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Early Vitamin K Deficiency Bleeding in a Neonate Manifested as Pulmonary Hemorrhage

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Abstract

Background: A female neonate was born at 40 weeks and 5 days gestation via spontaneous vaginal delivery with no complications. At 6 hours of life she was noted to have respiratory distress and bloody emesis. Following a non-traumatic intubation on the first attempt, bright red blood was suctioned from the endotracheal tube and a pulmonary hemorrhage was diagnosed. Initial labs revealed a prolonged PTT and INR. The infant did not receive vitamin K prior to development of respiratory distress and admission to the neonatal intensive care unit due to parental refusal.

Purpose: Vitamin K Deficiency bleeding in the neonatal period is a growing concern in the medical community as increasing numbers of parents are refusing vitamin K prophylaxis at birth. We herein report a complication of vitamin K deficiency that may be underreported in the literature.

Case findings/Results: After initial decompensation including suspected gastrointestinal bleeding, respiratory distress requiring intubation, and pulmonary hemorrhage, the infant improved clinically, the PT corrected, and the hemorrhage subsided following vitamin K administration.

Implications for practice: Pulmonary hemorrhage is not a commonly reported complication of early vitamin K deficiency bleeding, but health professionals should be aware of this as a potential complication of vitamin K prophylaxis refusal.

Implications for research: More research is necessary to describe the incidence of pulmonary hemorrhage attributable to vitamin K Deficiency.

Keywords: Vitamin K; Vitamin K deficiency bleeding; Hemorrhagic disease of the newborn; Pulmonary hemorrhage

Introduction

Bleeding in the neonate is a serious clinical situation that can progress rapidly if the coagulation cascade is compromised by either acquired or inborn factors. Bleeding caused by a deficiency of vitamin K dependent clotting factors is known as Vitamin K Deficiency Bleeding (VKDB) and can be classified as early, classic, or late. Early bleeding occurs in the first 24 hours of life and is typically associated with maternal medication intake during pregnancy. Substances associated with early bleeding can include but are not limited to anticonvulsants such as phenytoin, barbiturates, carbamazepine, the antitubercular drugs, rifampin and isoniazid, and vitamin K antagonists, warfarin and coumarin. Vitamin K associated bleeding occurs in this instance because these substances cross the placenta and either inhibit vitamin K or are vitamin antagonists [1].

Classic bleeding occurs during the first 0-2 weeks of life [2]. Classic bleeding has been associated with delayed or insufficient feeding. Late bleeding occurs from 2 weeks to 6 months of life and is mainly associated with strictly breastfed infants who did not receive adequate vitamin K prophylaxis [2,3]. Late bleeding was less frequently reported when formula feedings were more common. Breast milk has very low levels of vitamin K (between 1 and 4 μg/L of vitamin K) leading to increased reports of classic vitamin K deficiency bleeding as exclusive breastfeeding rates have risen and vitamin K refusal has become increasingly common. The main complications that are seen with early vitamin K deficiency bleeding are internal hemorrhage within 24 hours after birth or classically, gastrointestinal hemorrhages from days 2 to 7 [4]. The late form of VKDB is mainly reported as intracranial hemorrhages from 2 weeks of age to 6 months of age.

The incidence of bleeding during the first 2 weeks of life in babies who do not receive vitamin K prophlyaxis is estimated to be between 0.25-1.7% [3]. VKDB resulting in ecchymoses, umbilical cord bleeding, circumcision site bleeding, and epistaxis have additionally been described [3]. Pulmonary hemorrhage, however, is not a commonly reported complication of early vitamin K deficiency bleeding. We report a case of pulmonary hemorrhage that may be attributed to vitamin K deficiency.

Case

Prenatal and delivery

A female neonate was born at 40 weeks and 5/7 days gestation via spontaneous vaginal delivery to a gravida 3 para 1 live birth 0 preterm birth 1 miscarriage 1 living child (G3P1011). There were no complications during pregnancy and no maternal history of tobacco, alcohol, or illegal drug use. The mother's medications during pregnancy included: folic acid (800 mcg), cayenne (450 mg), vitamin D_3 (an unknown amount), GABA (100 mg), vitamin B_{12} (1000 mcg), Vitamin B_6 (20 mg), zinc (30 mg), and vitamin K (15 mg) all dosed daily. The mother was blood type O positive and maternal serologies were unremarkable. During the second stage of labor there was a 1 minute shoulder dytocia. The baby's Apgar's were 7 and 9 at 1 and 5 minutes, respectively.

Initial presentation

Initial care of the infant was delivered in mother's room by the newborn nursery staff. The parents elected not to administer vitamin K, Hepatitis B vaccine, or erythromycin eye ointment upon delivery. At 6 hours of life while receiving a bath, the baby was noted to be tachypneic (respiratory rate 80-90 breaths/minute) with increased work of breathing. She had oxygen saturations in the mid 80s. The baby was also noted to gag on her oral secretions. Initial temperature at 5 minutes of life was 98.6 axillary. At 37 minutes of life temperature was 98.8 degrees F, taken axillary while skin to skin with mother. Temperature at 67 minutes of life on was 98.6 degrees F. At six hours of life on initiation of the first bath the temperature was 98.6 thirty minutes later after the bath was completed was 99.5 degrees F, all taken axillary. Temperature at 10 hours when the infant developed increased respiratory distress and bloody emesis was noted was 98.6 degrees F, axillary, and the temperature at 14 hours of life, at the time of intubation was 99.1 degrees F.

Respiratory

At 10 hours of life the infant was transferred from the newborn nursery to the NICU and placed on nasal prong CPAP with a PEEP of 5. Physical exam revealed tachypnea with diminished breath sounds bilaterally, and an absence of nasal flaring and grunting. A chest radiograph showed evidence of reticulonodular air space opacity in the right upper lobe and in the perihilar distribution about the lower lobes. At 14 hours of life the infant's respiratory condition deteriorated further with development of retractions, intermittent grunting, and tachypnea (respiratory rate 120s-130s breaths/minute). Due to increasing respiratory distress the baby was intubated non-traumatically with a 3.5 ETT taped at 11 cm on the first attempt and placed on SIMV peak inspiratory pressure of 20, positive end expiratory pressure (PEEP) of 5, a rate of 30 and an inspiratory time of 0.4 seconds. The decision was made to transfer to a higher level NICU for further care. Notably, immediately after intubation and prior to transfer at 17 hours of life, significant amounts (estimated between 5 and 10 ml) of bright red blood was suctioned from the endotracheal tube. At this point the PEEP was increased to 7.0 Initial capillary blood gas was obtained on the higher PEEP and showed a pH of 7.32, a pCO_2 of 44, a paO_2 of 40, a HCO_3 of 22, and a Base Deficit of -4. A repeat chest radiograph on admission to a higher level NICU showed a decrease in the bilateral pulmonary opacities. By the next day, the patient's respiratory rate decreased and her breath sounds improved. A chest radiograph showed resolution of previously noted infiltrates and opacities, and she was extubated to room air.

Infection

Clinical presentation could not eliminate a possible pneumonia, so blood cultures, a CBC and CRP, were obtained and ampicillin and gentamicin were started at 7 hours of life. An initial CBC demonstrated polycythemia and mild bandemia. A follow up CBC was within normal limits and antibiotics were discontinued after 48 hours of treatment. Blood cultures were negative (Table 1).

	7 hrs of life	18 hrs of life	2 days	Institutional normal value
WBC	21.0	17.9	16.6	5.0-21 × 10 E3/μL
RBC	6.20	5.19	5.88	4.00-6.50 × 10 E6/μL
Hemoglobin	21.6	18.2	20.4	14.5-22.5 g/dL
Hematocrit	65.7	52.0	58	44.0-64.0%
MCV	106.0	100.2	98.6	95.0-125.0 fL
MCHC	32.8	35	35.2	32.0-36.0%
RDW	18.9	19.7	19.9	11.3-15.5%
Platelet count	282	244	284	150-400 × 10 E3/μL
Automated Abs netrophil count	15.6	13.9	-	1.0-8.5 × 10 E3/μL
Manual absolute netrophil count	15.3	15.4	-	1.0-8.5 × 10 E3/μL
Segs relative %	43	64	-	-
Bands relative %	30	22	-	-
Lymphocytes relative	22	9	-	-
Monocytes relative	5	3	-	-
CRP	<0.5	0.9	-	<1.0 mg/dL

Table 1: Laboratory Results.

Coagulation

As the infant developed increasing respiratory distress at 6 hours of age she was also noted to have multiple episodes of emesis that were dark in color and had the appearance of blood (these were not heme tested). Vitamin K (phytonadione 1 mg intramuscular injection) was administered upon admission to the referring NICU at 10.5 hours of life. This was done after a lengthy discussion with the family by the care team regarding the concern for bloody emesis consistent with a gastrointestinal bleed and the patient's continuing clinical deterioration. Upon admission to the level IV NICU, (after administration of IM vitamin K) the patient had mildly prolonged partial thromboplastin time (PTT) and international normalized ratio (INR) as well as an elevated D-Dimer, but no further frank red blood was noted and no blood or factor transfusions were necessary. The subsequent day, repeat coagulation studies showed a prolonged PTT with a normal INR. A consultant from the hematology department

suggested clotting factor studies but these were deferred as an inpatient at the parents' request with their stated intent to seek evaluation as an outpatient. On day of life 5, the patient had a normal PT/INR and a prolonged but improved PTT (Table 2). A head ultrasound was normal with no evidence of intracranial hemorrhage. The patient was discharged on day of life 6 with an outpatient follow-up with hematology scheduled for two weeks following discharge. The family was non-compliant with this appointment and has not rescheduled.

Cytes	On admission to higher level NICU (18 hours of life)	DOL 2	DOL 5	Reference range
Protime	16.7	12.9	12.1	9.5-13.5 sec
INR	1.5	1.1	1.1	0.9-1.1
PTT	52	51.6	46.8	24.0-36.0 sec
Fibrinogen	163	196	-	160-450 mg/dL
D-Dimer	1879	1943	-	<500 ng/mL FEU
Platelet count	244	302	-	150-400 × 10 E3/μL
Schistocytes	Occasional shistocytes	Occasional shistocytes	-	-
Antithrombin III activity	51	46	-	70-130%

Table 2: Coagulation Studies/DIC Screen.

Discussion

Coagulation and vitamin K deficiency bleeding

Vitamin K is a cofactor in the γ-carboxylation glutamic residues on clotting factors II (prothrombin), VII, IX, and X. This γ-carboxylation enables these coagulation factors to bind calcium and attach to phospholipid membranes in order to establish clotting. The enzyme vitamin K reductase which reverts vitamin K [2,3] epoxide back to vitamin K hydroquinone for participation in additional γ-carboxylation reactions is also necessary for a fully functioning coagulation cascade and proper coagulation. A less well understood but important function of vitamin K in coagulation is the impact it has on protein C, protein S, and protein Z [5]. A deficiency of vitamin K or the presence of antagonists to vitamin K can inhibit coagulation and lead to significant bleeding in the newborn [6]. Factor levels that are affected by vitamin K deficiency are in the intrinsic, extrinsic and common coagulation pathways as illustrated in Figure 1, leaving a vitamin K deficient infant at risk from every standpoint, and underscoring the mechanism behind the severe bleeding that can be seen with vitamin K deficiency [7].

The newborn infant has significantly decreased stores of vitamin K in the liver as compared to adults. Additionally, the transfer of vitamin K across the placenta is very low [1]. So, despite the maternal oral supplementation with vitamin K as was present in this case, prenatal therapy does not increase neonatal stores at delivery. A combination of low liver vitamin K in the neonate and minimal maternal transfer from the placenta untreated infants to bleeding from a primary deficiency of vitamin K which is manifested by low levels of factors II, VII, IX, and X and abnormal clotting [8].

Vitamin K activity in the evaluation of bleeding is measured indirectly by measuring the coagulation factors that are dependent on vitamin K, factors II, VII, IX, X. These will all normalize rapidly when vitamin K is administered parentally.

Vitamin K prophylaxis has been the standard of care since 1961 when it was recommended by the American Academy of Pediatrics and it is efficacious for the prevention of early and late VKDB [2]. Oral and parenteral formulations have shown similar efficacy for the prevention of early VKDB. However, parenteral administration is preferred for all infants because of better prevention of late onset bleeding. Administration of vitamin K by intravenous route has been associated with increased risk of anaphylaxis, in some cases severe and fatal [9]. For this reason, the preferred method of parenteral administration of vitamin K in the neonate is intramuscular (IM).

Estimates of the overall risk of late VKDB range from 4.4 to 7.2 per 100,000 births. Studies involving a single oral dose of vitamin K show a decrease in that rate to 1.4 to 6.4 per 100,000 babies. Babies administered parenteral vitamin K does not develop late VKDB except for a few rare cases with underlying severe malabsorptive disease [2]. Even when multiple oral doses are administered, the incidence of late VKDB is higher than with parental administration [10].

Case Discussion

This case describes an infant with a coagulopathy who had not received vitamin K at birth. While our case is not a classic presentation of VKDB there are several factors that lead to this diagnosis placement high on the differential diagnosis list. The patient had initial infiltrates on chest x-ray prior to intubation. Although the patient was started on antibiotics a diagnosis of pneumonia was not confirmed, and the infiltrates resolved over a short period of two days, more quickly than a chest x-ray consolidation from pneumonia would be expected to resolve in a neonate. There was a non-traumatic intubation followed by the suctioning of a large amount of blood from the ETT. Additionally, there were reports of blood stained emesis which is more consistent with VKDB gastrointestinal hemorrhage. Unfortunately these samples were not sent for heme testing. Although the patient did receive vitamin K upon admission to the NICU, and vitamin K has a relatively quick onset of action 30-120 minutes when given IM, the bleeding that was noted on intubation was likely to have occurred prior to the vitamin K administration. Blood is very caustic to tissues and could have contributed to increased respiratory distress over time due to increasing local pulmonary inflammation. This would also explain the chest radiograph changes noted initially and the quick resolution of radiographic findings after intubation.

The definitive diagnosis of vitamin K deficiency is significant elevation of the PT and INR with normal fibrinogen and platelets prior to administration of IM vitamin K. As vitamin K was administered prior to the initial coagulation studies by more than the 30 minute to two-hour time of onset expected for IM vitamin K we can only utilize clinical course and maternal history to diagnose the etiology of significant bleeding in this patient. However, a mild elevation of PT 8 hours did remain after vitamin K was administered, and platelets and fibrinogen were normal at all evaluated time points. Vitamin K does not effect platelet count or function and also has no effect on fibrinogen levels (Figure 1) [7], and as shown in Table 2, these values were normal throughout hospitalization. The PT corrected following the administration of Vitamin K and the hemorrhage subsided. A search was undertaken to determine whether the infant had risk

factors for bleeding in addition to vitamin K deficiency. There was no family history of hemophilia or other hematologic disorder. As the patient and family did not follow up with hematology for a full laboratory evaluation of coagulation, it is unknown whether or not she had an underlying clotting factor deficiency.

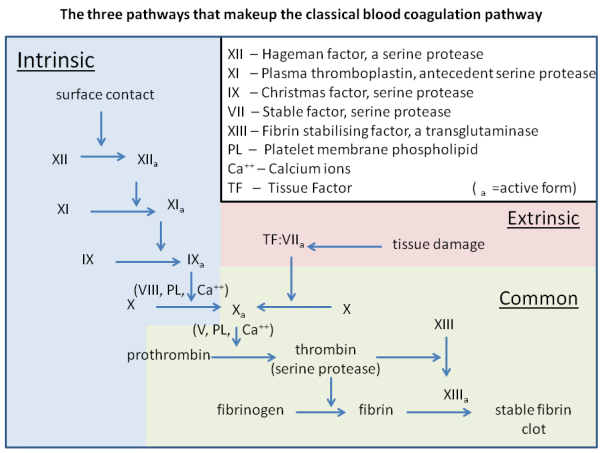

Figure 1: The Classical coagulation pathway. Note that vitamin K affects availability of functioning factor II (prothrombin) part of the common pathway, factor VII in the extrinsic pathway and factors IX and X in the intrinsic pathway.

It is known that maternal anticonvulsants that interfere with Vitamin K metabolism are risk factors for early VKDB in the neonate. This patient's mother took a significant number of natural supplements throughout the course of her pregnancy. These medications were mostly vitamins and although they are not known to be associated with inhibition of Vitamin K are also unregulated and may contain contaminating compounds that have some impact on the coagulation cascade and vitamin K levels at delivery and birth. Of interest is the GABA supplement that the mother took. This substance is a neurotransmitter that inhibits neurotransmission in the brain and is commonly used as a supplement to relieve anxiety. Although no case reports have associated GABA with vitamin K antagonism, anti-convulsants that inhibit neurotransmission have been associated with vitamin K deficiency bleeding. This is a good reminder to only ingest necessary substances during pregnancy to avoid untoward and unanticipated side effects.

There are other lessons for health providers concerning this case. One is an awareness of the characteristics of parents who may refuse Vitamin K prophylaxis. These characteristics have been studied and documented. Parents who had midwife assisted deliveries, planned home deliveries, and delivery in a birth center were more likely to refuse vitamin K as compared to those who had hospital deliveries. Also refusal of Vitamin K was associated in this study with a higher relative risk of having no childhood vaccinations at 15 months of age [11].

A report from a children's hospital in Tennessee described six cases of vitamin K deficiency bleeding following refusal of vitamin K prophylaxis in 2013 [12]. The parents were surveyed about their refusal. All of the parents reported a lack of knowledge about the risk for their child developing late VKDB at the time of refusal. Some parents thought the shot was a "toxin" or was unnecessary [8]. Clearly there is room for improved parental education about the necessity, benefits, and lack of harm from administration of vitamin K to their newborns. All infants survived, however two required surgical intervention for intracranial hemorrhage and three have neurological impairment (one severe, two mild to moderate).

In order to prevent VKDB, the American Academy of Pediatrics recommends Vitamin K1 be administered to all newborns as one intramuscular dose of 0.5 to 1 mg. A policy statement from the AAP in 2003 recommends more research be conducted on oral formulations in order to ensure proper dosing to prevent late VKDB complications as there have been reported cases of late VKDB following incomplete oral prophylaxis [2].

There are concerning trends in refusal of evidence based medical care for mothers and newborns around the time of delivery. With increasing reports of late onset VKDB leading to neurologic impairment, in is important for neonatal and newborn providers to understand the safety and proven benefits of IM vitamin K prophylaxis. All newborn providers should have the ability to answer parents questions and concerns with evidence based information to decrease further episodes of VKDB.

Summary of Recommendations

What we know:

The American Academy of Pediatrics recommends Vitamin K_1 is administered to all newborns as one intramuscular dose of 0.5 to 1 mg [2].

Vitamin K prophylaxis is efficacious for the prevention of early and late VKDB [2].

Oral and parenteral formulations have shown similar efficacy for the prevention of early VKDB [2].

Parenteral administration of vitamin K is preferred for all infants because of better prevention of late onset bleeding.

What needs to be studied?

More research should be conducted on oral vitamin K formulations in order to ensure proper dosing to prevent late VKDB complications as there have been reported cases of late VKDB following incomplete oral prophylaxis.

More research needs to be done about the incidence of pulmonary hemorrhage attributable to Vitamin K Deficiency.

More research should be conducted on parental rational for refusal of Vitamin K and strategies for caregivers to improve education and decrease refusal rates.

What can we do today that would guide caregivers in the practice setting considering use of this evidence for guiding practice:

Be aware of the characteristics of parents who may refuse Vitamin K prophylaxis. Studies have associated Vitamin K refusal with parents who had midwife assisted deliveries, planned home deliveries, and delivery in a birth center as well as refusal of childhood vaccinations [11].

Improve parental education about the necessity, benefits, and lack of harm from administration of vitamin K to their newborns.

One website targeted to educate parents is: (http://evidencebasedbirth.com/evidence-for-the-vitamin-k-shot-in-newborns/)

The CDC has developed parent educational sheets in order to improve the acceptance of vitamin K prophylaxis.

Health professionals should be aware of pulmonary hemorrhage as a potential complication of vitamin K prophylaxis refusal.

Hospitals and birthing centers should have protocols in place for education of parents who refuse vitamin K prophylaxis for their newborns

Infant's status for vitamin K prophylaxis should be clearly communicated to all members of the health care team including the PCP. Some institutions will choose to refuse circumcision and other elective surgical procedures to infants who have not received vitamin K prophylaxis.

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