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# The Role of Information Technologies in Natural Family Planning

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## Abstract

Freedom is needed in family planning and in the decision on how many children the couple will have, not to be influenced by a third person, political situations, or religious conviction. There is a need for information, education, and communication about possibilities in natural family planning, in order to be able to choose the right way, because there are many options even without side effects. Nowadays, we can add to these traditional possibilities of natural family planning also information technologies and electronic devices, which are increasingly available to a large portion of the population. Their reliability, with correct usage, is comparable to the barrier methods and in some cases to hormonal contraceptive methods. Next development of these devices can more increase their reliability. Of course, the active approach of users is needed.

**Keywords:** natural family planning, basal body temperature, cervical mucus, symptothermal method, information technologies, electronic devices, digitized records, application, evaluation, reliability, price

## 1. Introduction

“Natural family planning (NFP) is a term used to describe methods of planning or preventing pregnancy based on observation of naturally occurring signs and symptoms of the fertile and infertile phases of the menstrual cycle. People who use NFP to avoid or delay pregnancy abstain from intercourse on potentially fertile days. Those wanting to achieve pregnancy use NFP to identify the fertile phase and hence maximize the probability of pregnancy. Techniques include the basal body temperature method, the cervical mucus (Billings’) method, the symptothermal method, and the calendar or rhythm method (Ogino-Knaus). It is important to note that NFP is not a method of contraception but rather a technique for determining the fertile period; abstinence during this period is what prevents pregnancy. The methods are thus likely to be of interest to people who, for any reason, do not wish to use mechanical or pharmacological contraceptives” [1]. This is the definition given by the World Health Organization in their publication about NFP. To this definition, some additional notes have to be added: NFP is a manifestation of a responsible attitude towards family and own health, and it helps a woman to know how her body works, which has many benefits not only in family planning. The human body is the complex sensitive system. If the woman knows her own body and

makes regular self-monitoring, she knows when everything is alright and when it is needed to seek expert help. We must not forget either the psychological side of NFP, because the intercourse is not only a physiological act but it influences an individual's psychological state or soul and a mutual relationship, especially in marriage. If both partners identify the use of NFP methods, this strengthens their mutual bond. The use of these methods is becoming a lifestyle. No known side effects and no external factors that affect or damage this sophisticated, naturally designed fertility mechanism are also a benefit. The disadvantages include more demanding, but not impossible, use during nonstandard situations such as breastfeeding, menopause, the medications affecting the menstrual cycle, previous contraception use, and irregular cycles. The solution of some disadvantages and increase in the comfort of using NFP methods bring information technologies in the form of electronic devices and applications.

## 2. Natural family planning methods

Natural family planning methods are those that don't use a chemical or mechanical contraceptive. The basis of their use is the observation of fertility symptoms and determination of fertile and infertile windows and periodical abstinence practice. Each method uses another symptom singly or a combination of symptoms.

## 2.1 Cervical mucus method

This method is known as the Billings Ovulation Method (BOM). The method is based on the observation of the structure and density of cervical mucus. Cervical mucus is a normal, healthy secretion of the cervix formed by the effects of estrogen hormones, usually appears on the genitals a few days before ovulation and at the time of ovulation, and is usually lost after ovulation. The cervical mucus is a very positive sign of fertility as it provides the sperm with nutrition and a suitable environment for movement. Observations are indicated in **Figure 1** to obtain an accurate record of the course of the cycle and the onset of fertile days. The method has four rules: three preovulatory rules and one after ovulation rule—the rule of the peak. Method requirements are an accurate observation, accurate records, and motivation and cooperation of the couple. By following the rules of the method to delayed conception, efficiency is greater than 99% [1]. Another modification of this cervical mucus method is Creighton Model FertilityCare System (CrMS); however, it uses a different picture dictionary (PD) and standardized terminology. CrMS forms the basis for Natural Procreative Technology (NaProTECHNOLOGY) successfully used for achieving pregnancy in infertility problems and miscarriage. In addition, NaProTECHNOLOGY uses a series of sonographic examinations during different parts of the cycle and repeated blood tests to identify the causes of infertility. The main idea of this type of infertility treatment is a minimal intervention in the female cycle and the effort to avoid hormonal stimulation or in vitro fertilization (IVF), in accordance with NFP [2].

[illegible]

**Figure 1.**  
*BOM record table.*

2.2 Basal temperature method

Basal body temperature (BBT) is the temperature of a relaxed human body measured in a moment after waking up after a minimum of 6 h of night sleep, unaffected by food, drink, or physical exertion. After ovulation, the ruptured follicle becomes a yellow corpus luteum and begins to produce the hormone progesterone, which causes a postovulatory increase in BBT. This ascension lasts until the next menstruation. Two-level temperature curves are therefore typical for a healthy fertile woman, as shown in **Figure 2**. There are precise rules to record the temperature curve; temperature is measured to a minimum of two decimal places. The BBT shift typically occurs 1 day after the day of ovulation, so the fertile phase can be determined 5 days before the temperature shift and 2 days after it. This calculation of fertile window includes twofold ovulation and sperm life span. Approximately 1 day before ovulation, a decrease of BBT can be observed typically [3].

2.3 Symptothermal method

The combination of both previous methods, cervical mucus and basal temperature method, is the symptothermal method that was developed by Austrian Dr. Josef Rötzer [4]. As the name itself suggests, the method used to menstrual cycle evaluation basal body temperature and symptoms of fertility, viz., cervical mucus and cervix changes. Another symptom can be used too, e.g., breast tenderness and lower abdominal pain. All observed fertile symptoms are recorded in special record table and evaluated by 11 rules—4 rules for specifying infertility before ovulation and 7 rules for specifying postovulatory infertility. For evaluating one cycle, it is not needed to use every rule. The most appropriate rule applies. The reliability of the method was determined by the Pearl Index, PI 0.4 [5, 6].

2.4 Calendar/rhythm method

The calendar method (sometimes called the Ogino-Knaus method) assumes that a woman will have a regular menstrual cycle. The observed symptom is only the first day of menstruation. From the length of the previous cycles (shortest and longest), it determines the beginning and end of the fertile period of the following cycle according to certain rules (each author states slightly different rules). This method is obsolete and unreliable mainly for irregular cycles. Pearl Index of this method was estimated on  $18.5 + 1.8$  [7].

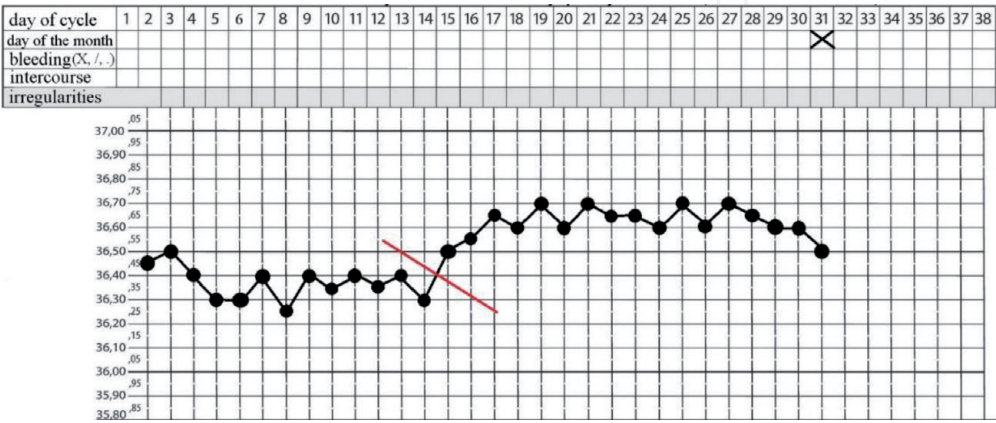


Figure 2.  
BBT records.



The successful use of NFP methods clearly involves a thorough study of the rules of a particular method and their consistent adherence. The success rate decreases significantly with careless use and application of the rules. Human factor failure is the most common cause of an unplanned pregnancy. Therefore, there are many books, courses, and professional teacher pairs, with a certificate for each method, that teach the rules of using NFP methods and usually offer free evaluation support of fertility symptoms. The practical experience of teacher couples using a particular method is very helpful.

### 3. Information technologies and electronic devices

New technologies are also entering NFP. There is a hope that it will make it possible to reduce the length of the required abstinence to the necessary time. These include, in the first place, devices for measuring hormone levels in the urine (e.g., Persona, ClearBlue Easy Fertility Monitor). The preliminary results of their testing in practice are encouraging, but their effectiveness has not yet exceeded the level achieved by the symptothermal method. There are also minicomputers that measure and evaluate the basal body temperature (e.g., Lady-Comp, Daysy, iFertracker, OvuSense) or the temperature and luteinizing hormone content in the urine and cervical mucus (Cyclotest myWay). Their advantage is that the woman does not have to keep records because they are stored in the computer memory but otherwise in principle do not differ from the temperature method. Miniature microscopes for monitoring saliva crystallization (e.g., Lady Q) have proven unreliable and can only be recommended to couples who wish to conceive.

#### 3.1 Cyclotest myWay

For evaluating fertile days by Cyclotest (Figure 3) the basis is the measurement of the basal body temperature. For increasing the safety of this device, the two fertile symptoms can be included—ovulation test or quality of cervical mucus. The cycle computers follow exactly the symptothermal methodology. Even an irregular cycle that is still within the normal range can be reliably evaluated, and it is possible to record the cycle length from 23 to 45 days. When irregularities occur, the temperature should not be measured. Alternatively, continue measuring and manually note the results for that particular day as a disruption. After pregnancy the device can be used as soon as the menstruation is regular again and woman is not nursing at night.

The cycles can be saved as a PDF file via Cyclotest mySoftware, the software comes for free. The computer alerts of possible ovarian insufficiency in the last



**Figure 3.**  
*Cyclotest myWay device and information on screen [8].*

12 cycles are stored and offer additional function skincare, which shows what type of cream is most applicable for which days of the cycle. The settings can be switched between the two modes—child planning and cycle control. One computer can be used for two objectives. In the child planning mode, the following additional functions will be activated:

- Indication of possible luteal phase deficiency
- Pregnancy display
- Birth planner
- Display of the highly fertile days

Apart from that, the menu only differs in coloration. In the “child planning” mode, the dominant color is magenta, and in the “cycle control” mode, it is violet. The price of these devices on the manufacturer’s website is \$ 333, and replacement of measuring probe costs \$ 56. In terms of reliability, manufacturers refers to the reliability of the symptothermal method; they do not specify reliability in percentage or Pearl Index for this device especially [8].

### 3.2 Lady-Comp

Lady-Comp is an intelligent fertility tracker/minicomputer designed to determine fertile and infertile days by morning BBT in the mouth 60 s every morning. The Lady-Comp works on the basis of more than 1 million cycles with statistical data to determine fertile and infertile days, with an accuracy of 99.3% [9], and the day of ovulation. Lady-Comp observes the individual cycle and determines fertility for the next 24 h. It correctly evaluates complicated and irregular cycles and identifies and eliminates unlikely temperature measurements, e.g., fever. The device displays temperature, menstruation, fertility: red, fertile day; green, infertile day; and yellow, learning phase or uncertainty. It offers the possibility to write personal data into the calendar, download and print raw data or upload it into the website, and get a full analysis of cycle, all averages, and a lot of interesting charts and graphs. Lady-Comp can be upgraded to Lady-Comp Baby, which works with over 5 million cycle data and has extra features to plan a baby naturally:

- CLI (low corpus luteum function)
- Forecast hits for 20 cycles
- Documentation of intercourse
- Indication of possible pregnancy after 4–5 days
- Indication of probable pregnancy after 15 days
- Conception date and birth date

Pearly is a simpler and less expensive solution from the same manufacturer. Pearly is a pocket-size fertility tracker working on the same way as Lady-Comp; however, it has fewer functions. Fertility status is evaluated via color lights, as



**Figure 4.**  
(a) *Lady-Comp*, (b) *Lady-Comp baby*, and (c) *Pearly* [10].

well as in *Lady-Comp* (**Figure 4**). The price of these devices ranges from \$ 375 for *Pearly*, \$ 455 for *Lady-Comp* to \$ 545 for *Lady-Comp Baby*. Replacement of measuring probe costs \$ 56 [11].

### 3.3 Daysy

*Daysy* uses the same evaluating algorithm as *Lady-Comp* and has the same reliability of 99.3%. Thermometer with accuracy 0.01°C records the BBT every morning in 60 s. The device itself does not have a display; it has only one activation button and three control lights. Information about fertility are separate—past data are only in the phone app, and actual fertility status is displayed in the device as color light. *Daysy* (**Figure 5**) is CE certified and is a Class I medical device. It has exceptional design and appearance, but for more detailed information, it is necessary to use the mobile application. The manufacturer’s price is \$ 333, and the application is for free [12].



**Figure 5.**  
*Daysy device* [13].

### 3.4 iFertracker

The iFertracker is applicable for both the fertility awareness method (FAM) and the symptothermal method of natural family planning. The device itself is actually a thermometer that captures core temperature opposed to the skin or environmental temperature which is stuck to the armpit by means of double-sided medical tape. iFertracker monitors temperature continuously overnight and collects 20,000 data points with an accuracy of 0.01°C in a single night. The device identifies invalid data, such as getting up in the middle of the night, and works around different sleeping schedules to provide flexibility without disturbing the integrity of data. It is necessary to send data from the thermometer to the mobile app every morning via Bluetooth. The application automatically charts data and provides a daily fertility snapshot. The application also offers notifications for when the pair should try to conceive and allows exporting the BBT chart from directly within the app. The manufacturer recommends keeping track of factors like sexual activity, stress, cervical mucus quality, and sleep to increase the accuracy of ovulation prediction. Change in these habits can cause natural BBT fluctuation and impact the menstrual cycle. The cost of iFertracker and 90 double-sided adhesive patches is \$ 129.00, 60 pieces of replacement disposable medical patches cost \$ 14.99, and the application is for free. The manufacturer does not report reliability or any scientific studies on their product [14].

On the market other thermometers are also available which measure continuous core body temperature (CCBT) on the shoulder or on the wrist like a watch (Termdrop, Ava bracelet) or in the ear (YONO); the hiMAMA monitor works on a similar principle to iFertracker but has a lower purchase price and does not use disposable patches. Although they offer many additional measurements such as heart rate or respiratory rate, their reliability could be much discussed as they do not measure basal body core temperature. Their applicability is often limited to regular cycles (**Figure 6**).

### 3.5 OvuSense

OvuSense is a fully certified medical device, clinically proven in over 50,000 cycles of use. It measures core body temperature using a specially designed vaginal sensor, which is used overnight only, and data are downloaded to the dedicated OvuSense app each morning (**Figure 7**). OvuSense provides live updates



**Figure 6.**  
*iFertracker thermometer [15].*





**Figure 7.**  
*OvulSense vaginal sensor and OvulSense app [17, 18].*

predicting ovulation up to 24 hours in advance using current cycle data, then confirming the date of ovulation. At the start of each cycle, OvulSense provides a full 8-day fertile window. Vaginal sensor needs to be worn for a minimum of 4 hours during rest or sleep. It is essential to remove the sensor before using a bathroom or before going to have sex. OvulSense can be used alongside fertility medications and procedures; it has intelligent filtering systems that remove the temperature spikes outside of that range which is caused by illness or other exceptional situations. It is a class of medical device which is tested and conforms to strict medical standards. The sensor is made of antibacterial medical grade silicone, simply cleaned daily with warm water and soap. If the woman has completely regular ovulation, the live prediction has a positive predictive value of 96% and accurate ovulation confirmation of 99%. OvulSense Starter Pack 2-month subscription cost is \$ 129 and its 1-year subscription cost is \$ 210 [15, 16].

Another device which continuously collects body temperature from inside the body not only at night but during the day too is Priya—an intravaginal ring—as a fertility sensor. The ring measures the core body temperature every 6 min and sends the data wirelessly to a paired smartphone for monitoring and interpretation. The Priya Sensor is not yet available for sale. The limited release program started in late 2019 [17].

### 3.6 Persona

Persona is a diagnostic tool for home use. Persona records hormone levels (it measures the changes in estrogen-3-glucuronide (E3G) and luteinizing hormone (LH) concentrations) that accompany the ovulatory phase of the woman's menstrual cycle and considers the life span of sperm. The test stick captures hormones from morning urine, and the device then reads, records, and uses this information to tell you if you have a fertile day when you can get pregnant (a red light) or an infertile day when you cannot get pregnant (a green light) (**Figure 8**). The device determines 8 test days in each cycle, so the woman needs 8 test sticks (only in the



first cycle the test is performed 16 times). Persona cannot be used by every woman, specifically women:

- Who cannot accept the possibility of pregnancy associated with the use of Persona (reliability confirmed by independent studies is 94%)
- With a cycle of less than 23 days
- With a cycle greater than 35 days
- Who have symptoms of menopause
- Who are breastfeeding
- Who use hormonal therapy, e.g., hormonal contraception, infertility treatment, hormone replacement therapy
- Who use any other treatment that affects their cycle
- Who use antibiotics containing tetracycline
- Who have reduced liver, kidney function, or polycystic ovary syndrome (PCOS) [18]

Persona is manufactured by SPD Swiss Precision Diagnostics GmbH in Switzerland. ClearBlue Easy Fertility monitor works on the same principle, but it is especially used to identify high-fertility days and achieve pregnancy. The price per Persona starts from \$ 45; additional components or programs are not necessary, except for test sticks [19] (Figure 8).

#### 4. Applications for natural family planning

The trends of the modern world are mobile applications; they are useful and easily available, and they can be used at any time with our mobile phone or tablet. The area of natural family planning did not also avoid the arrival of mobile applications. For the purpose of NFP, a lot of applications are available. Some offer reliable and quality results, but some are not recommended for use. However, all applications

need input data, which are obtained by measuring basal body temperature, ovulation test result, or observation—the onset of menstruation, cervical mucus quality, etc. BBT can be measured by an ordinary thermometer with an accuracy of  $0.01^{\circ}\text{C}$  and enter values into the application manually. The second solution is measured values by digital Bluetooth basal thermometer—values are automatically written to the app when connected to a mobile phone, and the app also creates graphs, notifications, and statistical data. The following section will first describe wireless thermometers with custom applications and then stand-alone applications.

#### 4.1 Cyclotest mySense

Cyclotest mySense is used to track the menstrual cycle without much effort, using Bluetooth technology. The basal temperature values measured each morning in 4-hour measuring window are transmitted wirelessly and directly to the smartphone. The thermometer is a Class IIb medical product, CE-certified, and thus approved for natural contraception. In the calculation of fertility, one of the observation data as cervical mucus quality or the result of an ovulation test (LH) can be included. The fertile phase is determined automatically in the application and offers a transparent view of the temperature curve and all additional inputs at all times. The application has two modes, fertility wish mode and contraception mode. The fertility algorithm is based on the symptothermal method and uses the algorithm of cyclotest myWay. The more recorded cycle the cyclotest mySense App has, the more accurate the forecast will be. If the measured temperature could be falsified by external influences, it should be excluded from the calculation directly in the application. Cyclotest mySense is suitable for cycles between 16 and 45 days, and the luteal phase should not be less than 11 days. The cyclotest mySense app is available for free, and the thermometer costs \$ 122 (**Figure 9**).



**Figure 9.**  
*Cyclotest mySense thermometer and app [21].*

## 4.2 Biolight PregAid

Biolight basal thermometer is a device designed for daily temperature measurement and monitoring. The thermometer is able to store measured data and transfer it to PregAid application. The application is able to evaluate the measured data and thus determine fertile and infertile days, menstruation arrival even in an irregular cycle, or the possibility of pregnancy. This is ideal for women who are trying to conceive and have an irregular cycle. The thermometer is easy to use; just turn on the thermometer every morning after waking up, and measure the temperature under tongue for 3 minutes. By turning on the application, data will be saved and synchronized with the cloud. The cost of the device is \$ 39.

The following products can also be included in the same user and price group of thermometers with own application as Biolight: Ovy, Kindara thermometer, TempCue, Femometer, PrecisionTemp, Xiaomi Mijia, and others.

## 4.3 Natural cycles

The natural birth control app uses a statistical algorithm that learns a woman's unique cycle from the BBT temperatures. Once Natural Cycles has analyzed the temperature curve, it can detect ovulation, learn fertile window, and determine the phase of the menstrual cycle. Natural Cycles offers a personalized fertility status every day. The application requires measurement of temperature at least 5 days a week within a 4-hour window. However, the fewer data are added, the more red days the app will give, hence recommending to use protection. Nature Cycles offers to add further data such as ovulation test results, premenstrual syndrome symptoms, and unprotected sex. The more data are put into the app, the more green days are going to get back. For irregularities as thyroid conditions, PCOS, or length of cycle out of range of 21–35 days, the app does not become any less effective. Natural Cycles is a handy tool for keeping track of irregularities in the cycle, but it gets more red days. The reliability declared by the manufacturer is 93% effective with typical use and 98% effective with perfect use (sexual abstinence or using condoms on red days).

Natural Cycles is in Europe the first CE-marked Class II medical device (CE0123) for use as a method of birth control, and in 2018 the US Food and Drug Administration (FDA) cleared Natural Cycles as a medical device for use as a digital method of birth control. The annual subscription (with thermometer) costs \$ 71.76, and the monthly subscription costs \$ 9.93 [22, 23].

## 4.4 OvuView

The application has no official website. Information can only be drawn from the Google Play Store and from the user experience or your own experience with the application.

OvuView offers three modes: (a) simple menstrual calendar, (b) achievement conception that highlights days with a high probability of pregnancy, and (c) preventing pregnancy. The app displays the menstrual wheel from which the day of the cycle, the number of days to menstruation, the start of fertile days, and the expected ovulation can be read, as well as the current phase of the cycle. Standard symptoms such as BBT and mucus symptoms are entered into the application. However, optional and intrinsic symptoms, e.g., mood, weight, PMS, and ovulation test can be recorded. When entering the observation of mucus, more symptoms of the predefined options can be selected at a time. Observation of mucus and the cervix



is automatically rewritten into international symbols. The “Calendar” function displays clearly a calendar with evaluated and predicted values of menstruation and fertile days. The “Graph” function displays the temperature curve along with other recorded symptoms. OvuView evaluates symptoms based on the following rules:

- Rule 21/20 (six cycles recorded, no mucus)
- Döring rule (six recorded cycles, mucus)
- Rule B (temperature, mucus)
- Rule R (temperature, mucus)
- Rule K (temperature, mucus)
- Rule C or O (temperature, mucus)
- Rule of 5 dry days (mucus)
- Rule of four high temperatures (temperature)
- Rule of five high temperatures (temperature),
- Marshall rule (temperature)
- Last dry day rule (mucus, six cycles recorded, min. of 5-day long mucus episode)

Each method indicates what symptoms it needs for the evaluation, the rule's effectiveness, and the symbol, which indicates the phases can evaluate for a particular method. Each method can be switched on or off (e.g., a woman after taking a contraceptive can limit the evaluation only to the 5 T rule). The paid version costs \$ 5 and offers extended functionalities: marking of low-temperature level and ovulation on the day when temperature increased; backup data to Google account (the free version can be backup to an SD card); sending data by e-mail and exporting graphs, password protection, widgets, own symptoms, alerts, e.g., mucus tracking, ovulation reminder, full picture mode, cycle management (pregnancy); removal of advertisements; and method selection/configuration.

To make the results as reliable as possible, OvuView offers the option to enter custom cycle lengths (longest and shortest) or to rely on general cycle lengths [24–28], which of course reduces reliability. If nothing is chosen, the application evaluates only based on the recorded cycles. Data can be imported from previously used another application.

According to the description on Google Play, the application evaluates using the symptothermal method as well as other methods. The description claims to be implementing 14 evaluating methods. In our opinion, this is a vague terminology, since the mentioned methods are actually the rules of the symptothermal method, of course, in addition to two trivial calendar calculation methods. However, it is not clear what precise didactic transposition of symptothermal method the app is. Compared to the paper form of evaluation, there are several differences in the electronic version. The reliability of the application depends on the accuracy and thoroughness of the entered data [29].

4.5 SymptoPlus

The SymptoPlus is not a medical device but an electronic learning tool to take charge of fertility. Application evaluation algorithm is based on a combination of three NFP methods—NFP-sensiplan (symptothermal method), Billings Ovulation Method (cervical mucus method), and Rötzer/Northwest Family Servis (NWFS, the American Rötzer version, symptothermal method). SymptoPlus is not an exactly didactic transposition of one particular method.

This stand-alone app doesn't require an Internet connection for its basic features. An Internet connection is only needed for syncing to secure access, even if losing the phone. To verify an account, go to [sympto.org](http://sympto.org). After verifying an e-mail address, the 15 days free of charge of personal follow-up with a symptothermal expert without any commitment is available. After a 15-day trial, the SymptoPlus must be purchased in the Google Play Store for a nominal fee. A free version is also available, but SymptoPlus is faster and simpler to view than SymptoFree. The app is available in several languages and offers an internal message box which allows the client to communicate directly with her adviser.

For guaranteed contraceptive effectiveness, it is needed to use the app properly and use Sympto for 6 months with a counsellor (Daisy PLUS) or enter six past cycles verified by Sympto. To interpret a cycle correctly, Sympto has defined a minimum of 10 crucial information in order: the beginning of the cycle which is triggered by the 3 red drop icons, a minimum of 4 low temperatures within 6 days to specify the cover line, the mucus peak day indication (2 signs), and the 3 correct high temperatures [24, 25] (Figure 10).

The market offers a number of similar applications, e.g., myNFP, LilyPro, CycleProGo, Lady Cycle, etc. Some are more functional, others are less, and some can be used only as a record table without evaluating or with not reliable evaluating. The applications for NFP have a huge potential, but thorough research is needed. Medical doctor, developers, expert of didactic transpositions, learning specialists, teacher pairs for a specific method, and women using the app should work together

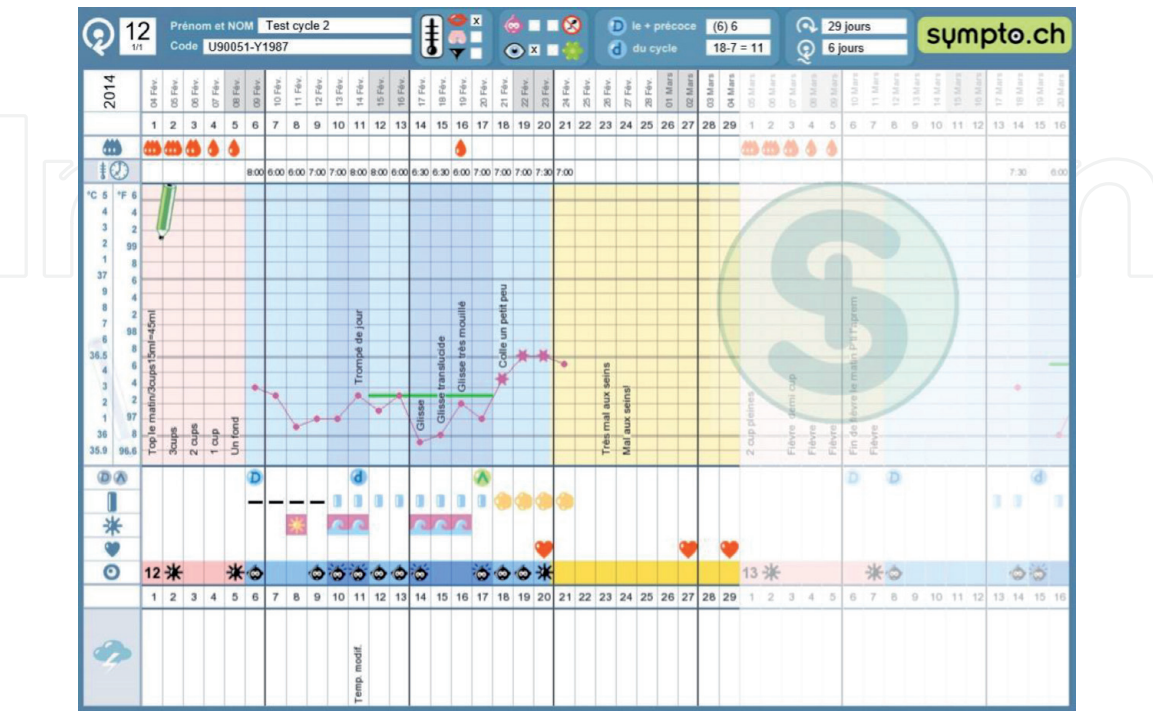


Figure 10.  
SymptoPlus application record table [26].

to create the app. From this cooperation arise a quality application, which however must be subjected to in-depth testing on a sufficient number of cycles. Entered data must be accurate and obtained in accordance with the knowledge of symptothermal cycle observation.

## 5. SymRec

Applications and IT tools for NFP are an interesting research area, and based on how they were mentioned above, they have great potential. On the basis of these facts, we also decided to create a web site for evaluating the menstrual cycle according to symptothermal method (STM). The IT tool SymRec is an accurate didactic transposition of rules of STM used in Slovakia with some restriction listed below. We followed the rules outlined in the book *Handbook of Symptothermal Methods* published by Couple to Couple League in Slovakia [27].

The goal of the work was to create an IT tool—electronic record table (ERT)—similar to the printed record table used for symptothermal observation. ERT serves for daily data entry, storage data, and evaluating menstrual cycle according STM rules. Access to data is possible for every device connected to the Internet. ERT is available on the website: <http://symrec.judak.eu/>.

### 5.1 Didactic transposition of STM rules

Didactic transposition is the isolation of certain terms and properties from the environment in which they originated and their adaptation to the context in the new environment. In fact, it is the transfer of the regularities of the teaching or learning process (rules of some NFP method) from the analogue environment (manual paper method) to the digital environment (application, IT tool). It is an interpretation of NFP rules in the digital world using programming code. The original manual STM has been transformed into an electronic version by transcription to PHP code. ERT evaluates the record according to these rules:

#### 1. Evaluation of the first phase of preovulatory infertility:

- Last dry day rule
- Doctors experience rule
- Rule 20/21 days
- Döring rule

#### 2. Evaluation of the third phase of postovulatory infertility:

- Rules R, B, and K—double-symptom rules (cervix mucus, basal body temperature)
- 4 T, 5 T, and Marshall rule—one-symptom rules (BBT)
- 5DMD—one-symptom rule (cervix mucus)

ERT expects that only valid temperatures are entered. Evaluation does not offer a possibility as “planning down” and averaging the temperatures, which are possible in manual evaluation in case of nonstandard temperature curves. To verify each rule, software checks at least six previous cycles and a maximum of thirteen cycles. According to the number of cycles in the recorded history of ERT, the evaluation is performed for the 8th recorded cycle, and a different evaluation rule is used for the

13th recorded cycle. It follows that for validation of all possibilities of evaluation, 27 rules have to be created. For evaluation of the first phase preovulatory infertility, it is necessary to have recorded at least six previous cycles—the STM rules require user experience with at least six previous cycles to allow for a reliable assessment of the current cycle. If there are not enough records in the recorded history of ERT, the evaluation for the first phase will not run, and the report with the alert to this situation is displayed.

The evaluation is possible until fulfilment at least one evaluation condition, e.g., for evaluation of the first phase, just enter the occurrence of cervical mucus, and the last dry day rule is activated. The accuracy of the evaluation depends on the amount of data collected, not only in the current cycle but also in previous cycles. The overall reliability of the ERT cannot be determined as the testing did not run with a statistically significant data set. As it is a precise didactic transposition of the rules and if accurate and clean data are entered, we assume reliability comparable to that of the symptothermal method. However, further testing with sufficient data is necessary to confirm this assumption.

## 6. Discussion

In this part of the paper, we discuss the problems associated with the use of NFP methods: the sense of using methods, determining reliability, and measuring basal body temperature.

The human body is an “unstable system,” and when we talk about fertility, women respond very sensitively to various stimuli. Every organism is unique; no two cycles of the tens of thousands of observed cycles are identical. Due to the current rapid lifestyle, sedentary work, artificial lighting, or lack of physical exertion, menstrual cycle irregularities are more common than in the past, not to mention other reproductive health problems, e.g., polycystic ovary syndrome, myomas, pre-menstruation syndrome, etc. No device can predict in advance that there will be any irregularities in the current cycle that will shorten or extend the cycle. Nothing in the menstruation cycle can be predicted at a hundred percent. At the same time, there are periods in women’s lives—e.g., before the first menstruation, after delivery, or in climacterium—when hormonal conditions can properly disrupt the cycle. From the experience of lecturers teaching NFP methods, it can be argued that in these cases the devices or applications cannot reliably evaluate the course of the cycle and pairs have to rely on prolonged sexual abstinence or use of barrier contraception due to inaccurate device estimation.

The accuracy of the outputs of the technical aids depends not only on the quality of the components they are made of but also on the software that makes the evaluation itself. Even the finest instruments and the most sophisticated software for determining fertile and infertile days have their limits, and it is not good to rely blindly on them. Even those who welcome technical innovations are advised to supplement the information from the device with their personal assessment of fertility symptoms (at least one symptom). Users will avoid unnecessary disappointment from possible failure, especially during nonstandard situations. Learning to understand some NFP methods is not as difficult as it may seem. Indeed, one of the prerequisites of NFP methods is knowing your own body, not mechanically thoughtless entering data into device/application.

The determination of the reliability of NFP methods can have a discussion for a long time. It is difficult to determine the evaluation criteria that will deliver the most relevant results. The most commonly used Pearl Index (PI) is under criticism because of the fact that different PI values are found in the literature for one



method [30]. Key parameters that are subject to comparability should be used to calculate the reliability of the method:

- a. Frequency of sexual intercourse—the difference is in recording 1 unwanted pregnancy for 5 years at 1 intercourse as 1 pregnancy for 5 years at 300 (or more) intercourses.
- b. Sample size—no sample size is specified for PI determination. The larger the sample, the more accurate the result.
- c. Age of women—fertility is different at every woman's age. The chance to conceive naturally in a 20-year-old woman is significantly higher than in a 38-year-old woman. Also, men's fertility rates decline by age [31].
- d. The period of application of the method—unexpected pregnancies usually come in the first months of using a particular method. The longer the couples use the method, the more they are trained, and the number of unexpected pregnancies decreases.
- e. User error—if an unexpected pregnancy occurs as a result of a conscious mistake by the user (e.g., situations where the partners have sexual intercourse during a period they know is fertile or use a barrier contraception during the fertile period), this situation should be recorded and should not be taken into account in establishing rate reliability.
- f. BMI—overweight and obese women have a significant relationship between body mass index, spotting, menstrual cycle length, menstrual bleeding, and passing clots [30].
- g. Diseases/medicaments/residual contraceptives.

A certain solution is to determine the reliability of typical use and perfect use, but the criteria mentioned above must be considered in this case too. Either, the individual approach of women to the use of a particular method should not be forgotten. Every woman is different; there is no universal solution for all women; however, solutions can be found for groups with similar method requirements. It is worth reminding that none of the NFP methods is 100% reliable (perfect use). In preventing unplanned pregnancy, only three methods of conceiving regulation have 100% reliability:

- 100% sexual abstinence (no genital contact).
- Removal of both testes.
- Removal of both ovaries.

All other methods of conceiving control have some degrees of failure. Failures of NFP, e.g., symptothermal method, in the most cases are caused by inconsistent observation and recording of fertility symptoms, the use of barrier methods in the fertile phase of the cycle, and the conscious reliance on chance [27].

The basal temperature measurement time frame is a topic that we supposedly should be giving due consideration too. Basal body temperature assessment is well described and applied. However, the time range of basal

temperature measuring remains a problem. This range is differently set for devices (Cyclotest myWay  $\pm 2$  hours, Lady-Comp  $\pm 3$  hours, Daysy no timeframe) and applications (Cyclotest mySense  $\pm 2$  hours, Natural Cycles  $\pm 2$  hours). Of course, this problem is eliminated in continuous temperature monitoring (iFertracker, OvuSense), although a system for determining a particular temperature, e.g., from 100 measured values, can be discussed. The question remains how much are the objective results of the measured basal temperature in an interval of 6 hours. Under normal circumstances, BBT reaches its lowest in the early morning hours and then rises by about  $0.05^{\circ}\text{C}$  every half hour. Thus, the BBT measured outside the tolerated range of 30 minutes may not be accurate. Dr. Rötzer states in his work that basal temperatures measured outside the tolerance range ( $\pm 30$  minutes) after 7:30 am tend to have a greater effect on the temperature curve than deviations measured in the early morning hours [32]. So wide time frame is naturally comfortable for users, but the most accurate results can be achieved by measuring at the same time every day. The condition of daily measurement also plays an important role in the degree of reliability.

The task of experts is to find a solution in the field of NFP that confirms the words by Will Sacks, which aptly described the present state of fertility control with words: “I think the last century was about solving health problems with pills and synthetics, and this century is about solving health problems with software and data. The pill was an enormous boon for the previous generation. It set women free in so many ways, but it also came with side effects that a lot of women nowadays are finding unacceptable. Fertility Awareness is effective, low-cost, and side-effect-free so I think women and couples are finding it an attractive option. I also happen to think that Fertility Awareness is a consciousness-raising tool—it helps women tune into and feel powerful and in control of their health, and it helps male partners better understand the feminine. As consciousness and mindfulness increase globally, using synthetic hormones to control fertility is becoming less acceptable, and Fertility Awareness, which is the practice of living in harmony with your cycle, is becoming more obvious” [33].

## 7. Conclusion

The paper provides an overview of technical devices and applications used for evaluating the menstrual cycle and determining fertile and infertile days. In the first part, the principle of using and evaluating the four most commonly used NFP methods is briefly described. The next part is devoted to currently available information technologies and electronic devices designed to evaluate the menstrual cycle in terms of NFP methods. The conditions of use, reliability, price, and limitations for the six devices and five applications are described. Finally, our proposed system of fertility assessment based on STM in the form of a website is described. The discussion critically evaluates the possibilities of use and weaknesses of the described technical devices and information means.

It follows that the success of the use of electronic devices or applications needs to be strengthened by some degree of knowledge and experience in assessing self-fertility. Although manufacturers report high reliability of their products, there is no need to blindly rely on the device and application results and evaluation should be complemented with own judgment. For a successful creation of quality and reliable application or device, cooperation from experts in various fields of science is needed, and research and experiences of practical users is necessary.

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