):1041-1047. doi:10.1111/j.1399-6576.2005.00781.x
- Søreide E, Holst-Larsen H, Reite K, Mikkelsen H, Søreide JA, Steen PA. Effects of giving water 20-450 mL with oral diazepam premedication 1-2 h before operation. *Br J Anaesth*. 1993;71(4):503-506. doi:10.1093/bja/71.4.503
- Friedrich S, Meybohm P, Kranke P. NPO per os (NPO) guidelines: time to revisit? *Curr Opin Anaesthesiol*. 2020;33(6):740-745. doi:10.1097/ACO.0000000000000920

32. Morrison CE, Ritchie-McLean S, Jha A, Mythen M. Two hours too long: time to review fasting guidelines for clear fluids. *Br J Anaesth*. 2020; S0007-0912(19)31004-9. doi:10.1016/j.bja.2019.11.036
33. Rüggeberg A, Dubois P, Böcker U, Gerlach H. [Preoperative fluid fasting: establishment of a liberal fluid regimen using fasting cards]. *Anaesthesist*. 2021;70(6):469-475. doi:10.1007/s00101-021-00918-7
34. Munting KE, van Zaane B, Schouten AN, van Wolfswinkel L, de Graaff JC. Reporting critical incidents in a tertiary hospital: a historical cohort study of 110,310 procedures. *Can J Anaesth*. 2015; 62(12):1248-1258. doi:10.1007/s12630-015-0492-y
35. Schaffer AL, Dobbins TA, Pearson SA. Interrupted time series analysis using autoregressive integrated moving average (ARIMA) models: a guide for evaluating large-scale health interventions. *BMC Med Res Methodol*. 2021;21(1):58. doi:10.1186/s12874-021-01235-8
36. Habre W, Disma N, Virag K, et al; APRICOT Group of the European Society of Anaesthesiology Clinical Trial Network. Incidence of severe critical events in paediatric anaesthesia (APRICOT): a prospective multicentre observational study in 261 hospitals in Europe. *Lancet Respir Med*. 2017;5(5):412-425. doi:10.1016/S2213-2600(17)30116-9