A case series of over-hydration in making baby formula - Importance of the metric system.

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Abstract

Over-hydration is a serious concern when making formula for infants. If the formula is not made according to the instructions because the wrong amount of formula is used in relationship to the volume of water added, the infant could experience life threatening changes. Understanding the difference between US fluid ounces (US fl oz) and UK fluid ounces (UK fl oz) was the objective of this case. Baby formula and breast feeding have been a topic of discussion in the media. Based on this case we are able to promote dialogue and critical analysis of the risk and benefits of formula feeding as compared to breastfeeding.

Keywords: Metric system, Over-hydration, Breastfeeding, Infant feeding, Formula feeding, Lactation.

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Introduction

There is continuous conversation and growing controversy of the need and use of baby formula in America. In 1992 a longitudinal study of the Infant Feed Practices Study II (IFPS II) was conducted by the US Food and Drug Administration to get a better understand of the general nutritional patterns of infants in the first year of life [1]. Despite some societal negatives associated with breastfeeding, a number of studies have been conducted and concluded that babies born in industrialized countries, and are not breastfeed, have a higher incident of respiratory infections and almost twice as likely to form ear infections [2]. The American Academy of Pediatrics now recommends that mothers breastfeed excessively at a minimum the first six months of life and if possible for the first year of a baby’s life. Despite this specific recommendation, a small percentage of US infants are breastfeed at 3 months and only 21% for 1 year of life [2-3]. There are many contributing factors to these low numbers. One idea supported by the literature is the lack of social acceptance. There have been a number of documented negative encounters experienced by lactating mothers, for example people have repeatedly reported that women have been told to feed their children in the bathroom and away from public view [4].

In 2008, Jacqueline Wolf made the following observation, “America’s focus on the sexual purpose of breasts, rather than the physiological function of breasts, has serious public health consequences. Discomfort with breastfeeding in public lowers breastfeeding rates, which in turn negatively affects women's and children's short- and long-term health” [5]. So because a myriad of reasons, American mothers are heavily reliant on bottle feeding. Thus, making sure that all aspects of bottle formula making is understood is critical for a healthy baby.

Lactation Process in Humans

Human milk is unique and complex. It has a complex immunology and the early milk provide colostrum which has a low concentration of fat but a high concentration of protein and minerals for the new infant. The process by which is created has been studied. The stages of lactation are summarized in Table 1 [6]. An excellent explanation of each stage is provided by Wagner et al. [7].

History of Formula

The creation of formula is a prime example of “better life, through better chemistry.” In the 18th century, the first chemical analyses of human milk and animal’s milk was accomplished. In 1760, Charles Des-Essartz published the Treatise of Physical Upbringing of Children [8,9]. In this Treatise he published a composition comparing human milk to cow, sheep, jackass, and other mammals.

<table>
<thead>
<tr>
<th>Process</th>
<th>Location</th>
<th>Physiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammogenesis</td>
<td>Mammary tissue growth</td>
<td>The size and weight of breast usually increases</td>
</tr>
<tr>
<td>Lactation</td>
<td>Occurs in two stages. The late states Endocrine system controls the flow and production of milk.</td>
<td>Stage 1 – Last trimester Alveolar cells differentiate from secretory cells.</td>
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<tr>
<td></td>
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<td>Stage 2 – up to 1 week after birth; breast are full and can become engorged.</td>
</tr>
<tr>
<td>Galactopoiesis</td>
<td>Secretion is maintained; Autocrine system controls continuation of lactation</td>
<td>Occurs 9 days after birth and continues toinvolution</td>
</tr>
<tr>
<td>Involution</td>
<td>Milk production is inhibited by peptides</td>
<td>Usually 30-40 days after last breastfeeding.</td>
</tr>
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In 2009, the Marin Breastfeeding Coalition (Marin County, California) placed life size cutouts of mothers breastfeeding in public locations to help destigmatize and normalize the idea of breastfeeding in public [16]. Similar campaigns have been launched in Australia and Canada. The WHO and UNICEF also recognizes breastfeeding as a global health issue and supports the need to reinforce it as a basic human right [17]. Although this additional campaigns have been introduced to the public with life size portraits of women, it has been recognized that men must be educated as women are empowered. Only one side of the issue is being addressed if the focus is only on women. Fathers holding their children, and various family photos displaying family units were introduced to widen the conversation. The issue is not a “women, infants and children” (WIC) issue [13]. It is a family and human rights issue. The outcomes have social and economic consequences for humanity.

Case Report

Clinical case - Miscalculation of baby formula

Maximus was an 8-month old baby boy. He was born in the United States on February during “Superbowl” Sunday. At birth he weighed 10 lbs. He was breastfed with occasional supplementing with baby formula. He had a healthy appetite and did not mind being fed from the bottle. When Maximus was 7 months old he and his parents visited Tanzania. He went to visit his paternal grandparents. While he was in Tanzania, his parents purchased a baby bottle for him. They also had to purchase formula for him while in Tanzania.

When they returned to the United States, Maximus went to visit his grandmother in Virginia. He was eating some baby cereals, but his primary food source was milk. His grandma in Virginia kept him for two weeks. His parents brought the “Tanzanian baby bottle” and the formula. The formula did not last for the two weeks so his grandfather went to the local grocery store and purchased a new powder formula. When it was time for Maximus’ next feeding, his grandma immediately, noticed that the milk looked differently. But she was sure she followed the directions (i.e., 3 scoops for 6 fl oz). But the milk did not look the same as before. And baby Maximus started to have some issues after a day or so with being fussy. His diapers content looked differently. Grandma was totally suspicious of the milk and if she had made it correctly. It had been more than 25 years since she had made formula so she was almost sure that it had to be the formula.

So re-evaluating the steps in the process of formula making. The first thing she noticed was that the bottle had three different measurements (Figure 1). The US fluid ounces and the UK fluid ounces, in addition to milliliters. Then she went to the formula can and noticed that the formula was purchased in the UK and she was using UK fluid ounces with the US measurements for “scoops.” The milk was too dilute. On average she adding about 30 mL more water for each feeding. She used Google to find support for her hypothesis and she was able to find a blog where other parents had similar experiences:

“... you need to use mL not oz. A UK fl oz is 28 mL not 30 mL. I think US fl. oz is 30 mL.”

“Yes, I noticed this and do it the same as you to the mL instead of the (sic) oz. Also, I have a bottle that has American oz on
as well and they are different to [E]nglish ounces!!! [M]adness!
- [Accessed: August 2016 from https://www.mumsnet.com/]

Once reading the dialogue she immediately realized her problem. It was easier enough to fix. The more grandma research the topic, the more she understood the importance of knowing the metric system. If she had simply used mL on the bottle and on the instructions she could have avoided a fussy baby. In reading about this problem grandma ran across an article titled, “A history of Infant Feeding” [19]. The article provided the evolution of baby formula in the United States.

Results
This case series describes the importance of understanding labels and what the nutritional consequences are if baby’s formula is not mixed properly. Baby formula is expensive. In the United States in 2017, it was estimated that 30 or more ounces per day of baby formula (i.e., 30 fluid ounces is equivalent to 887 mL) cost $3000 per year (or $250.00 per month) [20]. Babies like Maximus easily consumed more than 887 mL’s in a day. At the height of his growth curve he was consuming 1.5 mL of formula a day. So often when parents are feeling a tight budget they are tempted to water down the formula. Too much water is dangerous for infants. Babies do not have the ability to process water out of their bodies until they are at least 10 months old, and too much water can dilute their blood and interfere with their electrolytes, causing sodium and potassium levels to plummet and possibly resulting in brain damage or seizures.

Discussion
Generally, people do not consider the differences between US fl oz and UK fl oz. Besides not know the difference they often will confuse ounce mass with fluid oz. In 1795 the Paris Academy of Sciences adopted the metric system. The US Congress legalized the use of the metric system 90 years after the American Revolution for Independence. In 4 years after congressed legalized the measure, the US along with sixteen other nations established the Convention of the Meter. These conventions and those similar to the Paris Agreement of 2014 are critical to science and technology advancement. Countries have to speak the same language if they are to be trading partners in particular. As Sigmund Freud stated “It is impossible to escape the impression that people commonly use[d] false standards of measurement — that they seek power, success and wealth for themselves and admire them in others, and that they underestimate what is of true value in life”[22]. The use of the metric system which is designed on base 10 makes for the expected measurement to be exactly that and not for an ounce to mean an ounce no matter if you are in the United States or in the United Kingdom.

Conclusion
The idea of breastfeeding being a human right is very much a topic of discussion that is lacking in the United States. This case is able to address some critical concepts and allow for mature discussion on issues germane to the health of women and children. The case allows for the critical analysis of the
numerical data but in the context of human biology. This case would be ideal in a laboratory class of 20-24 students. We use this case at the beginning of the semester to help enforce the importance of the metric system in biology and the additive effect of consistent errors in measurements.

References


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