

Support for Raising Babies on Breast Milk New Research Elucidates Breast Milk Flow Patterns During Electric Breast Pump Use

Collaborative research by Pigeon Corporation (Headquarters: Tokyo; President and CEO: Norimasa Kitazawa) and the Japan Milk Bank Association (Headquarters: Tokyo, Representative Director: Katsumi Mizuno), has identified an innovative, easier way to measure breast milk flow during electric breast pump use. These research results will not only be used to improve the functionality and usability of breast milk pumps, they may also lead to personalized advice and support on expressing breast milk in clinical situations.

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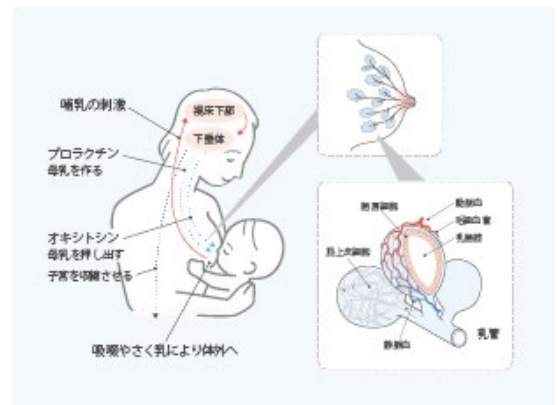
Research Overview

●Background to the Research

Mammary gland structure and reactivity to oxytocin vary from person to person. For that reason, there are individual differences in when and how often the milk ejection reflex activates while expressing breast milk, changing the way in which breast milk is expressed. We call these “flow patterns.”

Understanding flow patterns could be useful for more effective breast milk expression—for example, by making it easier to decide pumping time. However, the general difficulty of detecting peaks of flow from data and identifying the milk ejection reflex’s occurrences through analysis meant that an easier evaluation method was needed.

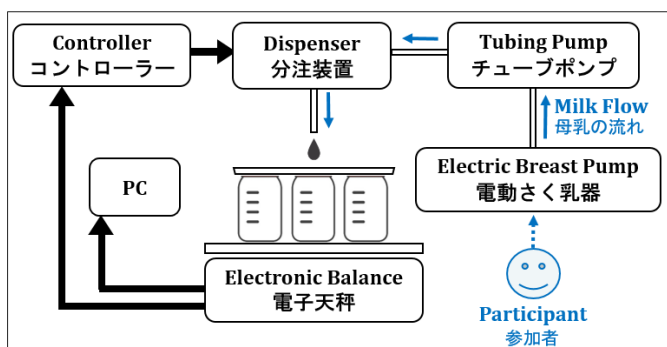
Devising a way to accurately and continuously measure breast milk flow during expression, without adding to the burden on mothers, was another challenge.



●Using Breast Milk Measuring and Dispensing Equipment for Real-Time Measurements During Pumping

As a result, the research project began by developing unique measurement equipment and breast pump parts. Because anxiety or pain can greatly effect breast milk expression outcomes, we made every effort to ensure that mothers could express milk in a comfortable posture without even noticing the measurement taking place. The pumping equipment also had to be hygienic and not waste any milk. The completed system allows mothers to sit in a comfortable position—for example, on the sofa—and pump in their usual posture. Breast milk volume is displayed and recorded on a computer in real time, and the breast milk is automatically dispensed among multiple containers hygienically and without any waste. This system was used to research the breast milk flow patterns of individual mothers.

Figure 1: Flow measurement system used for the research



The pumped breast milk flows through a tube into nursing bottles on an electric balance, allowing milk volume to be continuously recorded on a computer. The tubing pump installed partway along the tube prevents breast milk from building up in the tube and keeps the flow regular. Mothers can pump milk in a comfortable posture without being bothered by the measurement process.

This system allows volumes and times to be freely set for dispensing breast milk among multiple nursing bottles, which means it could be used to separate milk pumped at the beginning and end of the session (foremilk and hindmilk) or perform research on breast milk components.

Notes:

- All parts in contact with breast milk conform to food safety laws. (The pump shown in the photograph was not the one used in the actual research.)
- A commercially available electric balance and tubing pump were used.

Analyzing Flow Patterns Based on High-Flow Periods

The research focused on high-flow periods, defined as periods with flow of more than the standard 0.1 g/s. It showed that flow patterns can be analyzed by using the number and timing of high-flow periods as indicators.

Over the course of a pumping session, breast milk flow begins, gradually increases in intensity, peaks, and then slowly weakens. If pumping is continued after this, the next milk ejection reflex is triggered, and milk flow increases again. This kind of rise and fall in flow during pumping might be observed once or multiple times. Sometimes breast milk continues to flow in the periods between peaks, and sometimes the flow temporarily stops.

Because increases and decreases in flow can overlap, identifying peaks and analyzing the number and intensity of the milk ejection reflex's occurrences is difficult. However, by defining periods when milk was flowing at a rate above the standard rate as "high-flow periods," this research found that analyzing characteristics like number and length of high-flow periods can elucidate individual flow patterns. Figure 2 shows examples of high-flow periods occurring once, twice, and three times.

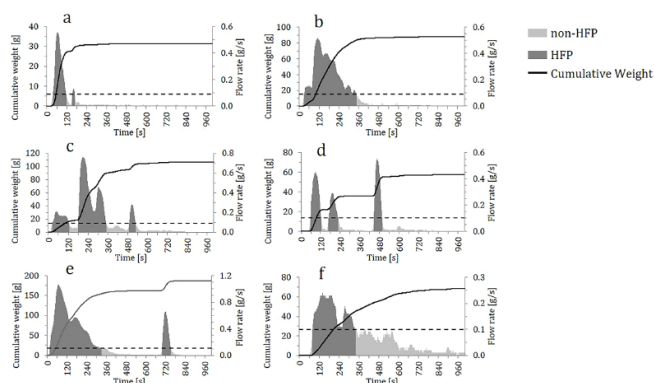


Fig. 3. Changes in breast milk amount and flow rate. Flow rate change curves with one high flow rate period (HFP) (b, f), two HFPs (a, e), and three or more HFPs (c, d) are shown, with individual differences in HFP appearance, frequency, and duration. After the expressed breast milk amount decreased once, a second HFP was observed approximately 10 min after the start of breast milk expression (e). Breast milk expression continued after the end of the HFP, and the flow rate fluctuated at regular intervals throughout the pumping session (f).

Figure 2: Example of observed flow pattern

(Horizontal axis shows pumping time. High-flow periods are in dark gray)

●Relationship Between High-Flow Periods and Expressed Volume

During a 15-minute pumping session, 82.5% of the breast milk is expressed during high-flow periods. Furthermore, the length of the high-flow periods is positively correlated with the total amount of milk expressed. It appeared that the characteristics of high-flow periods play an important role when investigating effective breast pumping.

Also, even during 15-minute pumping sessions when the flow never exceeded the basis rate of 0.1 g/s and the total amount of milk expressed was low, it was possible to identify the flow pattern by adjusting the threshold value. It seems likely that suitable flow patterns for given objectives could be analyzed by adjusting the threshold value to each individual mother.

●Future Challenges and Implications for Parents and Medical Personnel

The findings of this research offer information that could be valuable for mothers struggling with breast milk production and pumping methods. By understanding their individual flow patterns, mothers can identify the right pumping time to suit their natural rhythms and avoid over- or under-pumping. For medical personnel, the research suggests the possibility of augmenting traditional support methods with more effective pumping support for individual patients by taking flow patterns into consideration. For example, the suction strength and speed of the pump could be adjusted according to changes in flow. In the future, we will continue our research on breast pumping, using the methods developed for this research to investigate matters such as appropriate electric pump suction strengths and rhythms for high-flow periods, and pumping methods in between high-flow periods.

Comment from Pigeon

First-time users of electric breast pumps are often unsure how much time to spend pumping and what pumping methods might be effective for them. The high-flow periods studied in this research are essentially the periods when breast milk flows relatively abundantly. Simply by graphing changes in breast milk volume, or by examining how breast milk is expressed during pumping, it is possible to identify flow patterns to an extent.

Pigeon will continue engaging in research that will help us design pleasant, effective breast pumps and usage methods, and striving to provide insight useful on the front lines of lactation support. In closing, we would like to offer our sincere thanks to the mothers and their families who offered their cooperation with this research.

Comment from Research Collaborator

Dr. Katsumi Mizuno, Representative Director, Japan Milk Bank Association

Breast milk is important for babies both as nutrition and as medicine. When babies are in the hospital, their mothers must express their milk for a time, which is surely a burden. Breast milk pumps are evolving, but if we can understand mothers' flow patterns and use that knowledge to improve pumping should make it easier to pump effectively.



Bibliographical Information

Paper Title: Evaluating milk flow patterns using the high flow rate period during breast pumping

Authors: Yoko Idei^a, Yukifumi Ochiai^a, Kanae Yoshibe^a, Sumiko Kuroishi^a, Mariko Takase^b, Katsumi Mizuno^b

Affiliations:

a: Research & Development Division, Pigeon Corporation, 6-20-4, Kinunodai, Tsukubamirai, Ibaraki 300-2495, Japan

b: Department of Paediatrics, Showa University School of Medicine, 1-5-8, Hatanodai, Shinagawa, Tokyo 142-8555, Japan

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