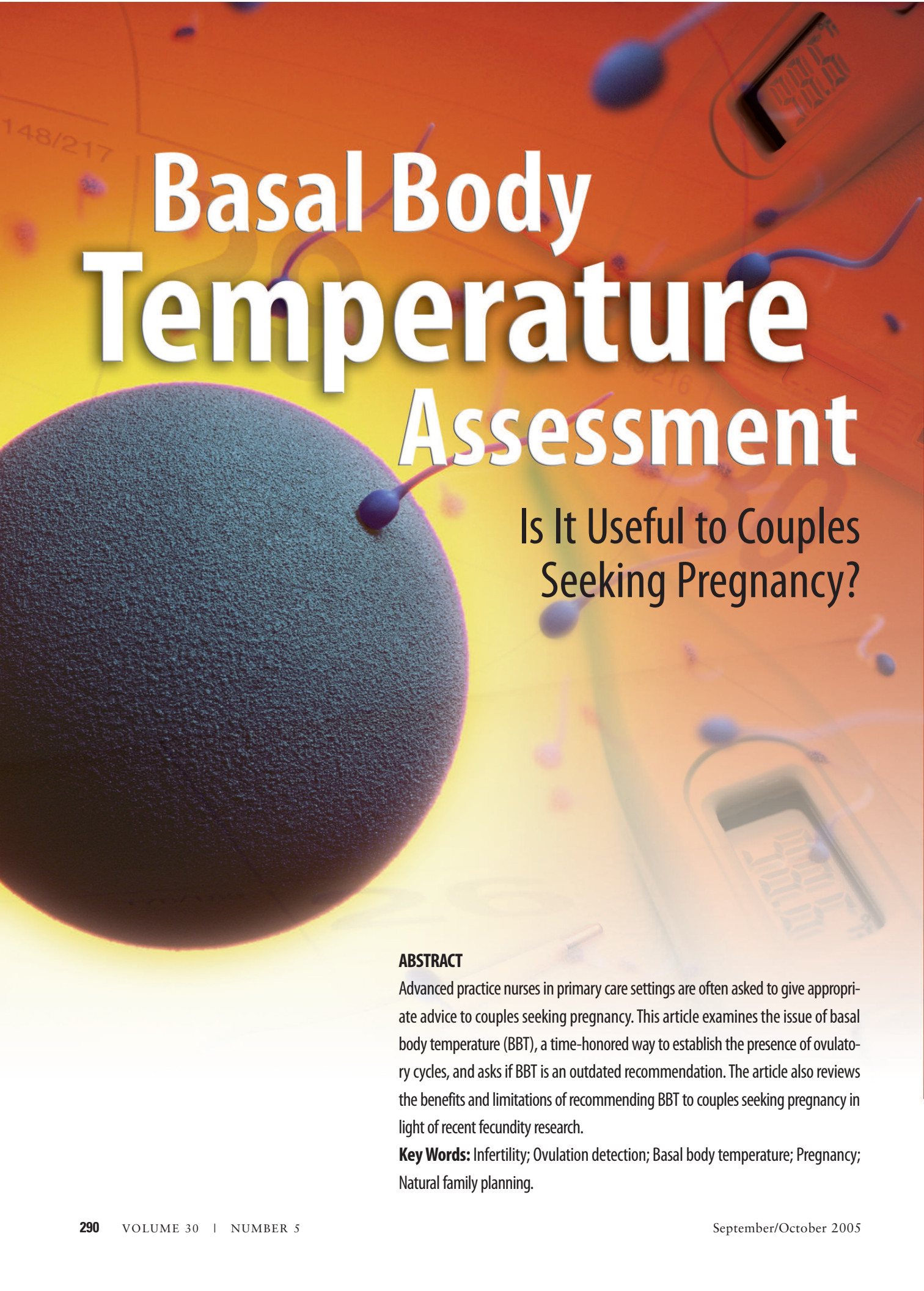




Basal Body Temperature Assessment

Is It Useful to Couples Seeking Pregnancy?

ABSTRACT

Advanced practice nurses in primary care settings are often asked to give appropriate advice to couples seeking pregnancy. This article examines the issue of basal body temperature (BBT), a time-honored way to establish the presence of ovulatory cycles, and asks if BBT is an outdated recommendation. The article also reviews the benefits and limitations of recommending BBT to couples seeking pregnancy in light of recent fecundity research.

Key Words: Infertility; Ovulation detection; Basal body temperature; Pregnancy; Natural family planning.

Advanced practice nurses (APNs) have an important role in the initial evaluation of both fertility and infertility and are frequently asked to discuss fertility issues with couples who desire a pregnancy. It is essential, therefore, that APNs understand the most current data regarding ovulation, optimal timing of intercourse in relation to ovulation, and time frames in which couples can expect to conceive. For many decades, basal body temperature (BBT) charting has been one of the methods discussed with couples to help them establish the presence of ovulatory cycles and to help them time intercourse. In view of the fact that now there are more accurate and prospective biologic markers available to predict and detect ovulation, it is relevant to ask whether BBT charting should be recommended. The purpose of this article, then, is to review the research basis for BBT to help APNs give the most current advice to couples seeking pregnancy.

The Ovarian Cycle

The ovarian cycle is a cyclical continuum of events that includes changes in ovarian hormonal secretions, which in turn actively influence the hypothalamic pituitary control (Figure 1) (Khan-Sabir & Carr, 2003). Follicle-stimulating hormone (FSH) is the key stimulant to the growing follicle, which in turn secretes estrogen in the form of estradiol. Estrogen, as the dominant hormone in the preovulatory phase, stimulates the cervix to soften, dilate, and produce profuse amounts of (estrogenic) mucus capable of supporting viable sperm for 3 to 5 days. Leuteinizing hormone (LH) allows the final maturation and growth of the dominant follicle, the initiation of ovulation, and the development of the corpus luteum. In the postovulatory luteal phase, LH supports luteal function, that is, the secretion of progesterone by the corpus luteum. Both selected follicles and luteal cells have a fixed lifespan that determines the length of the menstrual cycle. At the level of the endometrium, estradiol and progesterone are the main regulators of the cyclical transformations and prevent cell death, responsible in part for cyclical shedding during menstruation (Speroff & Fritz, 2004). Progesterone stimulates thickening of the cervical mucus and has a role in the warming of body temperature. In the presence of postovulatory progestogenic mucus, sperm die within 2 to 3 hours (Clubb & Knight, 1999; Hilgers, 2004).

How Can Women Find out When They Ovulate?

There are two methods usually used to teach women to understand when they are ovulating: prospective methods

and retrospective methods. These methods are essentially different. Prospective methods rely on preovulation events and reflect the presence or absence of a developing follicle, estrogen dominance, and/or an LH surge. Examples of prospective methods include the presence of cervical mucus (which at its peak looks like egg white), use of urinary LH detection kits, or the Clearblue Fertility Monitor (a handheld electronic device designed to detect urinary metabolites of the preovulatory estrogen rise and the LH surge) (Bigelow et al., 2004). Retrospective methods rely on postovulation events, namely the presence of a corpus luteum with progesterone dominance. The most common retrospective method of indicating ovulation is measurement of BBT. Assessment of when cervical mucus has ended can also be considered a retrospective method of ovulation (Baron & Daly, 2001).

The most accurate method of estimating the day of ovulation is performed by a healthcare professional: serial ultrasound of the developing follicles and detection of the day of ovulation (US-DO) by visualizing the day of follicular collapse and fluid in the cul-de-sac (Ecochard, Boehringer, Rabilloud, & Marret, 2001).

BBT and the Fertility Window

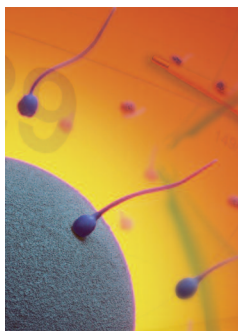
BBT is the waking temperature of the body before any activity. It reflects the ovarian cycle in two ways. Within 1 to 2 days before the LH surge there is a nadir (low point) in BBT (Martinez et al., 1992). For over 30 years, this nadir in temperature has been identified as possibly useful in predicting ovulation (Lundy et al., 1974). Following ovulation, women generally experience an increase in the BBT of 0.5°F to 1.0°F; this is called a biphasic pattern (Figure 2). This increase is thought to be due to the thermogenic effect of pregnanediol, a metabolite of progesterone, which increases after ovulation and is secreted by the corpus luteum. The biphasic shift can therefore be used as a confirmatory marker of ovulation. Advising women to use BBT basically alerts them to this small increase in body temperature, indicating that ovulation has occurred. However, it has long been recognized that some women may ovulate without a clear rise in temperature; this is called a monophasic pattern (Figure 3) (Morris, Underwood, & Easterling, 1976). This makes the use of BBT as a method of timing intercourse to achieve pregnancy less than useful.

Studies primarily from researchers at the National Institutes of Environmental Health Sciences have provided evidence that there is essentially a 6-day interval of fertility ending with the day of ovulation (Wilcox, Weinberg, & Baird, 1995). They also have shown that the most fertile

day is the day before ovulation and that the timing of the 6-day interval varies across menstrual cycles (Dunson, Baird, & Wilcox, 1999; Wilcox, Dunson, & Baird, 2001). The probability of pregnancy decreases by about 50% during this 6-day window when cervical mucus is not observed (Dunson, Sinai, & Colombo, 2001). Pregnancy probabilities are highest when vulvar observations indicate the presence of the most fertile type of estrogenic cervical mucus (Bigelow et al., 2004; Stanford, Smith, & Dunson, 2003).

Methods of Measuring BBT

Virtually the same procedure for measuring BBT has been followed for decades, except the route could be oral, rectal, or vaginal. With the advent of digital thermometers and the concern over mercury, women using symptothermal methods of natural family planning are now instructed to use an oral digital thermometer immediately after waking in the morning. Rectal or vaginal temperatures are recommended only when there is a lot of variability in the temperature pattern and/or it is difficult to distinguish the temperature shift. Factors that may affect the temperature readings include consumption of alcohol, having had a late night or disturbed night, oversleeping, holidays, travel, time zones, shift work, stress, illness, gynecologic disorders, and medications (Clubb & Knight, 1999).



Studies have provided evidence that there is essentially a 6-day interval of fertility ending with the day of ovulation, and that the most fertile day is the day before ovulation. Using a retrospective method to confirm ovulation, therefore, does not help the couple to time intercourse to achieve pregnancy.

In an attempt to increase the accuracy and utility of BBT, a number of computerized devices based on BBT have been developed. These rely on the time of the BBT shift in the previous cycle to estimate ovulation in the subsequent cycle. An example model currently available is the German-made Babycomp/Ladycomp, a fertility monitor that electronically records BBT and a calendar-based formula to identify the infertile and fertile days of the menstrual cycle (Ladycomp Fertility Monitor, 2005). The Babycomp version of the monitor is targeted for women who are trying to conceive a pregnancy. The monitor does not give readout of temperature but rather a green (infertility), red (fertility), or yellow (unsure) light. The U.S. Food and Drug Administration has approved these devices for use to achieve pregnancy. Although the Ladycomp version has been studied as a contraceptive device, data on the clinical

reliability of electronic fertility monitors to achieve pregnancy are extremely limited (Freundl, Frank-Herrmann, Godehardt, Klemm, & Bachhofer, 1998; Stanford, White, & Hatasaka, 2002).

Can the BBT Nadir Be Used as a Predictor of Ovulation?

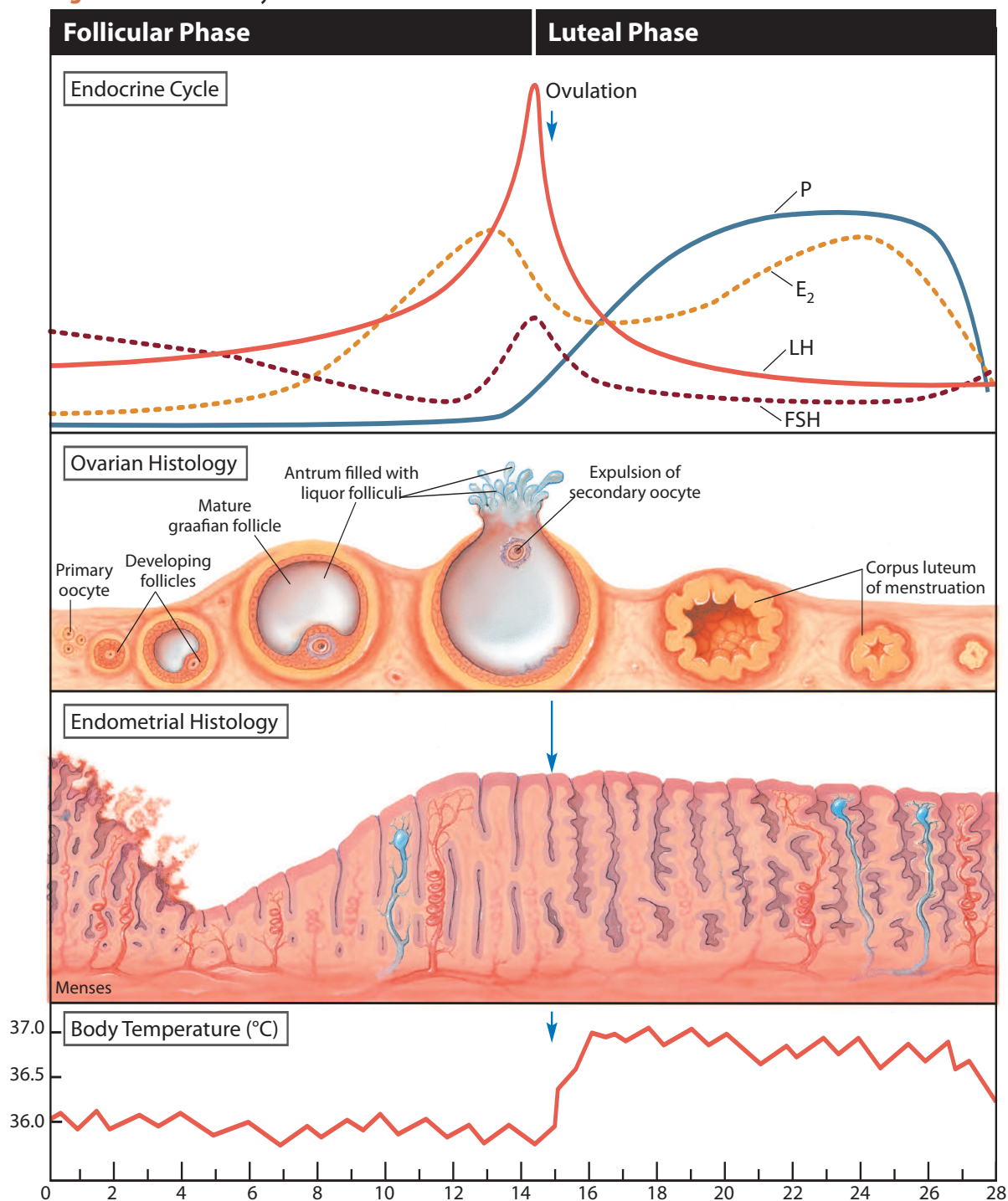
Since the BBT nadir is thought to precede ovulation, it has been proposed that the low temperature could be a useful predictor of ovulation and when couples who want to achieve pregnancy should have intercourse. However, research does not support the predictability of the BBT nadir. Morris, Underwood, and Easterling (1976) examined the temporal relationship between serum LH and the BBT nadir in 27 normal cycling women. In 22 of the cycles (81%), the LH surge occurred on the same day or within 1 day of the BBT nadir. They concluded that the BBT nadir was not satisfactory to predict the LH surge. Lenton, Weston, and Cooke (1977) in a study of normal and infertile women noted that the day of ovulation was predicted in only 34% of the charts ($n = 60$). Cycle charts were compared to serum hormonal profiles. In a retrospective review the thermal nadir coincided with ovulation in 43% of the cycles in fertile women and only 25% of the cycles in infertile women. They concluded that predicting ovulation from

BBT nadir readings was clearly unjustified. Hilgers and Bailey (1980) in a study of 74 cycles noted a 6-day variability of the nadir of BBT in estimating the time of ovulation in comparison with the serum estrogen:progesterone ratio determination of ovulation. Templeton, Penney, and Lees (1982) compared the BBT nadir and cervical mucus scoring to the LH peak by radioimmunoassay. The timing of the maximal cervical mucus score was similar to that of the LH peak in all but 7% of assessable cycles ($n = 198$ cycles). In contrast, the timing of the nadir of the BBT differed widely from that of the LH peak in 45%

of cycles with interpretable charts.

McCarthy and Rockette (1986) examined over 17,000 natural family planning charts for temperature and cervical mucus patterns. Although no hormonal comparisons were made, criteria for the presumed day of ovulation were defined based on thermal shifting and the peak of cervical mucus. Their conclusion was: "The prediction of ovulation solely with the basal body temperature graph is not useful because of the day-to-day variability of temperature readings, cycle variability and the effects of illness, medication, diet and changes in sleeping patterns" (p. 747). Likewise, Quagliarello and Arny (1985) in a retrospective 60-cycle chart review found BBT to be an inaccurate predictor of the day of the LH surge but did conclude that the periovulatory time could be identified. Luciano et al. (1990) and Guermendi et al. (2001) conducted research on the reliabil-

Figure 1. The ovarian cycle.



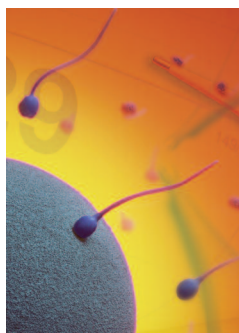
ity of clinical methods for predicting or confirming ovulation (BBT, LH, and progesterone assay) in infertile women while Guida et al. (1999) and Ecochard Boehringer, Rabiloud, and Marret (2001) studied normally cycling women. All four of these studies compared clinical and hormonal

indices of ovulation with ultrasonographic evidence of ovulation. The results from all four studies also demonstrated that BBT was not reliable as a predictor of ovulation. Furthermore, Ecochard et al. concluded that for practicality and accuracy, the cervical mucus peak symptom and uri-

nary testing of LH rise may be better indices of ovulation than the LH peak. Guermandi et al., similar to the Hilgers study of 1980, found that the BBT nadir had “a wide variability, ranging from 8 days before to 4 days after ovulation” (p. 94), concluding that the nadir of BBT was a poor predictor of ovulation.

Can the BBT Shift Confirm Ovulation?

Some providers think that the shift in BBT during a menstrual cycle is more reliable as a confirmatory marker of ovulation than the BBT nadir as a predictor of ovulation. However, research studies over the past 30 years have demonstrated problems with that notion. Bauman (1981) concluded that the BBT was an “unreliable method of ovulation detection” (p. 732). In Bauman’s study six experienced physicians evaluated BBT charts from menstrual cycles of 98 women. The time of ovulation was estimated from the charts by a consensus of at least five of the evaluators. Only 22.1% of the 77 cycles that were determined by endocrine profiles to be ovulatory and to have adequate luteal phases demonstrated an interpretable shift. Bauman noted the failure of BBT to identify short luteal phases and indicated that BBT patterns are inaccurate in the majority of women and also noted the resistance of healthcare professionals to abandoning the BBT method of confirming ovulation.



Currently, the most accurate method of estimating the day of ovulation, serial ultrasound, requires the assistance of a healthcare professional.

Research on BBT Compared to Other Methods of Ovulation Detection

Ultrasound

Wetzels, Hoogland, and de Haam (1982) compared BBT with ultrasound findings for ovulation detection in 47 cycles with hormonal evidence of ovulation. Volunteers and patients were carefully instructed to measure rectal temperature before getting up each morning. The ovulation detection rate by ultrasound proved to be considerably higher than by BBT criteria. The BBT nadir, the coverline-determined temperature shift, and eye-balling of the temperature shift as estimators for the day of ovulation showed a very wide frequency distribution. They concluded that ovulation detection by BBT was not reliable.

Urinary LH Detection

Martinez et al. (1992) opined that BBT is relatively accurate and useful in retrospectively identifying ovulation after conducting a retrospective assessment of 210 menstrual cycles. They found that 82% of the cycles had biphasic temperature shifts and 75% of the cases indicated a BBT nadir, 90% of which were within 2 days of ovulation of the estimated day of ovulation based on urinary evidence of the LH surge. Another 8% of the charts were noninterpretable. In an early comparison to urinary LH detection kits, Yong et al. (1989) concluded that BBT was a significantly poorer indicator of detecting ovulation. They found that only 18 of 25 cycles (72%) had a BBT shift, whereas LH kits detected 27 of 29 cycles (93%).

Multiple Method Comparisons

In a more sophisticated approach, Guida et al. (1999) compared BBT, cervical mucus observation, salivary ferning, salivary α -glucuronidase activity, and urinary LH in women who were followed by daily ultrasound until collapse of the follicle. BBT was among the least accurate of these measures. “BBT-determined ovulation days were scattered from day -1 to day $+3$ of actual ovulation,” indicating only the periovulatory period (Guida et al., 1999, p. 903).

Ecohard et al. (2001) collected a data set of menstrual cycles that included US-DO and with self-detected cervical mucous peak day and basal body temperature readings.

Daily measurements of urinary LH, FSH, estrone-3-glucuronide, and pregnanediol-3-glucuronide and transvaginal ultrasound examination of the ovaries were recorded for 326 cycles of data from 107 normally cycling women (aged 19 to 45). A biphasic shift occurred in 69 (68.3%) of 90 cycles and a monophasic or doubtful pattern in 21 (20.7%) cycles.

European and American researchers collaborated on a large study to determine days of highest fecundability (Dunson et al., 2001). The estimated day of ovulation for the study was based on the BBT shift; that is, the first day of the BBT rise was

considered the day of ovulation. Some would consider this an imprecise way to interpret a BBT chart, as there are others who consider the nadir of BBT to predict the LH surge (Martinez et al., 1992). Out of 7,288 cycles, approximately 20% of the BBT and mucous secretion data charts did not have enough information to provide an interpretable BBT shift (Dunson et al., 2001).

Studies Suggesting BBT Is Useful

Some recent studies have found that BBT can be accurate and useful. In a study to determine the reliability of the most widely used methods for predicting or confirming ovulation in infertile women, Guermandi et al. (2001) found that BBT agreed with ultrasonography in 74% of the cases. Smith et al. (1998), in a comparison of low-tech-

nology methods (BBT charts) with high-technology methods (urinary LH surge and vaginal ultrasound) when monitoring clomiphene citrate ovulation induction, found BBT to be the preferred method. BBT is inexpensive, and in this study of 45 women, more fecund cycles were identified. Researchers did not separately examine the use of a urinary LH kit compared with vaginal ultrasound in their cost analysis.

Should BBT Be Recommended?

Over the last 30 years the vast majority of researchers have concluded that BBT is not a reliable marker of ovulation. Interrater reliability in interpretation of temperature curves ranges from 25% to 50% depending on the day of the cycle being studied (Guerman-di et al., 2001). There are many reasons for this, including the technique of the patient, confounding factors such as alcohol intake or timing of temperature taking, or the woman's physiologic hormonal milieu.

Fertility investigation usually begins with considering whether the woman is ovulating (Corson, 2001; Speroff & Fritz, 2004; Youngkin, 2001). It is estimated that approximately 20% of women with infertility fall into the ovulatory dysfunction category (American College of Obstetricians and Gynecologists, 2002).

Despite their use for decades, BBT charts do not aid in diagnostic decision making about ovulation.

But do health professionals still recommend BBT? Fehring, Hanson, and Stanford (2001) examined attitudes of 450 certified nurse midwives (CNMs) toward natural family planning methods. For couples that were having difficulty achieving pregnancy most CNMs would recommend either observation of cervical mucus (81%), BBT (79%), or midcycle intercourse (77%). In a study of Missouri physicians who cared for patients with reproductive needs, Stanford, Thurman, and Lemaire (1999) concluded that physicians were more likely to recommend the initial steps of BBT or calendar calculations than monitoring of cervical mucous discharge. These studies tell us that numerous

physicians and nurses continue to support BBT as a low-tech method of confirming ovulatory cycles, probably because it is inexpensive, easy to learn, and well accepted by women (Corson, 2001; Speroff & Fritz, 2004; Star, Lommel, & Shannon, 1995; Youngkin, 2001).

In answer to the question of whether BBT should be recommended, research would tell us that the BBT chart is of limited usefulness. BBT does not serve well as an aid for timing intercourse. The biphasic BBT chart may provide other information that may be of use to the APN: duration of the menses (if charted), length of the cycle, length of the follicular and luteal phases, the pattern of the timing of ovulation, and intercourse patterns. However, because of the limitations of BBT identified over many years of research,

Figure 2. The biphasic pattern of basal body temperature.

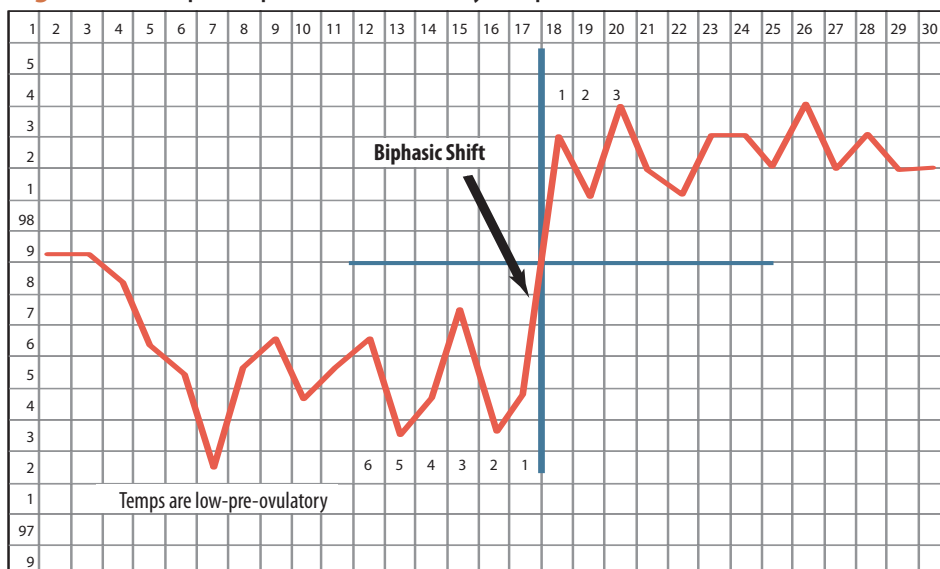
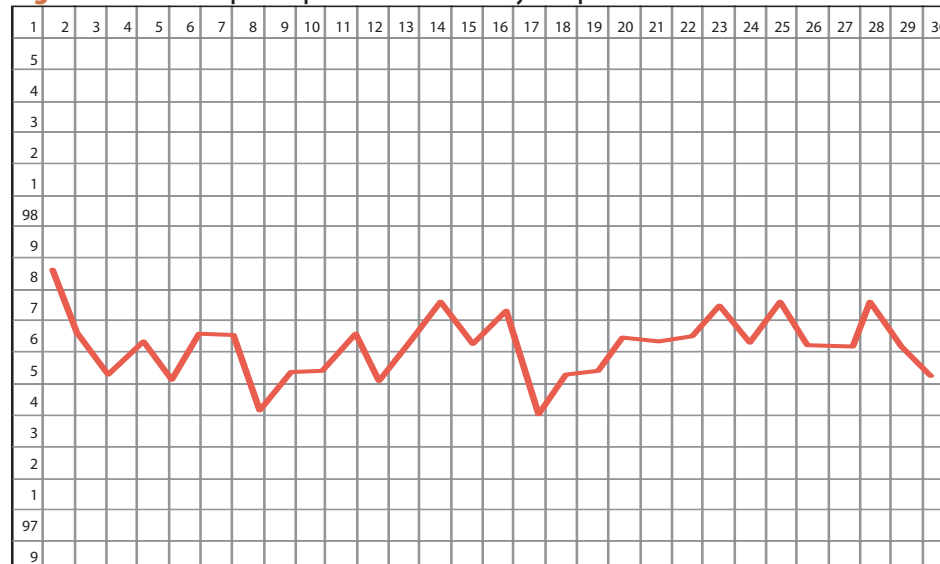


Figure 3. The monophasic pattern of basal body temperature.



advising couples to use BBT to achieve pregnancy is not the most appropriate method for them to identify ovulation.

Conclusion

The lack of expense, objectivity, simplicity, and high acceptability of BBT seem to be common reasons why health-care professionals still recommend BBT charting. This recommendation, however, is outdated. As a predictor of ovulation, BBT charting cannot be supported. In light of the recent fecundity research regarding the fertile window, we now know that it is important to identify the days *preceding ovulation* to time intercourse to achieve pregnancy. As a method to confirm ovulatory cycles, BBT charting has limited utility because of problems with interpretability. Rather than suggest BBT, APNs might consider recommending a low-technology method such as cervical mucus charting (Bigelow et al., 2004). For more accuracy but also more expense, use of the Clearblue Fertility Monitor can be recommended to identify the fertile window to appropriately time intercourse. ❖

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