Factors Associated With Refusal of Intramuscular Vitamin K in Normal Newborns

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abstract

BACKGROUND AND OBJECTIVE: Refusal of intramuscular (IM) vitamin K administration by parents is an emerging problem. Our objective was to assess the frequency of and factors associated with refusal of IM vitamin K administration in well newborns in the United States.

METHODS: We determined the number of newborns admitted to well newborn units whose parents refused IM vitamin K administration in the Better Outcomes through Research for Newborns network and, in a nested patient-control study, identified factors associated with refusal of IM vitamin K administration by using a multiple logistic regression model.

RESULTS: Of 102 878 newborns from 35 Better Outcomes through Research for Newborns sites, parents of 638 (0.6%) refused IM vitamin K administration. Frequency of refusal at individual sites varied from 0% to 2.3%. Exclusive breastfeeding (adjusted odds ratio [aOR] = 3.4; 95% confidence interval [CI]: 2.1–5.5), non-Hispanic white race and/or ethnicity (aOR = 1.7; 95% CI: 1.2–2.4), female sex (aOR = 1.6; 95% CI: 1.2–2.3), gestational age (aOR = 1.2; 95% CI: 1.1–1.4), and mother's age (aOR = 1.05; 95% CI: 1.02–1.08) were significantly associated with refusal of IM vitamin K administration. Refusal of the administration of both ocular prophylaxis and hepatitis B vaccine was also strongly associated with refusal of IM vitamin K administration (aOR = 88.7; 95% CI: 50.4–151.9).

CONCLUSIONS: Refusal of IM vitamin K by parents of newborns is a significant problem. Interventions to minimize risks to these newborns are needed.

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WHAT'S KNOWN ON THIS SUBJECT: Routine administration of intramuscular (IM) vitamin K prevents life-threatening vitamin K deficiency bleeding. Refusal of IM vitamin K administration by parents of newborns is an emerging problem, but how frequently this occurs is uncertain.

WHAT THIS STUDY ADDS: The frequency of IM vitamin K administration refusal was 0.6%. Almost three-fourths of parents also refused both ocular prophylaxis and hepatitis B vaccine. After controlling for this factor, only female sex was associated with refusal of IM vitamin K administration.

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Newborns have low reserves of vitamin K, putting them at risk for vitamin K deficiency bleeding (VKDB).[1,2] VKDB may present either in the first week of life (early VKDB) or between 2 and 12 weeks of life (late VKDB).[1] Estimates of the incidence of early VKDB (without vitamin K prophylaxis) range from 0.25% to 1.7%.[1] Estimates of the incidence of late VKDB from Europe and Asia range from 10.5 to 80 per 100 000 births.[3] VKDB in the first week of life usually presents with bleeding from the gastrointestinal tract and/or the umbilicus; late VKDB often presents with intracranial bleeding.[3] A 1-time prophylactic intramuscular (IM) injection of vitamin K administered shortly after birth, recommended by the American Academy of Pediatrics (AAP) since 1961, had virtually eliminated this serious disease.[1] In recent years in the United States, there has been an increase in the number of reports of parents who refuse IM vitamin K for their newborns,[4–9] with a concomitant increase in reports of newborns with VKDB.[4,8]

In large-scale studies on refusal of vitamin K administration in New Zealand and in Canada, the investigators reported refusal rates of 1.7% and 0.5%, respectively.[6,10] There is a paucity of data from large-scale, multisite studies on refusal of IM vitamin K administration and factors associated with refusal in the United States. The purpose of our study was to determine the frequency of and factors associated with the refusal of IM vitamin K administration by a parent.

METHODS

This study was conducted through the Better Outcomes through Research for Newborns (BORN) network, which includes newborn clinicians from 95 well newborn units in 34 states in the United States. Approximately 330 000 newborns are cared for at these sites annually (~8.3% of 4 million live births in the United States). At each participating site there is a BORN representative who is either the director of the well newborn unit or another newborn clinician who is knowledgeable about policies and clinical practice at that site. BORN site representatives were invited to participate in a 2-part study. Approval was obtained from the institutional review board at each participating site.

Part 1: Frequency of Refusal of IM Vitamin K Administration

The number of newborns admitted to the well newborn unit and the number that did not receive IM vitamin K in a 1-year period was determined at each site. Site representatives worked with their institution's technical support teams to access data about IM administration of vitamin K from the medication administration record in the electronic medical record (EMR). Records of newborns on whom receipt of IM vitamin K was not documented in the medication administration record were reviewed individually to confirm refusal by a parent. EMR systems used by BORN sites included Epic (71.4%), Cerner (14.3%), or other EMRs (11.4%). There was no EMR at 2.8% of the sites.

Part 2: Nested Patient-Control Study

At each site, newborns who did not receive IM vitamin K (patients) were identified. For each patient, the next 5 newborns who did receive IM vitamin K were selected as controls. For sites with >10 newborns who did not receive IM vitamin K, the first 10 newborns by date of birth were enrolled as patients. If the proportion of controls with a given risk factor was between 7% and 82%, and with 5 controls per patient, we would need ≥195 patients to have ≥80% statistical power to detect an odds ratio (OR) of ≥2.0 (with a 2-tailed α error <.05). This number of patients was also sufficient for a multivariable model because it provided at least 10 events per variable.[11]

We obtained data on gestational age, sex, mode of delivery, type of insurance (public, private, self-pay, or unknown), infant's race (white, African American, Asian American, Pacific Islander, American Indian, other, or unknown) and ethnicity (Hispanic, non-Hispanic, or unknown), type of feeding (breastmilk only, formula, or both), and mother's age. In addition, we obtained data about whether the newborns received ocular prophylaxis against gonococcal ophthalmia and/or hepatitis B vaccine. Newborns who received donor breastmilk were considered to be breastfed. Deidentified data extracted from the medical record were entered into a Yale Qualtrics electronic database by each BORN site representative.

We calculated ORs and 95% confidence intervals (CIs) to assess associations between refusal of IM vitamin K and other variables. A χ^2 test was used to assess the statistical significance of associations. Adjusted odds ratios (aORs) and 95% CIs for associations were calculated by using multiple logistic regression, with penalized maximum likelihood estimation.[12] We included variables that were statistically significant in the unadjusted analysis in the multiple logistic regression model as well as variables that were clinically relevant. Mother's age and the infant's gestational age were entered into the model as continuous variables. The effect modification of ethnicity on the association of refusal of IM vitamin K administration and race was examined by using the Mantel-Haenszel test to determine if race and ethnicity should remain as independent predictors in the adjusted analyses. As a result of the study design, there were exactly 10 patients and 50 controls from 62% of participating sites. This precluded adjusting for variation by site by using conventional methods in part 1 of the study. However, we conducted a sensitivity analysis

using the aggregate data from each nursery that participated in the nested patient-control part of our study by using hierarchical logistic regression with only a fixed intercept and a random effect for nursery. We then calculated an intraclass correlation coefficient and 95% CI to estimate the effect of varying hospital practices on the event rate. Statistical significance was established at a 2-sided α of .05. Analyses were performed by using SPSS (IBM SPSS Statistics, IBM Corporation, Armonk, NY)[13] and SAS 9.4 (SAS Institute, Inc, Cary, NC).[14]

TABLE 1 Factors Associated With Refusal of IM Vitamin K Administration, Unadjusted Analysis

	Patient *N* = 195 (%)	Control *N* = 985 (%)	ORs (95% CI)
Female sex	115 (59.0)	474 (48.1)	1.6 (1.1–2.1)
White, non-Hispanic	128 (65.6)	472 (47.9)	2.1 (1.5–2.9)
Vaginal delivery	148 (75.9)	721 (73.1)	0.9 (0.6–1.2)
Private insurance[a]	98 (50.3)	440 (44.7)	1.3 (0.9–1.8)
Mother's age[b]	—	—	1.05 (1.02–1.08)
Gestational age[c]	—	—	1.4 (1.2–1.5)
Breastmilk only	172 (88.2)	616 (62.5)	4.5 (2.9–7.1)
No ocular prophylaxis	160 (82.1)	43 (4.4)	98.0 (61.8–159.7)
No hepatitis B vaccine	173 (88.7)	128 (13.0)	51.5 (32.6–84.9)
No ocular prophylaxis and no hepatitis B vaccine	144 (73.8)	29 (2.9)	90.9 (56.8, 150.2)
No hepatitis B and received ocular prophylaxis	29 (14.9)	99 (10.1)	1.5 (1.0–2.4)
No ocular prophylaxis and received hepatitis B vaccine	16 (8.2)	14 (1.4)	6.2 (2.9–12.9)

—, not applicable.
[a] Private insurance includes self-pay (*N* = 24).
[b] OR for every 1 y increase in mother's age.
[c] OR for every 1 wk increase in gestational age.

RESULTS

Thirty-five sites (37% of the 95 BORN sites) from 23 different states from all regions of the country participated in part 1 of the study; 26 of these sites (74%) participated in part 2 of the study. Data were collected on infants born January 1, 2015, through December 31, 2015. The average number of births per site was 2939 (median: 2080; range: 928–11 967).

Part 1: Frequency of Refusal of IM Vitamin K Administration

Among 102 878 liveborn infants, 638 (0.6%) did not receive IM vitamin K due to refusal by a parent. The frequency of refusal of IM vitamin K at individual sites ranged from none (1 site in NY and 1 site in AL) to 2.3% (1 site in OR).

Part 2: Nested Patient-Control Study

To assess associations between refusal of IM vitamin K administration and various factors, we enrolled 195 patients and 985 controls. Of the 195 patients, 6 (2.1%) were late preterm (35–36 6/7 weeks' gestation); of the 985 controls, 47 (4.8%) were late preterm. The average ages of mothers were 30.8 years (median: 31 years; range 19–42 years) and 29.2 years (median: 29.0 years; range 14–48 years) in the patient and the control groups, respectively. Characteristics of patients and of controls and associations with refusal of IM vitamin K administration are shown in Table 1. Analysis of effect modification revealed that the association of white race with an increased rate of refusal of IM vitamin K administration was only observed in the non-Hispanic stratum ($P = .008$); therefore, we chose non-Hispanic white race and/or ethnicity as a main predictor of refusal of IM vitamin K administration. Other predictor variables that were significantly associated with refusal of IM vitamin K administration included female sex, non-Hispanic white race and/or ethnicity, exclusive breastfeeding, gestational age, maternal age, and private insurance (Table 2). With the exception of type of insurance, these remained statistically significant, with similar magnitudes of ORs, in an adjusted analysis. Patients also had higher odds of not having received either ocular prophylaxis or hepatitis B vaccine. When we adjusted for refusal of both hepatitis B vaccine and ocular prophylaxis (aOR = 88.7; 95% CI: 50.4–151.9), female sex (aOR = 2.0; 95% CI: 1.2–3.2) was the only other variable that remained statistically significantly associated with refusal of IM vitamin K administration. This only confirmed that refusal of these interventions (ocular prophylaxis and hepatitis B vaccine) was strongly associated with refusal of another intervention (IM vitamin K).

In addition to factors identified in the nested patient-control study, the sensitivity analysis revealed that the effect of nursery site explained 16.4% (95% CI: 6.1%–24.6%) of the variability in the rate of refusal.

DISCUSSION

Among a sample of >100 000 newborns born in 23 different states from all regions of the United States, we found that parents of 0.6% refused IM vitamin K administration. This refusal rate is similar to that reported in Canada (0.5%)[6] and lower than that reported in New Zealand (1.7%)[10] and in Tennessee (3%).[15] In our nested patient-control study, infants who did not receive IM vitamin K tended to also not receive both hepatitis B vaccine and ocular prophylaxis. The association of vaccine hesitancy and refusal of vitamin K has been reported previously.[5,10]

TABLE 2 Factors Associated With Refusal of IM Vitamin K Administration, Multivariable Adjusted Analysis

Associations	aOR (95% CI)
Sex	
Female	1.6 (1.2–2.3)
Male	Ref
Race and/or ethnicity	
Non-Hispanic white	1.7 (1.2–2.4)
Other[a]	Ref
Delivery	
Vaginal	(0.7–1.6)
Cesarean	Ref
Insurance	
Private	1.2 (0.8–1.6)
Public	Ref
Feeding	
Breastmilk only	3.4 (2.1–5.5)
Formula or combination[b]	Ref
Gestational age, wk[c]	(1.1–1.4)
Mother's age, y[c]	1.05 (1.02–1.08)

[a] Hispanic, African American, Asian American, Pacific Islander, American Indian, other, or unknown.

[b] Combination feeding is defined as feeding with breastmilk and with formula.

[c] Gestational age (wk) and mother's age (y) were entered into the logistic regression models as continuous variables.

When building the multivariable model, we included the variable for vaginal deliveries because of a previous study in which investigators reported an increased likelihood of vitamin K administration refusal after vaginal deliveries.[10] We included insurance type as a proxy for socioeconomic status because of the reported association of higher socioeconomic status in parents with vaccine refusal.[16]

In our study, we found a relatively small difference in the frequency of refusal of IM vitamin K administration between patients and controls who did not receive hepatitis B vaccine but who did receive ocular prophylaxis. It may be that most of these parents are amenable to preventive interventions such as ocular prophylaxis and IM vitamin K but for some reason choose to delay the hepatitis B vaccine. We were not able to assess the number of newborns that received the hepatitis B vaccine at the pediatrician's office, a practice that some parents or clinicians prefer. We did find that infants who received hepatitis B vaccine but who did not receive ocular prophylaxis had much greater odds (aOR = 6.2) also to have not received IM vitamin K ($P < .0001$). It may be that parents often refuse both IM vitamin K administration and ocular prophylaxis at the same time because these interventions are typically administered together immediately after birth. Our findings may have implications for well newborn units in light of the AAP's recent recommendation to give the first dose of the hepatitis B vaccine in the first 24 hours.[17]

We found a strong association with refusal of IM vitamin K administration and refusal of ocular prophylaxis. Although *Neisseria gonorrheae opthalmia neonatorum* is relatively uncommon in the United States, the Centers for Disease Control and Prevention reported an increase in the rates of gonorrhea in both adolescents and young adults in 2015–2016.[18] Mothers of newborns at highest risk for gonococcal *opthalmia neonatorum* often do not get prenatal care, engage in high-risk sexual behavior, and may have a history of sexually transmitted infections or substance abuse.[19] Efforts to understand why parents refuse ocular prophylaxis are needed, along with education about the safety of ocular prophylaxis in preventing the reemergence of this serious infection.

We found that girls had 1.6 times greater odds of not receiving IM vitamin K than boys. Circumcision of boys and the associated risk of bleeding may affect this decision for some parents. In the AAP's technical report on male circumcision, clinicians are advised to "confirm that vitamin K has been administered in accordance with standard practice of newborn care,"[20] and some hospitals require the administration of IM vitamin K before the procedure. Parents who may initially be hesitant about IM vitamin K may agree to the administration of IM vitamin K before a circumcision in the hospital.

Additional associations that were statistically significant in our analysis were non-Hispanic white race and/or ethnicity and breastmilk feeding during the newborn hospital stay. Our findings differ with those reported by investigators in New Zealand, who found that Asian/Indians, vaginal delivery, and greater gestational age were significantly associated with refusal of vitamin K administration.[10] The increased risk of refusal of IM vitamin K administration by a parent in newborns who receive breastmilk feeding in our study may partially be explained by a desire by some parents (who refuse vitamin K) to be more "natural," as reported in a qualitative study by Miller et al[21] in 2016. In a nationally representative sample of US mothers surveyed in the Study of Attitudes and Factors Affecting Infant Care study, mothers with negative attitudes about vaccination were more likely to be white and to exclusively breastfeed.[22] Exclusively breastfed newborns receive small amounts of vitamin K compared with the amount received by newborns who get formula. There also is a delay in colonization of the gut with bacteria that synthesize vitamin K_2 in breastfed newborns,[1,2] who may be at increased risk of VKDB if they do not receive IM vitamin K.

Our study has several limitations. BORN sites are generally academic centers in which there may be different rates of refusal of vitamin K administration than in other settings. Participation in the study by BORN sites was voluntary, and it may be that those that perceived vitamin K administration refusal to be a problem were more likely to participate in the study. Race and ethnicity were collected as recorded in the medical record and may be subject to error and variability. We did not collect information about procedures performed, alternative options provided to parents such as oral vitamin K, or outcomes of infants who received oral vitamin K. Because of limited funding, we asked each site to review up to a maximum of 10 cases for our nested patient-control study. This provided adequate statistical power for our analysis but limited our ability to adjust for the effect of site. Of the 26 sites that participated in the nested patient-control study, the proportion of all cases of vitamin K administration refusal at each site that were included in the nested patient-control study was 70% on average, with a median of 83%. However, we were able to show that there was substantial variability in the refusal rate across the nurseries using the aggregate data for the participating sites. Sites selected the first 10 cases of IM vitamin K administration refusal that year, and although there is the potential for bias, there is no known seasonal variation in vitamin K refusal by parents of newborns.

We provide with this study additional quantitative data on the frequency of refusal of IM vitamin K administration in multiple well newborn units across the United States and highlight the importance of ongoing national surveillance of this emerging problem. The refusal of other interventions, such as ocular prophylaxis and hepatitis B vaccine, that are considered the standard of care for newborns, in addition to refusal of IM vitamin K administration, should prompt us to consider new, comprehensive approaches to educating new and expectant parents that may help to decrease this serious, emerging problem.

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ABBREVIATIONS

AAP: American Academy of Pediatrics
aOR: adjusted odds ratio
BORN: Better Outcomes through Research for Newborns
CI: confidence interval
EMR: electronic medical record
IM: intramuscular
OR: odds ratio
VKDB: vitamin K deficiency bleeding

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REFERENCES

1. American Academy of Pediatrics Committee on Fetus and Newborn. Controversies concerning vitamin K and the newborn. American Academy of Pediatrics Committee on Fetus and Newborn. *Pediatrics*. 2003;112(1 pt 1):191–192
2. Pichler E, Pichler L. The neonatal coagulation system and the vitamin K deficiency bleeding - a mini review. *Wien Med Wochenschr*. 2008;158(13–14):385–395
3. Sankar MJ, Chandrasekaran A, Kumar P, Thukral A, Agarwal R, Paul VK. Vitamin K prophylaxis for prevention of vitamin K deficiency bleeding: a systematic review. *J Perinatol*. 2016;36(suppl 1):S29–S35
4. Centers for Disease Control and Prevention. Notes from the field: late vitamin K deficiency bleeding in infants whose parents declined vitamin K prophylaxis–Tennessee, 2013. *MMWR Morb Mortal Wkly Rep*. 2013;62(45):901–902
5. Abrams S, Savelli SL. Be prepared to address parents' concerns about vitamin K injection. *AAP News*. 2014;35(5):1
6. Sahni V, Lai FY, MacDonald SE. Neonatal vitamin K refusal and nonimmunization. *Pediatrics*. 2014;134(3):497–503
7. Hamrick HJ, Gable EK, Freeman EH, et al. Reasons for refusal of newborn vitamin K prophylaxis: implications for management and education. *Hosp Pediatr*. 2016;6(1):15–21
8. Kassis KL, Wada KJ, Milton A. Another disease re-emerges due to parental shot refusal: case report of a fussy infant with blood in stool. *J Emerg Med*. 2015;49(1):e15–e17
9. Loyal J, Taylor JA, Phillipi CA, et al. Refusal of vitamin K by parents of newborns: a survey of the Better Outcomes through Research for Newborns network. *Acad Pediatr*. 2017;17(4):368–373
10. Burke M, Bernhardt H, Reith DM, Barker D, Broadbent RS, Wheeler BJ. Perinatal influences on the uptake of newborn Vitamin K prophylaxis–a retrospective cohort study. *Aust N Z J Public Health*. 2015;39(6):573–576
11. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. *J Clin Epidemiol*. 1996;49(12):1373–1379
12. Firth D. Bias reduction of maximum likelihood estimates. *Biometrika*. 1993;80(1):27–38
13. SPSS [software]. Armonk, NY: SPSS IBM Corp; 2016
14. SAS [software]. Version 9.4. Cary, NC: SAS Institute Inc; 2011
15. Marcewicz LH, Clayton J, Maenner M, et al. Parental refusal of vitamin K and neonatal preventive services: a need for surveillance. *Matern Child Health J*. 2017;21(5):1079–1084
16. Wei F, Mullooly JP, Goodman M, et al. Identification and characteristics of vaccine refusers. *BMC Pediatr*. 2009;9:18
17. Committee on Infectious Diseases; Committee on Fetus and Newborn. Elimination of perinatal hepatitis B: providing the first vaccine dose within 24 hours of birth. *Pediatrics*. 2017;140(3):e20171870
18. Centers for Disease Control and Prevention. Sexually transmitted disease surveillance 2016. Available at: https://www.cdc.gov/std/stats16/CDC_2016_STDS_Report-for508WebSep21_2017_1644.pdf. Accessed October 17, 2017
19. US Preventive Services Task Force. Final evidence review for ocular prophylaxis for gonococcal ophthalmia neonatorum: preventive medication. Available at: https://www.uspreventiveservicestaskforce.org/Page/Document/EvidenceReportFinal/ocular-prophylaxis-for-gonococcal-ophthalmia-neonatorum-preventive-medication#citation10. Accessed October 17, 2017
20. American Academy of Pediatrics Task Force on Circumcision. Male circumcision. *Pediatrics*. 2012;130(3). Available at: www.pediatrics.org/cgi/content/full/130/3/e756
21. Miller H, Kerruish N, Broadbent RS, Barker D, Wheeler BJ. Why do parents decline newborn intramuscular vitamin K prophylaxis? *J Med Ethics*. 2016;42(10):643–648
22. Fadel CW, Colson ER, Corwin MJ, et al; Study of Attitudes and Factors Effecting Infant Care (SAFE) study. Maternal attitudes and other factors associated with infant vaccination status in the United States, 2011-2014. *J Pediatr*. 2017;185:136–142.e1