

1. Natural Family Planning (NFP)

The work of Drs John and Evelyn Billings, spanning several decades from around 1953, constituted a very significant advance in NFP. The trials of cervical mucus observations during the 1950's involving volunteer women established the correlation between observable cervical mucus symptoms and the time of ovulation and led to the empirical rules for avoiding or achieving a pregnancy known as the Billings Method [1],[2],[3],[4],[5],[6],[7]. The work of Professor Brown at the University of Melbourne and that of Professor Odeblad at the University of Umeå independently validated these findings.

Brown's work over several decades enabled him to develop a comprehensive theory about the types of ovarian activity in women which he called the Continuum [8]. In this work he noted the correlation between oestrogen and progesterone rises and the behaviour of the mucus symptom and he published a monograph [9] on the relationship with the Billings Method. This is summarised in Figure 1 taken from that work where he used a reference cycle of 28 days to explain the relationship.

The single pronounced rise of oestrogen shown in Figure 1 is a standard reference model, but Brown reported many different hormonal developments that occur in women at different times of their reproductive life and in different women. One example given by Brown [9] (see www.woomb.org/omrrca/science/variants.html) is shown in Figure 2. Brown states that the rise in FSH (follicle stimulating hormone) production above the threshold (see Figure 1) may arrest before the intermediate level is exceeded and the follicles remain in a state of chronic stimulation. The amounts of oestradiol secreted stabilize at levels less than those of the pre-ovulatory peak. The vaginal discharge shows fertile characteristics corresponding to the oestradiol levels reached but these do not progress. Usually, the feed-back mechanism corrects itself, the FSH values begin to rise again, they exceed the intermediate threshold and a follicle is boosted to ovulation with the same mechanisms, timings and Peak day calculation as in the 28-day ovulatory cycle. This situation is the cause of pre-ovulatory bleeding or spotting. Indeed, it is the final rapid rise in oestradiol output to the pre-ovulatory peak which stops the bleeding and the woman should be aware that she is in a phase of high fertility during such a bleed, i.e. a bleed which has not been preceded approximately 14 days earlier by an identifiable progesterone mucus change (PC, see Figure 1). Brown observed numerous other variants such as in amenorrhoea, oestrogen withdrawal bleeding, luteinized unruptured follicle, deficient and short luteal phases.

Odeblad began his work on the biophysical properties of cervical mucus and the functions of the cervix and vagina [10] about the same time as the Billings began their empirical studies. He has since published widely on this topic. Odeblad [11] explained why the cervical mucus was so significant in fertility. He identified four major types of mucus which he called G, L, S and P types. G mucus, the presence of which is caused by progesterone, plugs the cervical opening and is responsible for the minimal amount of discharge that is noted in the infertile parts of the cycle in Figure 1. S and P mucus are caused by oestrogen presence. They have critical roles in sperm survival and sperm transport, and are responsible for the symptoms of stringy discharge and slippery sensation that precede the Peak day (see Figure 1). Odeblad also identified the role of the Pockets of Shaw (in the vagina) in contributing to drying of the discharge and the reduced sensation at the vulva and hence the abrupt change in the symptoms observed at the vulva after the Peak day.

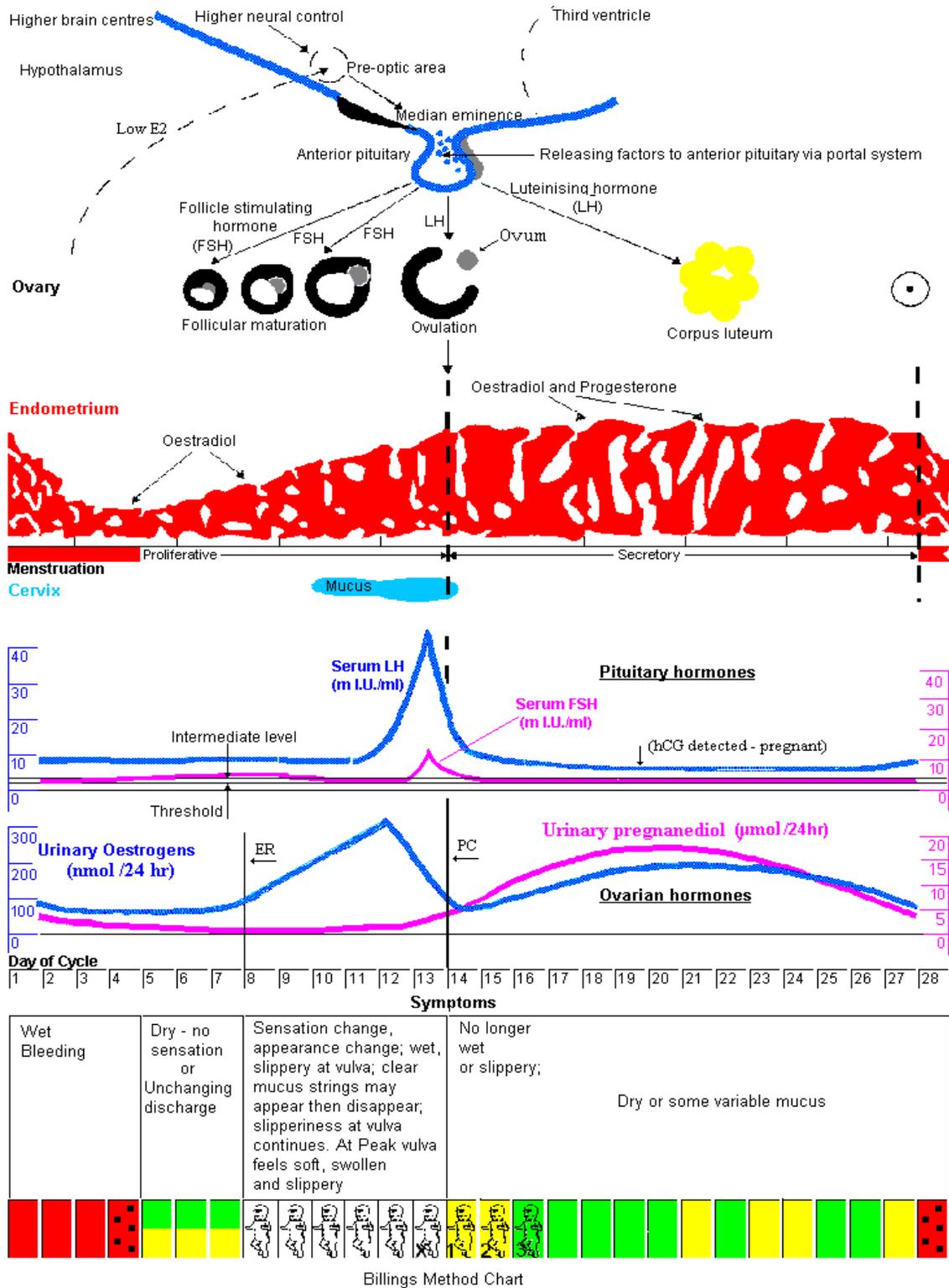


Figure 1. Relationship of the hormonal events of a woman's reproductive cycle and the mucus related symptoms (example description text added by the authors). The symptoms are classified with the use of stamps used in the Billings Method (Peak marked by X).

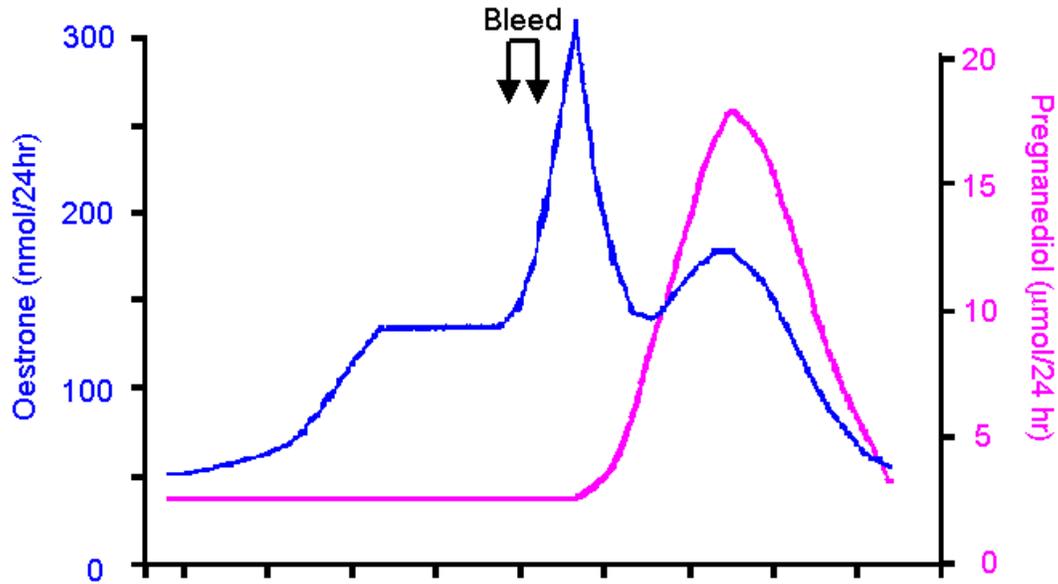


Figure 2. FSH production above the threshold (see Figure 1) may arrest for some days and then rise again, followed by a normal ovulation.

Brown showed that it was the hormonal development that determined when ovulation occurred and hence the length of the cycle. He confirmed that the Peak symptom of the Billings Method (shown at day 13 of the reference cycle in Figure 1) which occurs with the sudden drop in oestrogen and the rise in progesterone is a good marker for the time of ovulation.

The Billings Method is sometimes referred to as the Ovulation Method or the Billings Ovulation Method.

1.1 Symptoms-based methods

The World Health Organisation (WHO) uses the term Fertility Awareness Methods to describe all NFP methods and uses the term Symptoms-based Methods to identify those methods based on cervical secretions and /or basal body temperature (BBT) [12].

Symptoms-based methods involve tracking one or more of the three primary fertility signs - BBT, cervical mucus, and cervical position. The main symptoms-based methods, except the pure BBT method [13], stem from the Billings Method. These are the Creighton Model [14], the Two-Day Method [15] and the Symptothermal method [16]. Symptothermal methods combine observations of BBT, cervical mucus, and sometimes cervical position.

The first organization to teach a symptothermal method was founded in 1971. John and Sheila Kippley [16], joined with Dr. Konald Prem in teaching an observational method that

relied on all three signs: basal body temperature, mucus, and also cervical position. Their organization is now called Couple to Couple League International (www.ccli.org). Josef Roetzer [17] was also a pioneer of the symptothermal method especially in Europe.

Subsequently Hilgers described the Creighton Model as being based on "a standardized modification of the Billings Ovulation Method". Hilgers originally worked closely with Dr John Billings and then gradually refined the standardised observations [18], [19].

WHO [12] classifies calendar-based methods with fertility awareness methods. Calendar-based methods rely only on a history of cycle lengths and are disputed as being symptoms-based methods. However, a new development in calendar-based methods occurred in 1999, when Georgetown University introduced the Standard Days Method [20], [21]. The Standard Days Method is promoted in conjunction with a product called CycleBeads, a ring of colored beads which are meant to help the user keep track of her fertile and non-fertile days. It is only useful for women whose cycle length is regular and between 26 and 32 days.

1.2 The Fertile Window and the Probability of Pregnancy

The fertile window is made up of the days in the ovulatory cycle where pregnancy is possible. The length of the fertile window is determined by the maximum lifespan of the male sperm in the female reproductive tract, and the lifespan of the ovum (not more than 24 hours [9]), making conception highly unlikely a day after ovulation.

Barrett and Marshall [22] used data from 241 British married couples who were charting basal body temperatures, and a study by Wilcox et al [23] used data from 221 healthy women who were planning to become pregnant, to suggest that the maximum fertile window includes the day of ovulation and the five days before ovulation.

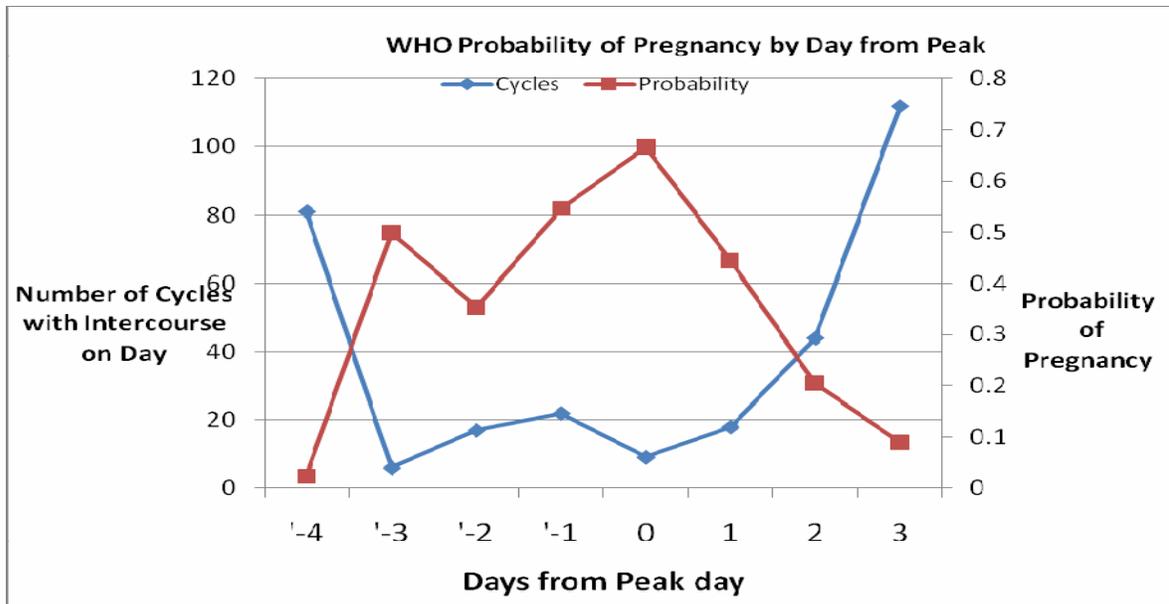


Figure 2. Plot of WHO study results for the fertile window around the Peak day.

A WHO study (see next section) of fertile women reported the probability of pregnancy for days before and after the Peak day, when intercourse occurred [24]. The sample sizes (number of cycles) are shown in Figure 3 along with the derived probability of pregnancy

based on pregnancies reported during the study trial. These show that ovulation may occur after the Peak day. The sample sizes for the main part of the fertile window were small and this would account for the anomalous probability for (Peak day – 3). Nevertheless the overall result was consistent with other research.

1.3 The Use Effectiveness of NFP

Critics of natural family planning draw the distinction between perfect use (proper fertility awareness and adherence to the rules) and imperfect use. Trussel and Grummer-Strawn [25] cite a Pearl Index (pregnancies per 100 women per year) of 3.2 for the ovulation method in perfect use and 84.1 in imperfect use. Similarly, Betts argued that “the biological basis and the instructions to the user are both part of the method”, so that if the user did not adhere to the rules any resulting pregnancy should be counted as a method failure [26].

Proponents of NFP draw the distinction between perfect use of NFP and perfect use of artificial contraception. Barron [27] argues that “if young women have a better understanding of fertility and menstrual cycle function, they are in a stronger position to make informed decisions about how they wish to manage their reproductive and sexual health”. On the other hand there are numerous side effects of contraception that result in either discontinuation or unwanted pregnancy [28], and there are also significant failures because of involuntary imperfect use of contraception [29], [30].

The focus of this proposal is the Billings Method. A summary of results of all known trials of the use effectiveness of the Billings Method is available at www.woomb.org/bom/trials/. Three major independent trials of the Billings Method (used to avoid pregnancy) have been conducted. A WHO trial involving 869 women and 10, 215 cycles of use resulted in 2.2 method related pregnancies per hundred women years in initiates (2.8 when the teaching phase was excluded) [31,32]. The Indian Council of Medical Research Task Force on NFP (1995) conducted a trial involving 2,059 women and 32,957 woman months of use resulting in 0.86 Method related pregnancies per hundred women years in initiates [33]. The Jiangsu Family Health Institute, China (1997) reported 1,235 women, 14,280 women months of use, and no method related pregnancies in initiates [34]. The evidence-based method-related Pearl Index for BOM is 0 to 2.2 in initiates.

WHO [12] recently published use effectiveness of the well known NFP methods as shown in Table 1. The use effectiveness quoted for the Billings Method is from WHO’s trial [31] and does not include the better effectiveness results claimed in the more recent trials referenced above. Nevertheless the effectiveness quoted is comparable to all other methods of family planning. The WHO data also indicates that other symptoms-based NFP methods have better use effectiveness than the Billings Method. This will be made known to participants in the proposed trial.

Betts [26] was critical of the WHO trial results, citing poor results in earlier studies. Betts’ description of these trials only mentions the mucus symptom. This indicates that the trials were employing an early form of the Billings Method in which little attention was placed on sensation at the vulva and the concept of Basic Infertile Pattern [1] was not yet defined. These factors were not present in the WHO trial because a modification of the then published Billings Method rules was employed.

Table 1: Pregnancy Rates with Consistent and Correct Use and Abstinence on Fertile Days

Method	Pregnancies per 100 Women Over the First Year
Calendar-based methods	
Standard Days Method	5
Calendar rhythm method	9
Symptoms-based methods	
TwoDay Method	4
Basal body temperature (BBT) method	1
Ovulation method	3
Symptothermal method	2

1.4 Hormone Measurement

A home use kit was developed by Brown of the University of Melbourne which measures urine oestrone glucuronide and urine pregnanediol glucuronide, accurately identifying approaching ovulation and the occurrence and day of ovulation [35]. There have been similar developments in biochemical analysis to determine ovulation using the ovarian hormones by DD Baird [36] and by WP Collins [37].

In more recent times there is a range of products on the market that involve testing the ovarian or the pituitary hormones to identify fertility and infertility. These can be easily identified by web search. One product combines measurement of the Luteinizing Hormone with other observations. The manufacturers advise that it works by assessing the beginning of fertility by the oestrogen rise, then waits for the LH surge to mark imminent ovulation then waits three days for the start of the post-ovulatory infertile phase. It is not to be used with irregular cycles (e.g. stress, exertion, peri-menopausal, breastfeeding, post-pill). Fluctuation of oestrogen levels instead of gradual rise approaching ovulation also creates unreliability for some users.

Fehring et. al. [38] conducted a trial to determine if an electronic hormonal fertility monitor aided method of family planning is more effective than a cervical mucus only method in helping couples to avoid pregnancy. They concluded that the electronic hormonal fertility monitor aided method was more effective and that further research is needed to verify the results.

1.5 Fertility Awareness

The results of a survey carried out in 1993 in six Western European countries found that the majority of women lacked knowledge concerning basic facts about menstruation, fertility and pregnancy [39]. A New Zealand study found that the majority of women (74%) seeking help for infertility lacked adequate fertility awareness [40].

Klaus et. al. [41] define fertility awareness to be “experiential learning about cyclic fertility”.

Kramer [42] described a fertility awareness program at the University of California/Berkeley: “The instructors present the first fertility symptom, mucus. Mucus is discussed in terms of the fertility phases of the menstrual cycle: relatively infertile, fertile, and infertile. Students are taught how to check their cervical mucus, how to chart it, and how to calculate the beginning of their infertile phase. ... Teaching Fertility Awareness has been a stimulating experience. Classes are always full and there is a demand for additional classes each quarter.”

The proposers of this trial believe that there is a latent demand for fertility awareness that is not being met in appropriate ways. The need is for several reasons. First, for young women in particular, a sense of well being derives from understanding the cyclical changes and being able to predict menstruation. Second the knowledge provides a reliable way of achieving family planning without using the contraceptive process. Third the information is helpful for women seeking to achieve pregnancy as they can identify peak fertility and ensure that intimacy happens at the time. Finally knowledge of her own cycle allows a woman to be aware early of possible reproductive tract pathology indicating a need for investigation.

2. Internet Intervention

In 2004, the International Society for Research on Internet Interventions (ISRII) was formed to encourage e-Health researchers to collaborate in their efforts to further the science behind developing, testing, and disseminating Web-based treatment programs. In 2006 a few of the founding members published a peer reviewed paper [43] in which they stated:

“While the feasibility (can the intervention be delivered) of Internet health interventions in general has been well validated, efficacy (is the intervention successful when delivered under controlled conditions [44]) of Internet applications has now also been established for a number of health problems, including anxiety (e.g. panic [45], post-traumatic stress disorder [46], social anxiety disorder [47]), depression [48], eating disorders (eg, weight loss [49], binge eating and bulimia [50]), body image [51], insomnia [52], and more general medical areas such as headache [53], back pain [54], diabetes management [55], encopresis [56], tinnitus [57], and smoking cessation [58]. True effectiveness (is the intervention successful in actual clinical practice [43]) and cost-effectiveness trials are underway.” (Some of the references in this quote have been omitted and others have been changed.)

“Clearly, there is an appreciation for this new form of treatment and its unique ability to be widely disseminated as millions of dollars have already been allocated by the National Institutes of Health in the United States and other government agencies and various industries around the world. The recommendation of computer-based interventions such as Fear Fighter [59] (for anxiety) and Beating the Blues [60] (for depression) by the United Kingdom’s National Institute for Health and Clinical Excellence (NICE) introduces a new level of acceptance by government and medical insurers of the feasibility and value of such interventions. This acceptance is an essential step in establishing this mode of treatment delivery (via computers and the Internet). This, along with investigating how Internet interventions compare with more traditional forms of treatment delivery (eg, bibliotherapy, individual and group face-to-face, telephone), will be important in clearly establishing Internet

interventions as a viable and effective form of treatment, as well as demonstrating their ability to change behaviours and improve symptoms, cost-effectiveness, scalability, and acceptance in the community.”

Despite the above positive review there is evidence that internet intervention is not always successful. Bessièrè et. al. [61] report that “using the Internet for health purposes was associated with increased depression”. Webb et al [62] report that “we found 85 studies that satisfied the inclusion criteria, providing a total sample size of 43,236 participants”. “On average, interventions had a statistically small but significant effect on health-related behaviour”.

In a report prepared for the US Department of Education by SRI International in 2009 [63] it is concluded that “The corpus of 51 effect sizes extracted from 46 studies meeting these criteria was sufficient to demonstrate that in recent applications, online learning has been modestly *more* effective, on average, than the traditional face-to-face instruction with which it has been compared.”

Internet intervention can be classified into unguided or guided intervention [64]. The client of an unguided system accesses a web-site which contains information and episodes that provide automated assessment and advice for therapeutic activity. A guided system also includes the means to contact a clinician, whether via the internet or face to face.

2.1. Internet Intervention for NFP

Internet intervention is available in the area of natural family planning but as yet it has not been the subject of any peer reviewed publication. There are two prominent web-sites for internet intervention for the Billings Method. Both www.nfpcharting.com and www.woomb.org offer the option of guided or unguided use of the Billings Method. Unguided use is simply an automated form of “charting” that enables the user to record and display her symptoms in a conventional chart [1]. www.nfpcharting.com offers email contact with a registered Billings Method teacher to whom the client grants permission to access to her chart which is held on the web-site database. Similarly, if the client chooses the guided option at www.woomb.org the chart is shared with a designated registered teacher and a communications channel between teacher and client is established and all communications are logged on the web-site database. Privacy is an issue for www.nfpcharting.com because clients are identified by their email address. No personal identifying information is recorded on www.woomb.org and a computer generated identifier and client password is used by the client to access her records.

One of the authors of this proposal (J L Smith) developed and operates the system on www.woomb.org . There was an earlier version operated on a different URL from which 400 users were given guided intervention over several years beginning in 1999. To our knowledge this was the first internet intervention system for NFP. The following experiences have not been peer reviewed or published.

All clients on www.woomb.org register anonymously and usually consent to having their records used for research. About 800 clients have had introductory guidance which usually includes one cycle of charting under guidance from a teacher. Many clients go on to longer

term guidance according to their satisfaction and needs. There is an up-front fee of \$25 for introductory guidance and \$75 for long term guidance. The vast majority of clients have achieved the experience of recognising their Peak symptom and/or Basic Infertile Pattern. No follow-up occurs once a client ceases to use the service. Teachers report that communication and the discernment of client misunderstandings is more challenging because of the lack of the “body language” that is a component of face to face teaching.

Charts produced by clients of the unguided system on www.woomb.org have been evaluated by the author. The majority of clients do not have an adequate understanding of the charting conventions or sufficient fertility awareness to be a successful user.

2.2. Unpublished Analysis of Data from www.woomb.org

More than 20,000 days of client descriptions of mucus symptoms recorded under the Billings Method intervention system at www.woomb.org have been analysed for vocabulary (e.g. see the text at the bottom of Figure 1). Thirty four different English language words were identified in use to describe the symptom of sensation felt at the vulva. More than 80 English language words were identified in use to describe the symptom of appearance of any discharge observed at the vulva. In recent years a log has been maintained of the use of any words outside the recognised vocabulary. Except for qualifying adjectives and adverbs, the use of words outside the recognised vocabulary is no longer occurring. Thus we are confident that this vocabulary for describing symptoms for the Billings Method will only change in the future with the normal evolution of language.

These results have been employed in a semantic pattern recognition module which forms part of the automated guidance system which is the basis of the trial being proposed.

2.3 Personal Computer based Intervention

There are always two main components of an internet intervention system. These are the server which can be viewed as part of the web-site, and the client's computer which provides the access to the service. All the client has to provide is a personal computer with a web browser and an internet connection. Typically users obtain an account on the web-site whereby they can log-in and access any personal intervention data such as their response to a questionnaire that has been designed by clinicians for the purpose of diagnosis. The results of the questionnaire are held in a server database at the web-site.

A typical diagnosis questionnaire has a number of episodes in which the client answers multiple choice questions and conveys the answers to the server. The diagnosis algorithms in the server then make a decision what should be the next set of diagnosis questions for the client and the iteration continues until some other action is recommended to the client.

There is always some concern about the privacy and security of this personal data [65], even though reputable web-sites employ the best technology to preserve privacy and security.

PC technology lends itself to the development of “thick clients” that are more effective for some intervention systems. A “thick client” is one in which most of the processing to accomplish the intervention is done on the client’s PC [66]. The client becomes responsible for the privacy of data held on her PC.

Because of the complex real-time interactions of the guidance system, the complexity of components involved in the display and printing of a Billings Method chart, and the privacy issue, internet intervention for the Billings Method is best implemented in a thick client.

3 Proposed trial

The associated research proposal is for a trial of a new internet intervention system for fertility awareness based on the Billings Method. This will be the first guided intervention system that is based on automated guidance and that uses a semantic module to guide the client, and interprets her descriptions of her fertility symptoms.

The system will be based totally on software in the client’s PC (“thick client”) thereby offering the best privacy provisions and best use of technology for visual interaction.

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