Ringer's Lactate Versus Normal Saline in Urgent Cesarean Delivery in a Resource-Limited Setting: A Pragmatic Clinical Trial

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BACKGROUND: Crystalloids are used routinely for perioperative fluid management in cesarean delivery. Few studies have determined the crystalloid of choice in obstetric anesthesia. We compared the effects of Ringer's lactate (RL) versus 0.9% normal saline (NS) on maternal and neonatal blood pH and 24-hour postoperative morbidity in urgent cesarean delivery in a low-resource setting. Our hypothesis was that RL would result in 30% less acidosis than NS.

METHODS: This was a pragmatic prospective double-blind randomized controlled trial in the Mulago National Referral Hospital Labor Ward Theater from September 2011 to May 2012. Five hundred parturients were studied; 252 were randomly assigned to NS and 248 to RL groups. Preoperative and postoperative maternal venous blood gases and placental umbilical arterial cord blood gases were analyzed. The primary outcome was incidence of maternal acidosis, as defined by a postoperative drop in venous pH below 7.32 or reduction in base excess below −3 in a previously normal parturient. Maternal 24-hour postoperative morbidity, neonatal pH, and neonatal base excess were the main secondary outcomes. The study was registered in ClinicalTrials.gov as NCT01585740.

RESULTS: The overall incidence of maternal acidosis was 38% in NS and 29% in RL (relative risk, 1.29; 95% confidence interval, 1.01–1.66; $P = .04$). Thirty-two percent of parturients in NS experienced a drop in venous pH below 7.32 postoperatively, compared with 19% in RL (relative risk, 1.65; 95% confidence interval, 1.18–2.31; $P = .003$). The comparative drop in base excess postoperatively below −3 between the 2 groups was not statistically significant. There were no significant differences in the incidence of maternal 24-hour postoperative morbidity events and neonatal outcomes between the 2 groups.

CONCLUSIONS: NS may be a safe choice for intraoperative fluid therapy in urgent cesarean delivery as RL, albeit with an increased incidence of metabolic acidosis. (Anesth Analg 2017;125:00–00)

The most common fluid strategies in obstetric anesthesia are usually aimed at the management and control of spinal hypotension[1,2] and replacement of fluid losses, to maintain intravascular volume and tissue perfusion, thereby preventing severe hypotension, postoperative nausea and vomiting, and metabolic acidosis.[3,4] These fluid strategies have largely compared colloids to crystalloids but have not focused on the type of crystalloid in this population.[5–8] Furthermore, spinal hypotension,[9] fetal acidosis,[10,11] and higher mortality in preterm infants[12] are major concerns to the anesthesia provider.

A total of 0.9% normal saline (NS) is used routinely in our institution, and in most resource-limited settings, due to its "near physiologic/isotonic" properties.[13] However, the administration of saline in large volumes has been associated with undesirable effects, including hyperchloremic metabolic acidosis,[14] acute kidney injury,[15] bowel edema,[16] pulmonary edema,[17] tissue anoxia,[18] dilutional hypocoagulability,[19] and hyperkalemia following renal transplant.[20] The common alternative, Ringer's lactate (RL), has a closer ionic composition to blood, less chloride content, and is considered a more balanced crystalloid than NS.[21–28] Most guidelines for fluid therapy in surgical patients recommend the use of RL due to the hyperchloremic metabolic acidosis associated with 0.9% saline. However, this evidence is based on underpowered randomized clinical trials, showing no overt evidence of harm. There are limited data on the type of perioperative fluid in the obstetric surgical population.[29] Moreover, the anesthesia provider in the low-resource setting is likely to encounter either a dehydrated mother or a mother who has received NS for resuscitation preoperatively.[30] The question is whether NS should be used intraoperatively for fluid therapy in urgent cesarean delivery. Therefore, in this pragmatic prospective double-blind randomized control trial, we compared the effects of RL versus NS on the maternal and neonatal acid-base status in urgent cesarean delivery. Our hypothesis was that, compared with NS, the intraoperative infusion of RL would result in 30% less incidence of acidosis.

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METHODS

This study was designed as a prospective double-blind randomized controlled trial and registered before completion of data collection in ClinicalTrials.gov: registration number, NCT01585740; principal investigator's name, Dr Emmanuel Timarwa Ayebale; date of registration, April 5, 2012. The study protocol was approved by the School of Medicine Research and Ethics Committee (institutional review board number: REF 2011–150). Written informed consent was obtained from each patient before randomization to treatment groups. The Research and Ethics Committee ruled the attainment of informed consent in urgent cesarean delivery as possible and ethical. However, since arterial blood gas measurement was not part of our routine perioperative care for parturients, we chose to perform venous blood gases as a reasonable substitute. The study was conducted between September 2011 and May 2012 at the Department of Anesthesia and Labor ward theater of a tertiary university teaching hospital (Mulago National Referral Hospital, Kampala, Uganda). The Labor ward theater performs at least 15, mostly urgent, cesarean deliveries per day; in some of these urgent cesarean deliveries, maternal and/or fetal compromise is evident.

Study Patients

All informed consented parturients for urgent cesarean delivery surgery at Mulago National Referral Hospital with American Society of Anesthesiology class II were assessed for enrolment. Patients who declined to consent were not enrolled, and those whose spinal anesthesia was not successful were excluded. Candidate parturients were selected from the operating theater list in the labor ward theater. In total, 576 mothers were screened; 500 met the inclusion criteria and were recruited into the study, with 252 in the NS and 248 in RL groups.

Study Protocol

Simple randomization, using computer-generated random numbered codes in sealed envelopes, was used to allocate parturients to either NS or RL after recruitment in the labor ward. The study fluids were prepared in colorless infusion bottles labeled with codes and administered according to a corresponding patient code. The patient could receive up to 5 L of the assigned fluid. The assigned fluid was continued in the recovery area until discharge to the ward.

Packaging was done at the fluids manufacturing factory (Abacus Parenteral Drugs Uganda Ltd, Kampala, Uganda). Each patient code was assigned to ten 500-mL infusion bottles of either RL or NS. Through the randomization process and allocation of fluid, the patient received only the fluid assigned as the principal intraoperative fluid.

Perioperative Management

The indication for cesarean delivery, mother's weight, and decision to delivery interval (DDI) were recorded. Baseline blood samples were obtained upon entry into theater, prior to administration of spinal anesthesia. A sample of maternal venous blood was drawn for baseline venous blood gas measurement in 2-mL heparinized Pico 70 (Radiometer Medical, Brønshøj, Denmark) blood gas sampling syringes and analyzed within 15 minutes. Another sample of maternal venous blood was drawn for preoperative urea and creatinine measurements. Baseline vital signs were recorded upon entry into the theater. Spinal anesthesia was administered via a midline subarachnoid block through the L3–L4 or L4–L5 interspaces in the sitting position using 12 mg preservative-free hyperbaric bupivacaine (0.5%) injected with 25-gauge Spinocan Quincke spinal needles (B. Braun, Melsungen, Germany). Patients then lay supine with a 15° left lateral tilt. The level of the sensory block was assessed using a pin prick and light touch, followed by the administration of 2 g ceftriaxone prior to skin incision. Vasopressors were used to treat hypotension, defined as a greater than 20% reduction in systolic blood pressure from baseline. In such cases, the supervising anesthetist administered phenylephrine as 40-μg intravenous (IV) boluses, titrated to maintain near-baseline systolic blood pressure. Study crystalloid was administered as the sole intraoperative fluid. Blood loss was estimated by visual inspection of gauze pads, mops, and the total amount of blood suctioned. Blood transfusion was considered if the intraoperative blood loss exceeded 1000 mL. Upon delivery of the infant, 5 units of oxytocin were administered IV as a slow bolus. The neonate's Apgar score was recorded at 1 and 5 minutes after delivery. Immediately after delivery and cord ligature, prior to placental separation, a sample of placental umbilical cord arterial blood was collected and analyzed within 15 minutes. At the end of the operation, mothers were transferred to the recovery area in the left lateral position with continued infusion of the study fluid. Once stable enough to be transferred to the ward, the study fluid was discontinued, and a sample of venous blood was drawn for postoperative venous blood gas measurements and analyzed within 15 minutes. The total volume of study fluid infused intraoperatively, estimated blood loss, urine output, and total time of the operation (minutes) were recorded. Postoperative analgesia and fluid management were provided according to standard hospital protocols. Mothers were monitored for 24 hours postoperatively for complications, which were recorded using the Postoperative Morbidity Survey (POMS), a reliable and valid survey of short-term postoperative morbidity in major elective surgery.[31]

Data Documentation

A data collection sheet (Supplemental Digital Content, Figure, http://links.lww.com/AA/B810) was administered by trained research coordinators prior to the commencement of the study, and results entered into a database. Data monitoring and source data verification were conducted according to a prespecified plan. The data and safety monitoring committee reviewed data after the enrolment of 50% of the participants. The principal investigators checked for completeness and accuracy at the end of every day to ensure that data were collected according to standard operation procedures. Data from every questionnaire verified for completeness and accuracy were entered into EpiData 2.1b software (The EpiData Association, Odense, Denmark). Blood urea nitrogen and creatinine were measured in the Mulago National Referral Hospital Clinical Chemistry Laboratory using a Roche COBAS Integra 400 plus analyzer with standard reagent solutions (Roche Diagnostics Ltd, Rotkreuz,

Switzerland). Blood gases were measured on a Radiometer ABL 800 Flex Basic series blood gas machine (Radiometer Medical, Brønshøj, Denmark).

Statistical Analyses

The primary outcome was incidence of maternal acidosis, as defined by the proportion of mothers who exhibited a postoperative drop in venous pH below 7.32 or reduction in base excess below −3 in a previously normal parturient preoperatively. Maternal 24-hour postoperative morbidity, neonatal pH, and neonatal base excess were the main secondary outcome variables.

Primary analysis was based on the intention-to-treat principle. We analyzed the data using Stata version 14.1 software (StataCorp, College Station, TX) as follows: We made comparisons between the 2 groups of patients receiving NS and RL on the incidence of maternal acidosis. For the continuous variables, we made the comparisons using the Student *t* test for normally distributed variables. Parametric data were then summarized using means and corresponding standard deviations. The only variable that was nonparametrically distributed was fetal carbon dioxide concentration. For this variable, comparisons were made using the Mann-Whitney *U* test (Wilcoxon rank sum test) and summarized using median with corresponding interquartile ranges. We used a difference in the means as the measure of strength of the relationships for the continuous data. Comparisons between categorical variables were made using the Pearson χ^2 test.

Sample Size Justification

A sample size of 490 parturients, with 245 per group, was calculated to detect 30% less incidence of acidosis in RL compared to NS (90% power at the .05 significance level).

RESULTS

Baseline Demographics and Clinical Characteristics of Each Group

In total, 576 parturients were assessed for eligibility between September 2011 and April 2012 in the Mulago Hospital Labor Suite. Of these parturients, 76 were excluded and 500 were randomly assigned to the 2 treatment groups (Figure). There were no clinically important differences in baseline parturient characteristics between treatment groups (Table 1). The overall mean perioperative arterial pressure was 81 ± 31 mm Hg, and the mean urine output was 334

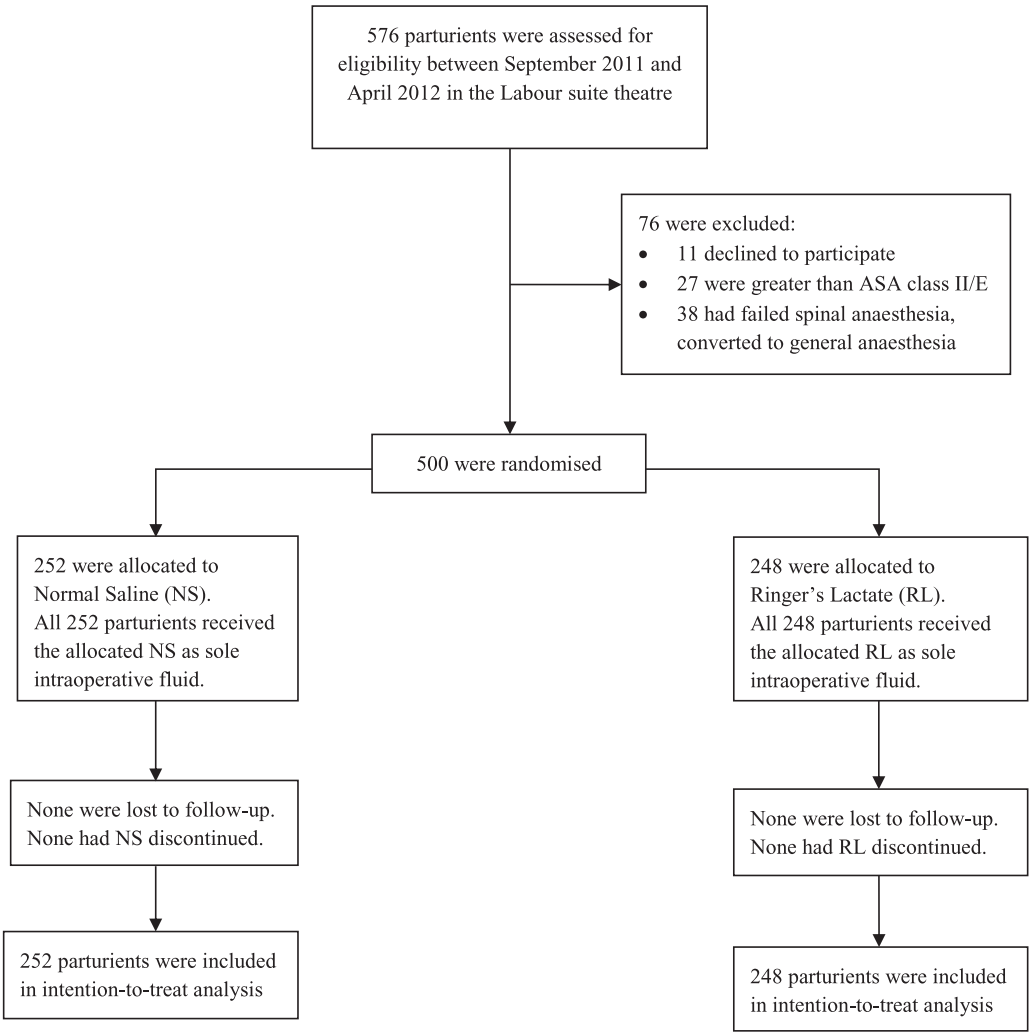

Figure. Study flow diagram. ASA indicates American Society of Anesthesiology; NS, normal saline; RL, Ringer's lactate.

Table 1. Baseline Maternal and Fetal Characteristics

Variable	NS (N = 252)	RL (N = 248)
Maternal characteristics		
Mean age (y)	27.2 ± 6.4	26.7 ± 6.2
Weight (kg)	67.1 ± 10.8	67.1 ± 10.6
Mean arterial pressure		
Highest (mm Hg)	94.2 ± 8.5	93.7 ± 8.6
Low (mm Hg)	65.7 ± 10.3	66.3 ± 8.9
Mean (mm Hg)	80 ± 8.1	82.7 ± 42.5
Preoperative renal function		
Blood urea nitrogen (mmol/L)	5 ± 5.4	4 ± 1.7
Creatinine (μmol/L)	75.3 ± 23.9	66 ± 25
Electrolytes (mmol/L)		
Potassium	3.7 ± 0.5	3.8 ± 0.5
Calcium	1.18 ± 0.08	1.19 ± 0.06
Sodium	136.9 ± 3.2	137.6 ± 3.2
Chloride	108.6 ± 3.3	109 ± 3
Acid-base		
pH	7.37 ± 0.05	7.38 ± 0.05
Lactate (mmol/L)	3.4 ± 1.5	3.3 ± 1.5
HCO_3^- (mmol/L)	19.9 ± 2.6	20.1 ± 2.2
Base excess (mmol/L)	−5.2 ± 3.6	−5.2 ± 3.1
Anion gap (mmol/L)	8.4 ± 3.3	8.5 ± 3.7
Surgery characteristics		
Indication for surgery		
Previous scar	50 (51)	49 (50)
Obstructed labor	71 (50)	71 (50)
CPD	29 (47)	33 (53)
Poor progress of Labor	22 (67)	11 (33)
Fetal distress	37 (46)	43 (54)
Others	42 (51)	41 (49)
DDI (h)	4.9 ± 5.9	4.6 ± 5.9
Duration of surgery (min)	44.5 ± 13.6	48.9 ± 42.6
Volume of fluid used (mL)	2384.9 ± 440.3	2381.9 ± 414.9
Intraoperative urine output (mL)	326.5 ± 195.3	342.4 ± 161.9
Fetal characteristics		
Apgar score		
At 1 min	8.1 ± 1.3	8.1 ± 1.3
At 5 min	9.7 ± 0.9	9.7 ± 0.9
Birth weight (kg)	3.4 ± 0.6	3.4 ± 0.5

Data are represented as n (%) or mean ± standard deviation.

Abbreviations: CPD, cephalo-pelvic disproportion; DDI, decision to delivery interval; NS, normal saline; RL, Ringer's lactate.

± 180 mL. The mean estimated blood loss was 612 ± 488 mL; only 6 parturients in NS and 7 in RL were transfused perioperatively.

Primary Outcome

The overall incidence of maternal acidosis was 38% (96/252) in NS and 29% (73/248) in RL (relative risk, 1.29; 95% confidence interval [CI], 1.01–1.66; $P = .04$).

Maternal pH. Thirty-two percent (66/206) of parturients in NS with a normal preoperative pH experienced a drop in venous pH below 7.32 postoperatively, compared with 19% (43/222) in RL (relative risk, 1.65; 95% CI, 1.18–2.31; $P = .003$). Forty-six parturients in NS and 26 in RL had a preoperative venous pH below 7.32 and were thus excluded from the analysis.

Maternal Base Excess. Seventy-one percent (43/61) of parturients in NS with a normal preoperative base excess experienced a drop in base excess below −3 postoperatively, compared with 61% (37/61) in RL (relative risk, 1.16; 95% CI, 0.90–1.51, $P = .26$). One hundred ninety-one parturients in NS and 187 in RL had a preoperative base excess below −3 and were thus excluded from the analysis.

Maternal postoperative venous blood gas values are displayed in Table 2.

Secondary Outcomes

Maternal 24-Hour Postoperative Morbidity. Eighty-eight of 500 mothers (18 %) experienced a morbidity-related event as specified by the 24-hour POMS. However, none of these differences was statistically significant (Table 3).

Neonatal pH. There was no difference in mean neonatal pH between the 2 groups (NS, 7.27 ± 0.11; RL, 7.26 ± 0.10; 95% CI, −0.01 to 0.03; $P = .14$; Table 4). Ten percent of neonates in each group (25/252 in NS and 24/248 in RL) were born acidotic, with pH < 7.14, $P = .93$. Twenty-three of 49 (47%) of the acidotic babies had low Apgar scores (<7) at 1 minute with 6 of 49 (12%) persisting with Apgar scores less than 7 at 5 minutes. This was significantly higher than the nonacidotic group, where 106 of 459 (24 %) had Apgar scores less than 7 at 1 minute and 6 of 451 (1%) persisted with Apgar scores less than 7 at 5 minutes, $P < .001$.

Neonatal Base Excess. There was no difference in mean base excess between the 2 groups (NS, −4 ± 3.9; RL, −4.2 ± 4; 95% CI, −0.36 to 1.02; $P = .17$), with 144 of 252 neonates in NS (57%) and 153 of 248 neonates in RL (61%) having a base excess <3, $P = .30$.

DISCUSSION

In this pragmatic clinical trial, significantly fewer parturients developed postoperative metabolic acidosis when RL was infused as the sole intraoperative fluid. Cesarean delivery is the most common operation performed in Mulago National Referral Hospital, with the bulk of these being nonelective surgeries. We therefore selected this patient population, because improving fluid administration guidelines could lead to a meaningful difference in outcomes.

Study Fluids

NS solution is 0.9% (9 g/L) sodium chloride, and at approximately 300 mOsm/L (154 mEq/L of Na^+ and Cl^-), it is also known as physiologic or isotonic saline. However, it can be used as half NS (0.45%), quarter NS (0.27%), or hypertonic saline.[14] RL is an isotonic balanced salt IV solution, more closely resembling the ionic composition of blood than NS. It is composed of sodium chloride, sodium lactate, potassium chloride, and calcium chloride at 130 mEq Na^+ (130 mmol/L), 109 mEq Cl^- (109 mmol/L), 29 mEq lactate (28 mmol/L), 4 mEq K^+ (4 mmol/L), and 3 mEq Ca^{2+} (1.5 mmol/L).[22] The cost of both fluids in Uganda is comparable, with each 500-mL bottle of either NS or RL costing approximately 30 cents (US dollars). In our setting, most clinicians dogmatically use NS as their primary choice of crystalloid. Some clinicians view the potassium and lactate in RL as being potentially harmful to patients; a belief not grounded in evidence.

Table 2. Maternal Postoperative Venous Blood Gas Values				
Variable	**NS (N = 252)**	**RL (N = 248)**	**Difference (NS − RL) (95% CI)**	***P* Value**
Electrolytes (mmol/L)				
Potassium	3.4 ± 0.6	3.7 ± 0.6	−0.29 (−0.39 to −0.20)	.98
Calcium	1.1 ± 0.1	1.2 ± 0.1	−0.05 (−0.06 to −0.03)	.99
Sodium	137.1 ± 3.1	136.7 ± 3	0.40 (−0.15 to 0.96)	.08
Chloride	111.9 ± 4.7	110.2 ± 3.6	1.64 (0.89 to 2.38)	.00
Acid-base				
pH	7.33 ± 0.07	7.36 ± 0.08	−0.03 (−0.04 to −0.02)	.97
Lactate (mmol/L)	3.13 ± 1.7	3.05 ± 1.8	0.08 (−0.21 to 0.38)	.30
HCO_3^- (mmol/L)	18.5 ± 2.6	19.4 ± 2.5	−0.96 (−1.42 to −0.50)	.98
Base excess (mmol/L)	−6.8 ± 3.5	−5.8 ± 3.4	−1.01 (−1.64 to 10.40)	.95
Anion gap (mmol/L)	6.7 ± 3.9	7.1 ± 4.4	−0.44 (−1.19 to 0.30)	.88

Data are represented as mean ± standard deviation.
Abbreviations: CI, confidence interval; NS, normal saline; RL, Ringer's lactate.

Table 3. Maternal 24-Hour Postoperative Morbidity Survey				
System	**NS (N = 252), N (%)**	**RL (N = 248), N (%)**	**OR (95% CI)**	***P* Value**
Pulmonary	3 (1)	3 (1)	0.9 (0.23–4.38)	.99
Renal	2 (1)	2 (1)	0.9 (0.19–5.23)	.99
Gastrointestinal	15 (6)	6 (2)	2.6 (1.02–6.59)	.05
Cardiovascular	13 (5)	11 (4)	1.2 (0.49–2.94)	.71
Neurological	11 (4)	9 (4)	1.2 (0.51–2.95)	.68
Hematological	6 (2)	7 (3)	0.8 (0.30–2.46)	.76

Abbreviations: CI, confidence interval; NS, normal saline; OR, odds ratio; RL, Ringer's lactate.

Outcomes

In our study setting, parturients in labor are permitted to drink clear fluids. Crystalloids, predominantly NS, may be infused in indeterminate amounts during labor and delivery, at the discretion of either the midwife or obstetrician. Once the decision to perform an urgent cesarean delivery is made, mothers are kept strictly nil per os and maintained on IV fluids alone. We therefore acknowledge preoperative NS administration as a possible confounder that must be controlled for in future trials. Labor is monitored with the aid of partographs, with up to 100 deliveries being conducted daily by 5 midwives working in three 8-hour shifts. It is therefore not uncommon to encounter inadequately filled partographs and mothers laboring for an indeterminate period of time. With at least 15 urgent and emergent cesarean deliveries performed daily, the DDI times commonly extend beyond the standard 30 minutes advised. Indeterminate periods of labor and possible inadequate fluid resuscitation in labor may explain the high lactate levels observed. Although elevated lactate was common to both groups, classic lactic acidosis (with raised anion gap) was rarely observed. This may be supported by the observation that the mean estimated blood loss was within acceptable limits for cesarean delivery. Severe hemorrhage in our study population was minimal, with only 13 patients transfused with whole blood perioperatively. We, however, did not observe a correlation between longer DDI times and indication for cesarean delivery or preoperative acidosis. The type of acidosis observed (in the absence of the other possible causes of normal anion gap metabolic acidosis) was consistent with hyperchloremic metabolic acidosis in over 70% of cases. However, other studies showing RL to be superior did not report this trend.[15,18–22] Of note, however, is that the mean chloride levels were elevated preoperatively and increased postoperatively, with postoperative chloride levels being 1 mmol/L higher in NS, a difference that is not clinically meaningful.

The mothers were followed up for 24 hours postoperatively using POMS for incidence of morbidity in different organ systems. The incidence of morbidity, although low, was similar between both groups. There was no difference in the incidence of neonatal acidosis between either NS or RL. However, a significant number of neonates born acidotic exhibited low Apgar scores (<7) at both 1 and 5 minutes, consistent with the conclusions of a previous meta-analysis.[10]

Both interim and final analyses showed that no participant in our trial experienced an adverse event associated with the study fluids. Two neonates born with severe birth asphyxia died despite adequate neonatal resuscitation. The cause of death was prolonged fetal distress, not associated with the study fluids.

Limitations

We were unable to ascertain the type and volume of fluids administered to the mothers before the decision to deliver by urgent or emergent cesarean delivery, mainly because we were not involved in the management of the parturients in the labor suite prior to arrival into theater. Records of fluids administered to the mothers in labor by the midwives were inadequate, hence, the uncertainty whether the fluid administered was RL or NS.

CONCLUSIONS

This pragmatic clinical trial showed significantly less postoperative metabolic acidosis when RL was infused intraoperatively in urgent cesarean delivery compared with NS. The observed acidosis did not seem to affect maternal outcomes in the immediate postoperative period. Neither NS nor RL infusion seemed to have a significant effect on the incidence of neonatal acidosis. Acidotic neonates were more likely to have lower Apgar scores at 1 and 5 minutes. High preoperative lactate levels in the absence of classic raised anion gap lactic acidosis were noted in our parturients.

Therefore, NS may be a safe choice for intraoperative fluid therapy in urgent cesarean delivery as RL, albeit with an increased incidence of metabolic acidosis. Adequate

Table 4. Fetal Umbilical Arterial Blood Gas Values

Variable	NS (N = 252)	RL (N = 248)	Difference (NS − RL) (95% CI)	*P* Value
Electrolytes (mmol/L)				
Potassium	4.5 ± 1.1	4.6 ± 1	−0.15 (−0.33 to 0.02)	.95
Calcium	1.4 ± 0.1	1.4 ± 0.1	−0.02 (−0.39 to −0.01)	.99
Sodium	135.6 ± 3.2	136 ± 3.6	−0.33 (−0.96 to 0.29)	.87
Chloride	107.6 ± 3.2	107.3 ± 3.1	0.36 (−0.19 to 0.91)	.10
Acid-base				
pH	7.27 ± 0.11	7.26 ± 0.10	0.01 (−0.01 to 0.03)	.14
Lactate (mmol/L)	4.4 ± 2.5	4.8 ± 2.8	−0.46 (−0.94 to 0.02)	.97
Median PCO_2 (mm Hg)[a] (interquartile range)	50.1 (36.7 to 67.7)	49.7 (37.9 to 60.4)	0.51 (−1.89 to 2.91)	.36
HCO_3^- (mmol/L)	19.3 ± 3.2	18.9 ± 3.2	0.36 (−0.19 to 0.91)	.10
Base excess (mmol/L)	−4 ± 3.9	−4.2 ± 4	0.33 (−0.36 to 1.02)	.17
Anion gap (mmol/L)	8.7 ± 4.6	9.9 ± 5.2	−1.18 (−2.03 to −0.32)	.99

Data are represented as mean ± standard deviation.
Abbreviations: CI, confidence interval; NS, normal saline; RL, Ringer's lactate.
[a]*P* value based on Wilcoxon rank sum test (Mann-Whitney U test).

preoperative fluid resuscitation in the laboring mother may help reduce the high lactate levels observed in our setting.

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