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Open Access Original Article

Universal Versus Selective Sampling of Umbilical Cord Gases in University-Based, Academic Community-Based, and Private Practice Settings: A Cross-Sectional Study

Review began 09/29/2026
Review ended 10/17/2026
Published 10/20/2026

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DOI: 10.7759/cureus.118240

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Abstract

Background

Umbilical cord blood gas analysis provides an objective assessment of fetal metabolic status at delivery and may aid in identifying acute intrapartum hypoxic-ischemic events and newborns at risk for neurologic injury. However, there is no consensus regarding universal versus selective cord gas sampling, and professional society recommendations vary. This study aimed to evaluate differences in umbilical cord gas sampling practices, institutional protocols, and indications for sampling among obstetric providers across university-based, academic community, and private practice settings.

Methods

An anonymous survey was distributed to independent obstetric providers at hospitals with labor and delivery units throughout the greater Philadelphia region, including New Jersey, from September through December 2023. Eligible respondents included physicians (MD/DO) and certified nurse-midwives who independently managed deliveries. Respondents were categorized as practicing in university-based hospitals with residents, academic community hospitals with residents, or private practices without residents. The survey assessed demographics, knowledge of institutional protocols, individual practice preferences, and indications for cord gas sampling. Pairwise comparisons were performed among practice settings using Fisher's exact test for unordered categorical variables and Wilcoxon tests for ordinal variables.

Results

Seventy-eight providers responded, of whom 77 met inclusion criteria: 29 (37.7%) practiced in university-based settings, 33 (42.9%) in academic community settings, and 15 (19.5%) in private practice. University-based providers were more likely to report the presence of an institutional cord gas protocol ($p<0.01$), favor universal cord gas sampling ($p<0.05$), and obtain cord gases in patients requiring fetal surveillance. Reported frequency of cord gas sampling differed significantly by practice setting, with the highest frequency in university-based hospitals, followed by academic community hospitals and private practices ($p<0.05$). Across practice settings, providers generally agreed that fetal growth restriction <3rd percentile, Category III fetal heart rate tracings, maternal substance use, and five-minute Apgar scores <7 were indications for cord gas sampling. No significant differences were identified in awareness of protocol specifics, institutional indications for sampling, or methods of cord gas procurement. University-based providers were more likely to report preemptively setting aside a segment of umbilical cord after delivery ($p<0.001$). Providers across all practice settings supported delayed cord clamping.

Conclusions

Umbilical cord gas sampling practices and provider preferences vary significantly by practice setting, with university-based providers reporting greater use of cord gas sampling, greater awareness of institutional protocols, and stronger preference for universal sampling compared with academic community and private practice providers. Despite these differences, providers demonstrated agreement on several high-risk clinical indications for cord gas analysis. These findings highlight variability in current practice and identify areas of provider consensus that may help inform standardized criteria for selective cord gas sampling and future prospective studies comparing selective with universal sampling.

Categories: Obstetrics/Gynecology
Keywords: apgar scores, category iii fetal heart rate tracing, fetal growth restriction (fgr), neonatal birth asphyxia, umbilical cord blood gas analysis

Introduction

Umbilical cord gas sampling is a staple in determining an intrapartum acute hypoxic-ischemic event (HIE)

[1] and has become widely performed to objectively determine fetal metabolic condition at the time of delivery [2]. Current evidence suggests that umbilical arterial pH analysis provides the most sensitive reflection of birth asphyxia [3]. It is also a part of the criteria for therapeutic hypothermia [4] and can allow for the early identification of those at risk to allow for the early initiation of neuroprotective therapies [2]. Studies have shown that standardized evaluation of infants at risk for HIE using umbilical cord gas acidemia led to timely identification and intervention [5].

There is, however, no consensus about the specific indications to perform umbilical cord acid/base analysis and no evidence that supports universal vs. selective sampling. At present, the American College of Obstetricians and Gynecologists (ACOG) and the American Academy of Pediatrics (AAP) recommend umbilical cord blood gas analysis to be performed in all high-risk deliveries with a suspicion of fetal metabolic abnormality [2]. In contrast, the Society of Obstetricians and Gynecologists of Canada (SOGC) recommends that cord blood gas analysis be performed at all births [6].

Proponents of universal sampling argue that selective umbilical cord sampling may miss newborns with birth asphyxia due either to incomplete sampling indications or delayed presentation, with the potential for significant medico-legal ramifications. Proponents of selective sampling point to the cost of universal sampling and the fact that only a minority of birth asphyxia are acidotic at delivery [7].

Our study aims to determine differences in provider preferences in university-based vs. academic community hospital vs. private practice settings. We hypothesize that university-based locations will have the highest draw rates and more stringent guidelines, followed by academic community hospitals, followed by private practice. Secondary outcomes assessed overall knowledge of hospital protocols and provider-specific indications for cord gas analysis.

Materials And Methods

This was a cross-sectional survey using an anonymous, de-identified recruitment email. A link to the survey was sent out to representatives of all greater Philadelphia area-based hospitals (including New Jersey) that contained a labor and delivery unit through convenience sampling. For individual hospital information, please see Appendix. Representatives then sent out the email to their departments. Multiple respondents could originate from the same institution. Our study duration was from Sept 2023 to Dec 2023. For inclusion criteria, survey responders needed to be independent providers who delivered babies without any oversight. This included MDs, DOs, and CNMs. Our exclusion criteria included workers who were not independent providers (nurses, residents, nurse practitioners, and physician assistants).

The survey was split into four parts: question 1 - demographics, question 2 - knowledge of hospital protocols, question 3 - individual practice preferences, and question 4 - specific indications for cord gas procurement. The first two questions involved basic direct answers. The second two questions were answered via a Likert scale. All surveyors were split into three main groups: university-based with residents, academic community practice with residents, and private practice with no residents. Answers to all questions were self-reported and not directly measured. Pairwise comparison between the three groups was performed. Answers to question 4 were also evaluated independently.

Answers to questions 1 and 2 were compared using Fisher's exact test for unordered categorical data. Questions 3 and 4 were compared using the Wilcoxon test for ordinal, i.e., ranked categorical data.

This study was reviewed and approved by the Crozer Keystone Health Institutional Review Board (CKHS23-015).

Results

There were 78 total responses. One responder reported not being an independent provider and was excluded. Of our total N value of 77, 33 identified as academic community practice with residents, 15 identified as private practice, and 29 identified as university-based with residents. Within Table *1*, private practice responders were more likely to see low-risk patients compared with academic community and university-based responders (p = 0.049, Fisher's exact test). They were also more likely to have a gestational age limit for their deliveries (p = 0.048, Fisher's exact test) and did not have the capability of diagnosing and treating hypoxic-ischemic encephalopathy (p < 0.001, Fisher's exact test).

Characteristic	Academic community practice with residents, N = 33[1]	Private practice-minimal resident involvement, N = 15[1]	University-based with residents, N = 29[1]	p-value[2]
The majority of my deliveries are high-risk patients (as defined by >50% of patients requiring antepartum surveillance).				0.049
Agree	22 (67%)	5 (33%)	20 (69%)	-
Disagree	11 (33%)	10 (67%)	9 (31%)	

My practice delivers approximately _____ babies per month.				
>200	10 (30%)	0 (0%)	18 (62%)	
0-50	6 (18%)	4 (27%)	6 (21%)	
101-150	3 (9.1%)	6 (40%)	0 (0%)	-
151-200	2 (6.1%)	0 (0%)	3 (10%)	
51-100	12 (36%)	5 (33%)	2 (6.9%)	
My licensing credential is				0.035
CNM	5 (15%)	1 (6.7%)	3 (10%)	
DO	10 (30%)	2 (13%)	1 (3.4%)	-
MD	18 (55%)	12 (80%)	25 (86%)	
I have been out of training and independently practicing for				0.5
>10 years	19 (58%)	5 (33%)	12 (41%)	
1-3 years	5 (15%)	2 (13%)	6 (21%)	
3-6 years	3 (9.1%)	5 (33%)	5 (17%)	-
6-9 years	6 (18%)	3 (20%)	6 (21%)	
I do approximately _____ shifts per month (as defined by daytime/nighttime shifts)				0.2
>10	5 (15%)	0 (0%)	2 (6.9%)	
2-4	12 (36%)	2 (13%)	6 (21%)	
4-6	8 (24%)	6 (40%)	13 (45%)	-
6-8	4 (12%)	5 (33%)	3 (10%)	
8-10	4 (12%)	2 (13%)	5 (17%)	
My practice has a limit on the gestational age at which I can deliver				0.048
>28 weeks	1 (3.0%)	3 (20%)	1 (3.4%)	
>32 weeks	1 (3.0%)	1 (6.7%)	1 (3.4%)	
>34 weeks	3 (9.1%)	4 (27%)	2 (6.9%)	-
Any gestational age	28 (85%)	7 (47%)	25 (86%)	
My hospital is capable of diagnosing and treating hypoxic ischemic encephalopathy via therapeutic hypothermia				<0.001
Agree	27 (82%)	5 (33%)	27 (93%)	
Disagree	3 (9.1%)	9 (60%)	1 (3.4%)	-
Unsure	3 (9.1%)	1 (6.7%)	1 (3.4%)	

TABLE 1: Demographics

[1] n (%) and [2] Pearson's Chi-squared test; Fisher's exact test.

Responses to question 2 and its sub-questions are shown pictorially in Figure *1*. Bar asterisks denote a statistically significant difference in answers between the groups the bar includes. University-based settings were more likely to agree on the presence of a protocol ($p < 0.01$, Fisher's exact test) and were more likely to advocate for universal cord gas than community or private practice ($p < 0.05$, Fisher's exact test). There was no difference in answers regarding awareness of protocol specifics, specific indications for cord gas procurement by the hospital, or the hospital methodology for obtaining cord gases. All three groups disagreed on their knowledge of the cost of a single cord gas, while agreeing on having set critical cord gas

values within their hospital.

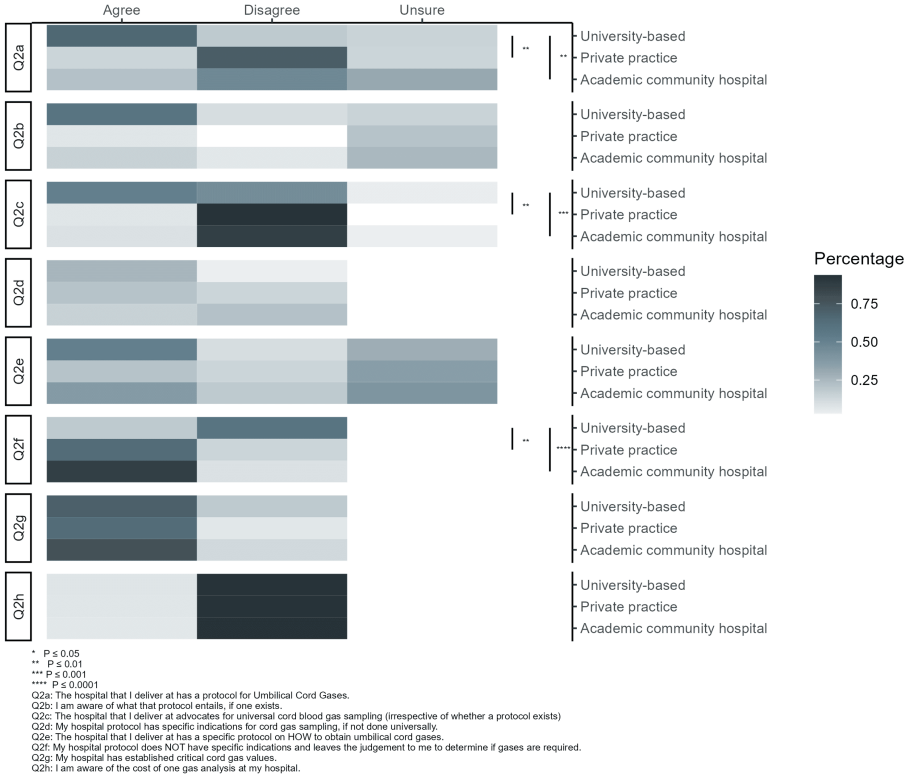


FIGURE 1: Provider Awareness of Hospital Protocols

Responses to question 3 are shown pictorially in Figure *2*; all groups agreed upon delayed cord clamping for all patients. University-based providers were more likely to prefer universal cord gases and obtainment for any patients who required fetal surveillance.

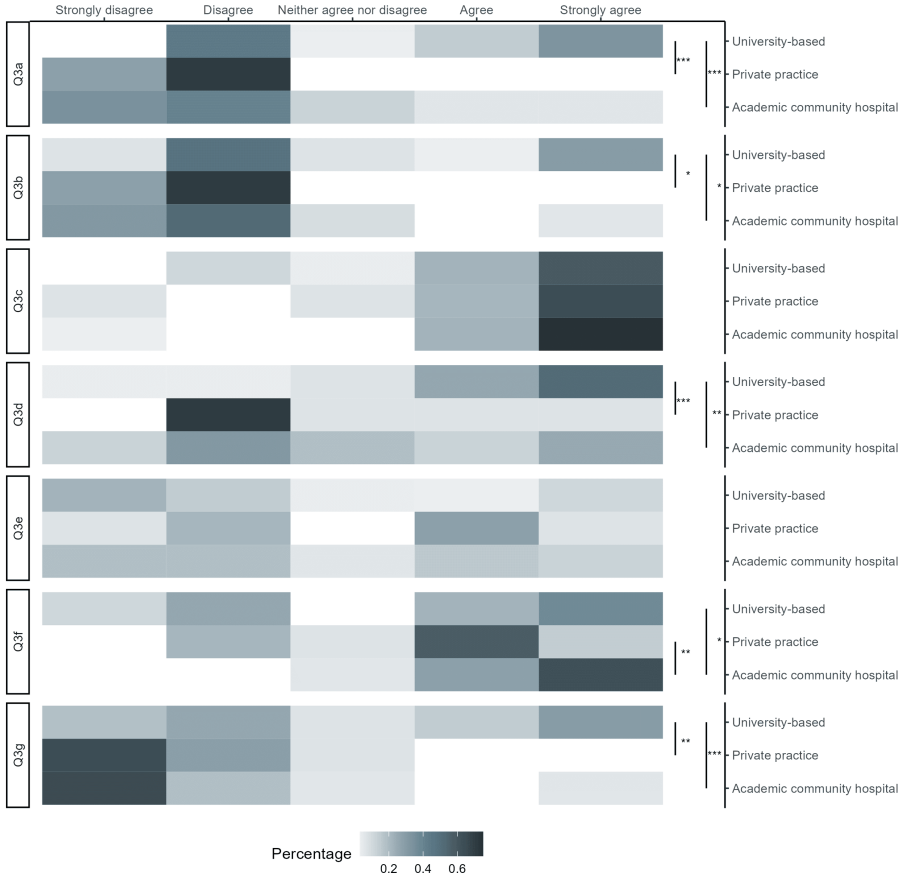


FIGURE 2: Individual Provider Preferences

Answers to question 4 are shown in a tile plot in Figure *3*. The universally agreed-upon answers were fetal growth restriction <3%, category III fetal heart tracing (FHT), maternal substance abuse, and Apgar scores <7 at five minutes.

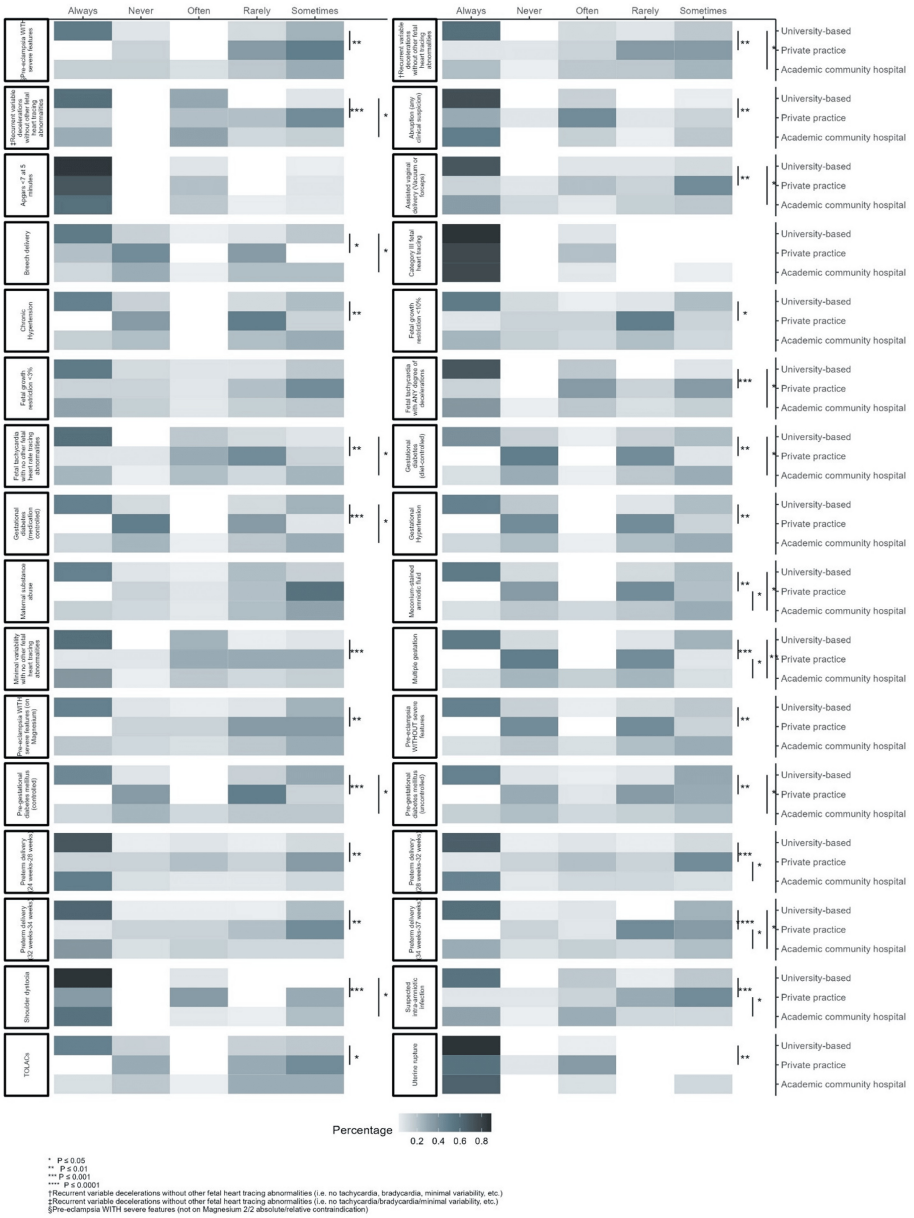


FIGURE 3: Specific Indications for Cord Gas Procurement Amongst the Groups

University settings were also found to obtain the greatest amount of cord gases, followed by academic community settings and private practice ($p < 0.05$, Wilcoxon T test; Figure *4*).

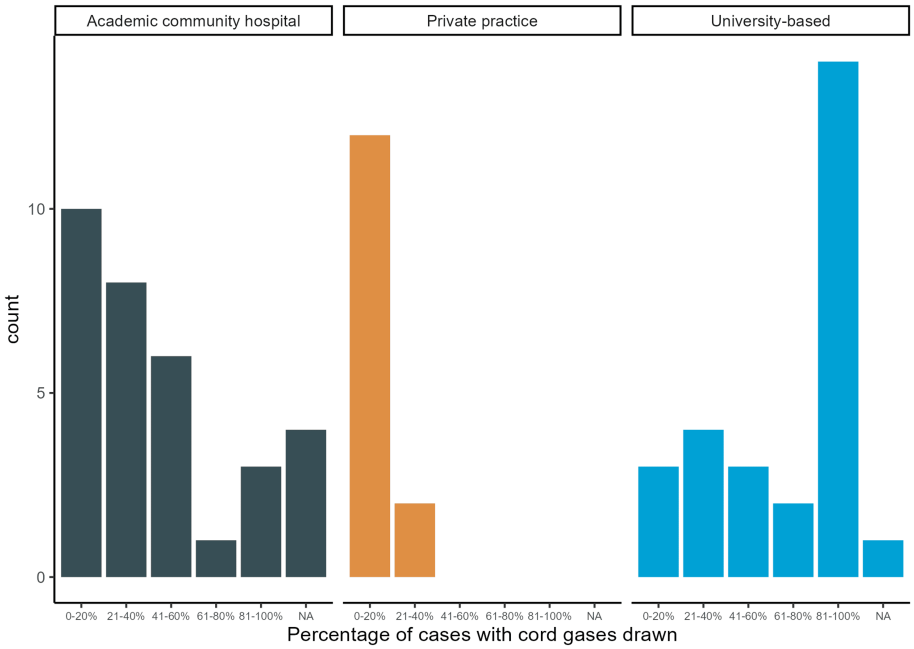


FIGURE 4: Percentage of Cases With Cord Gases Drawn

Discussion

Our study showed that university-based hospitals had the highest self-reported rate of obtaining cord gases, followed by academic community hospitals and then private practices. This is in keeping with the increased perception of having more high-risk patients in university/academic community settings versus private practice. As a consequence, universities were more likely to agree that a protocol was present and knew what it entailed. This can be attributed to a multitude of different factors, including the location of most universities in inner cities, acceptance of more Medicaid/Medicare populations, and a higher concentration of specialists.

ACOG and the AAP advocate for gas analysis in deliveries at high risk for fetal metabolic abnormality [1]. Examples given include, but are not limited to, low Apgar scores at five minutes, Category III fetal heart rate pattern, operative delivery performed for nonreassuring fetal status, severe fetal growth restriction, meconium-stained fluid, intrapartum fever, and preterm delivery [8]. The ACOG Committee on Obstetric Practice recommends a double-clamp technique in which a segment of cord is removed from all deliveries and set aside. This segment can be discarded without obtaining gases if a vigorous infant or acceptable five-minute Apgar score is present [8]. Protocols on how to obtain cord gases also differed substantially between the three groups. No consensus was reached on techniques, other than that university-based settings were more likely to set aside a segment of cord preemptively after delivery ($p < 0.001$).

Selective policies, however, miss clinically significant acidemia. A substantial fraction of neonates with metabolic acidemia have reassuring five-minute Apgar scores. In a universally sampled cohort, umbilical artery pH < 7.0 occurred in 0.5% and pH < 7.1 in 3.4% of neonates with Apgar scores > 7, and these were associated with markedly higher rates of respiratory distress syndrome (RDS) (aOR 6.5), neonatal intensive care unit (NICU) admission (aOR 10.8), and sepsis [9].

The intrapartum FHT is an unreliable proxy for fetal hypoxia, with weak correlation between pathologic tracings and actual acidemia. In a prospective study of non-reassuring fetal status, FHT identification of non-reassuring fetal tracings predicted umbilical artery pH < 7.2 with a sensitivity of 42.9%, specificity of 73.6%, positive predictive value of 7.4%, and negative predictive value of 96.3% [10]. Interobserver reliability is also limited, which further degrades real-world correlation [11].

To our knowledge, this is the first study to ask providers what would prompt cord gas sampling. Our cohort largely agreed collectively on a five-minute low Apgar score and Category III fetal heart rate. Although operative delivery was not agreed upon, we did not preface our question about operative delivery with non-reassuring status. There are no prospective randomized trials comparing universal versus selective sampling in the literature. Studies on universal sampling have not shown associations between cord blood gas results at delivery and long-term neurodevelopmental outcomes and mortality [12]. Our study could contribute to identifying which criteria could be used in a future study comparing selective versus universal sampling.

All groups agreed on universal delayed cord clamping. ACOG states that the effect of universal delayed cord clamping on cord gas analysis is conflicting, but ultimately, any effect is small [13].

Our surveyors were unaware of the cost of a single umbilical cord sample analysis. The largest cost-effectiveness analysis modeled the initial and ongoing costs of universal analysis. Universal analysis was less costly and more effective than selective sampling. This was due to a higher initial cost for analysis but savings from a decrease in admissions to the special care nursery [14]. Universal cord gas sampling practices may provide medico-legal benefits. In situations where gases may not have been obtained in the setting of an otherwise indeterminate or pathologic FHT pattern or Apgar score, it has also been theorized that, without blood gas analysis in a medico-legal situation, providers may be at increased liability. In those with a depressed or pathologic infant, abnormal cord gases will likely do little to affect medico-legal outcomes [15].

Strengths of this study include a breakdown of three different practice environments and how they affect cord gas procurement.

Weaknesses of this study include that providers relied on self-reported sampling frequencies and institutional practices without independent verification against hospital protocols, medical records, or actual cord gas collection rates, which may limit generalizability. As with any survey, there will be selection bias and nonresponse bias.

Conclusions

Umbilical cord gas sampling practices vary significantly across obstetric practice settings, reflecting the lack of standardized recommendations regarding universal versus selective sampling. In our study, university-based providers reported the highest frequency of cord gas collection and were more likely to favor universal sampling and report the presence of institutional protocols compared with providers in academic community and private practice settings. Despite these differences, providers demonstrated substantial agreement on several clinical indications for cord gas analysis, including Category III fetal heart rate tracings, fetal growth restriction below the third percentile, maternal substance use, and a five-minute Apgar score < 7.

These findings highlight both the variability and areas of consensus in current cord gas sampling practices. The indications consistently identified across practice settings may provide a foundation for developing standardized criteria for selective cord gas sampling. Further prospective studies comparing universal and selective sampling strategies are needed to determine whether standardized protocols can optimize identification of neonatal acidemia while balancing resource utilization and clinical utility.

Appendices

Appendix: Survey

Practice Demographics

I perform deliveries as an independent provider

Agree / Disagree

The majority of my deliveries are high-risk patients (as defined by >50% of patients requiring antepartum surveillance)

Agree / Disagree

My obstetrics practice is best described as

University Based with Residents

Academic Community Practice with Residents

Private Practice - minimal resident involvement

My practice delivers approximately ____ babies per month

0-50

50-100

100-150

150-200

>200

My licensing credential is

MD

DO

CNM

I have been out of training and independently practicing for

1-3 years

3-6 years

6-9 years

> 10 years

I do approximately ___ shifts per month (as defined by 12 hr daytime/nighttime shifts)

2-4

4-6

6-8

8-10

>10

My practice has a limit on the gestational age in which I can delivery

>37 weeks

>34 weeks

>32 weeks

>28 weeks

Any gestational age

Hospital Protocols

My hospital is capable of diagnosing and treating hypoxic-ischemic encephalopathy via therapeutic hypothermia

Agree / Disagree / Unsure

Knowledge of hospital procedures and protocols / Procurement of gases

The hospital that I deliver at has a protocol for Umbilical Cord Gases.

Agree / Disagree / Unsure

I am aware of what that protocol entails, if one exists

Agree / Disagree / Unsure / not applicable

The hospital that I deliver at advocates for universal blood gas sampling (irrespective of whether a protocol exists)

Agree / Disagree / Unsure

My hospital protocol has specific indications for cord gas sampling, if not done universally.

Agree / Disagree / Not Applicable due to universal screening or no protocol

The hospital that I delivery at has a specific protocol on HOW to obtain umbilical Cord Gases

Agree / Disagree / Unsure / Not applicable due to no protocol

My hospital protocol does NOT have specific indications and leaves the judgement to me to determine if gases are required

Agree / Disagree / Unsure / Not Applicable due to no formal protocol

My hospital has established critical cord gas values (ie values that automatically get flagged for peer review etc etc)

Agree / Disagree / Unsure / Not Applicable due to no formal protocol

I am aware of the cost of one gas analysis at my hospital

Agree / Disagree

Practice Preferences

Irrespective of my hospital protocol, I prefer universally drawn cord gases

Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree

I would draw cord gases, irrespective of intrapartum events, for all pts who required antepartum fetal surveillance

Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree

I performed delayed cord clamping for all patients, unless there is an unresponsive baby upon delivery

Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree

I always set aside a segment of cord pre-emptively after delayed cord clamping (if applicable), and draw gases if needed from the set aside cord

Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree

Not Applicable - I draw directly from umbilical cord

I draw cord gases directly from the umbilical cord during delayed cord clamping (if applicable) and/or after cutting/clamping to disconnect baby from placenta.

Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree

I draw from a disconnected cord segment

I draw blood from BOTH umbilical artery and umbilical vein when I choose to sample gases

Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree

I draw universal cord gas sampling from all cesarean sections; including scheduled repeats

Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree

Specific Indications: Please assume for the next questions that this is the ONLY indication present at delivery. The mode of delivery can be vaginal or cesarean.

Rate 1-5; 5 being most likely to draw cord gases under these conditions.

I would draw cord gases for the following intrapartum events.

Meconium-stained amniotic fluid

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Fetal growth restriction < 10%

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Fetal growth restriction < 3%

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Breech delivery

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Multiple Gestation

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Recurrent Variable deceleration without other FHR abnormalities (i.e., no tachycardia / brady cardia / minimal variability etc.)

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Recurrent Late decelerations without other FHT abnormalities (i.e., no tachycardia / brady cardia / minimal variability etc.)

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Minimal variability; no other FHT abnormalities

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Cat III strip

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Fetal Tachycardia (no other FHT abnormalities)

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Fetal Tachycardia with ANY degree of decelerations

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Preterm Delivery (34 weeks-37 weeks)

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Preterm Delivery (32 weeks - 34 weeks)

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Preterm Delivery (28 weeks-32 weeks)

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Preterm Delivery (24 weeks - 28 weeks)

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Abruption (any clinical suspicion)

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Assisted vaginal delivery (vacuum or forceps)

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Shoulder dystocia

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Uterine rupture

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

TOLACs

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Maternal substance abuse

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Suspected Intraamniotic infection

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Apgars < 7 at 5 minutes

1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always

Other (give line for people to type)

I estimate that I draw and send cord gases on the following percentage of my deliveries

0-20%

21-40%

41-60%

61-80%

81-100%

Hospitals that participated

Jefferson Einstein Philadelphia Hospital

Cooper University Hospital

Lankenau Medical Center

Thomas Jefferson University Hospital

Jefferson Abington Hospital

Temple University Hospital

Virtua Voorhees Hospital

University of Pennsylvania Hospitals

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Tino L. Tran, Katrina Austin

Acquisition, analysis, or interpretation of data: Tino L. Tran, Katrina Austin

Drafting of the manuscript: Tino L. Tran, Katrina Austin

Critical review of the manuscript for important intellectual content: Tino L. Tran, Katrina Austin

Disclosures

Human subjects: All authors have confirmed that this study did not involve human participants or tissue. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. American Academy of Pediatrics: Neonatal encephalopathy and neurologic outcome. Pediatrics. 2014, 133:1482-8. 10.1542/peds.2014-0724
2. Saneh H, Mendez MD, Srinivasan VN: Cord blood gas. StatPearls [Internet]. StatPearls Publishing, Treasure Island (FL); 2023.
3. White CR, Doherty DA, Henderson JJ, Kohan R, Newnham JP, Pennell CE: Benefits of introducing universal umbilical cord blood gas and lactate analysis into an obstetric unit. Aust N Z J Obstet Gynaecol. 2010, 50:318-28. 10.1111/j.1479-828X.2010.01192.x
4. Papile LA, Baley JE, Benitz W, et al.: Hypothermia and neonatal encephalopathy. Pediatrics. 2014, 133:1146-50. 10.1542/peds.2014-0899
5. Blecharczyk E, Lee L, Birnie K, et al.: Standardized evaluation of cord gases in neonates at risk for hypoxic ischemic encephalopathy. Hosp Pediatr. 2022, 12:29-37. 10.1542/hpeds.2021-006135
6. Stirk L, Kornelsen J: No. 379-attendance at and resources for delivery of optimal maternity care . J Obstet Gynecol Canada. 2019, 41:688-96.
7. Thorp JA, Dildy GA, Yeomans ER, Meyer BA, Parisi VM: Umbilical cord blood gas analysis at delivery . Am J Obstet Gynecol. 1996, 175:517-22. 10.1053/ob.1996.v175.a74401
8. ACOG Committee on Obstetric Practice: ACOG Committee Opinion No. 348, November 2006: umbilical cord blood gas and acid-base analysis. Obstet Gynecol. 2006, 108:1319-22. 10.1097/00006250-200611000-00058
9. Sabol BA, Caughey AB: Acidemia in neonates with a 5-minute Apgar score of 7 or greater - what are the outcomes?. Am J Obstet Gynecol. 2016, 215:486-1. 10.1016/j.ajog.2016.05.035
10. Çetinkaya Demir B, Orhaner A: Association of intrapartum cardiotocography findings with umbilical arterial blood gas parameters and neonatal outcomes in non-reassuring fetal status. J Clin Med. 2026, 15:5464. 10.3390/jcm15145464
11. Zamora Del Pozo C, Chóliz Ezquerro M, Mejía I, et al.: Diagnostic capacity and interobserver variability in FIGO, ACOG, NICE and Chandraharan cardiotocographic guidelines to predict neonatal acidemia. J Matern Fetal Neonatal Med. 2022, 35:8498-506. 10.1080/14767058.2021.1986479
12. Myrhaug HT, Kaasen A, Pay AS, Henriksen L, Smedslund G, Saugstad OD, Blix E: Umbilical cord blood acid-base analysis at birth and long-term neurodevelopmental outcomes in children: a systematic review and meta-analysis. BJOG. 2023, 130:1156-66. 10.1111/1471-0528.17480
13. American College of Obstetricians and Gynecologists' Committee on Obstetric Practice: Delayed umbilical cord clamping after birth: ACOG Committee Opinion, Number 814. Obstet Gynecol. 2020, 136:e100-6. 10.1097/AOG.0000000000004167
14. White CR, Doherty DA, Cannon JW, Kohan R, Newnham JP, Pennell CE: Cost effectiveness of universal umbilical cord blood gas and lactate analysis in a tertiary level maternity unit. J Perinat Med. 2016, 44:573-84. 10.1515/jpm-2015-0398
15. Olofsson P: Umbilical cord pH, blood gases, and lactate at birth: normal values, interpretation, and clinical utility. Am J Obstet Gynecol. 2023, 228:S1222-40. 10.1016/j.ajog.2022.07.001