

Preconceptional care: a systematic review of the current situation and recommendations for the future

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Abstract

Objective: To review the current knowledge and implementation of preconceptional care (PCC) in the Western world, focusing both on health care workers and the general population, and to analyze pathways to disseminate the influence of preconceptional care on pregnancy outcome.

Methods: A systematic literature study was performed using OvidSP and Pubmed, searching for articles about PCC and its implementation, published between 1966 and October 2012. Only randomized controlled trials and systematic reviews dealing with PCC in the Western world were retained.

Results: Forty-six articles were identified for review. PCC might result in better pregnancy outcomes, including e.g. a reduction of congenital abnormalities. There are no proven disadvantages of PCC. Health care workers are in favor of the implementation of PCC, but claim that they don't have enough knowledge to do so. The general population shows interest in receiving PCC. The implementation of PCC should be improved by e.g. the development of guidelines and checklists.

Conclusions: As PCC might improve pregnancy outcomes and is considered important by health care workers and the general population, its implementation should be improved, e.g. by the development of guidelines and checklists.

Key words: General population, guidelines, preconceptional care, pregnancy outcome, prevention.

Introduction

Preconceptional care (PCC) focuses on the potential medical and psychosocial problems of a couple before conception takes place. In most western countries 2 to 3% of newborns demonstrate a congenital anomaly (Atrash et al., 2006; Ebrahim et al., 2006). Preconceptional care could probably reduce these numbers. Elsinga et al. (2008) state that PCC leads to better pregnancy outcome. This is because PCC interferes before the critical period of organogenesis (day 17 to 56 after conception) (Leuzzi and Scoles, 1996; Allaire and Cefalo, 1998). Usually prenatal counseling takes place after this critical period. In addition, with the application of PCC there is a shift from acute care to counseling-based preventive care, which might make PCC cost effective (Berghella et al., 2010).

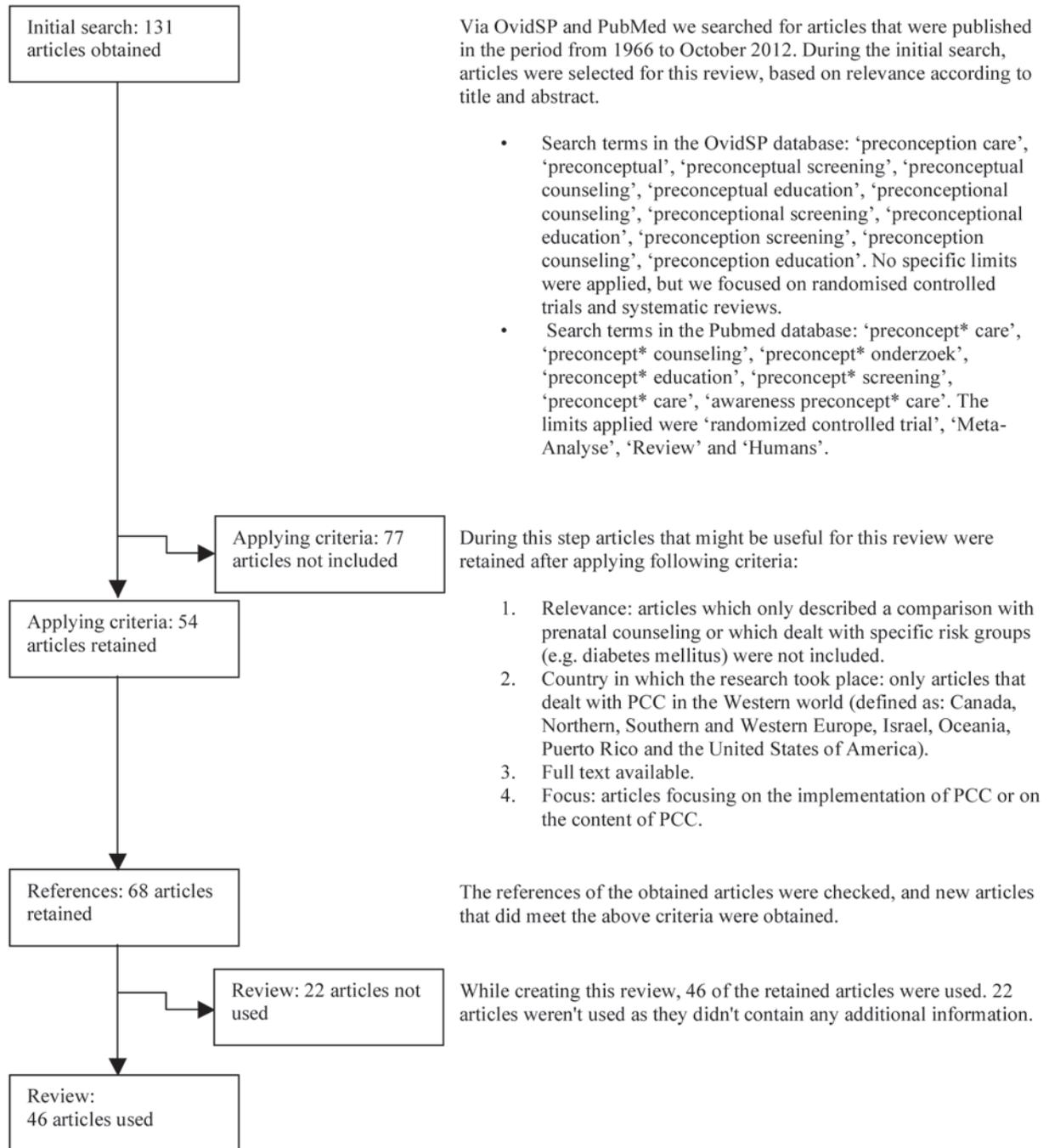
Research has shown that in the Netherlands 80 to 90% of pregnancies are planned (Wallace and Hurwitz, 1998; de Jong-Potjer et al., 2003), which creates the possibility to inform the general population carefully before conception occurs.

All these reasons justify a literature review. We aim to review current knowledge on PCC, both in health care workers and in the general population, and to identify potential actions to improve the knowledge on PCC in the future.

Methods

A brief summary of the methods used in order to search, obtain and retain articles for this review can be found in Table I. Via OvidSP and PubMed we searched for articles that were published in the period from 1966 to October 2012. In the OvidSP

Table I. — Summary of the methods used in this review to search, obtain and retain articles.



database, articles were searched using the following terms: ‘preconception care’, ‘preconceptual’, ‘preconceptual screening’, ‘preconceptual counseling’, ‘preconceptual education’, ‘preconceptional counseling’, ‘preconceptional screening’, ‘preconceptional education’, ‘preconception screening’, ‘preconception counseling’, ‘preconception education’. No specific limits were applied, but we focused on randomised controlled trials and systematic reviews. In the PubMed database, articles were

searched using the following terms: ‘preconcept* care’, ‘preconcept* counseling’, ‘preconcept* onderzoek’, ‘preconcept* education’, ‘preconcept* screening’, ‘preconcept* care’, ‘awareness preconcept* care’. The limits applied were ‘randomized controlled trial’, ‘Meta-Analyse’, ‘Review’ and ‘Humans’. Through a first rough selection based on relevance according to title and abstract 131 articles were retained. Subsequently, these articles were analyzed regarding to quality, relevance, the country

in which the research took place, the focus on implementation of PCC and the focus on the content of PCC. Articles which only described a comparison with prenatal counseling or which dealt with specific risk groups (e.g. diabetes mellitus) were not included. Only articles that dealt with PCC in the western world (defined as: Canada, Northern, Southern and Western Europe, Israel, Oceania, Puerto Rico and the United States of America) and articles for which the full text was available were retained. After applying the above mentioned criteria, eventually 54 articles were retained. Also, the references of the obtained articles were checked, and another 14 new articles were retained. In creating this literature review, 46 of these articles were used. The other 22 articles didn't contain any additional information.

Results

There was a marked majority of studies about PCC which took place in the Netherlands, the United Kingdom and the United States of America.

Contents of PCC

Several authors suggested that PCC consists of some important domains. As a physician or health care provider, one should certainly question a woman with a pregnancy desire about the following subjects: the personal and familial medical history, past infections and immunization status, gynecological problems, personal environment, food habits and possible exposure to teratogenic substances, use of drugs, medication and alcohol, personal and family antecedents of thrombosis, congenital malformations, surgery or pregnancy complications. Furthermore, each preconceptional consultation should be completed with a clinical examination and application of appropriate laboratory tests, including blood group and irregular antibodies (Lanik, 2012; Cefalo et al., 1995; Leuzzi and Scoles, 1996; Reynolds, 1998; Korenbrot et al., 2002; Lu, 2007; Rappaport, 2008). A more detailed overview of the contents of these domains can be found in Table II.

Alcohol intake

At least 10 to 15% of women in of childbearing age in the western world suffer from alcohol overuse (Leuzzi and Scoles, 1996). Alcohol intake in pregnancy increases the risk of birth deficits and developmental disabilities, in particular the fetal alcohol syndrome (FAS) (Cefalo et al., 1995). The incidence of FAS is correlated with the amount of alcohol intake (Lanik, 2012). FAS outnumbers Down

Syndrome and neural tube defects as the main cause of mental retardation for the newborn. Since fetal brain cell damage and fetal brain cell loss have been linked to a single episode of alcohol intake as less as 2 alcoholic drinks, it is advised to pregnant women not to drink any alcohol at all (Lanik, 2012).

Smoking cessation

As approximately 30% of women of childbearing age smoke cigarettes, smoking cessation is an important part of PCC. About 20% of tobacco smoking women will discontinue smoking once pregnant (Konchak, 2001). Smoking during pregnancy increases the risk of miscarriage, placental abruption, intra-uterine growth restriction, preeclampsia, premature rupture of membranes, premature birth and low birth weight (Reynolds, 1998; Konchak, 2001). Maternal smoking is associated with an increased rate of neonatal respiratory tract infection, hypoglycaemia, sudden infant death syndrome and asphyxia (Gottesman, 2004). Smoking cessation should be advised to future mothers. If cessation cannot be achieved, it should be encouraged to smoke less cigarettes a day since the adverse effects of smoking tobacco on pregnancy are dose-related. Nicotine substitution therapy during pregnancy is safer than smoking. The best results to achieve smoking cessation is through counseling and nicotine substitution with bupropion or nicotine patches (Konchak, 2001; Gottesman, 2004). Moreover smoking cessation intervention is cost-effectiveness (Reynolds, 1998).

Toxoplasmosis

Toxoplasmosis is a parasitic infection caused by *Toxoplasma gondii*. The primary host of *Toxoplasma* is the domestic cat. Infected cats excrete *Toxoplasma* oocytes through their feces. Humans can get infected with *Toxoplasma* through oral ingestion of parasites. In pregnancy Toxoplasmosis can result in miscarriage, hydrocephaly, splenomegaly, fetal death, chorioretinitis, microcephaly, mental retardation, developmental problems and hearing loss of the newborn (Allaire and Cefalo, 1998; Reynolds, 1998). It is recommended to systematically test women preconceptionally for *Toxoplasma* immunity. Approximately 20 to 50% of women in Europe and USA have serologic evidence of prior exposure to *Toxoplasma* and are protected for Toxoplasmosis during pregnancy. The incidence for *Toxoplasma* seronegative women to become infected with *Toxoplasma* during pregnancy is 0,1 to 1% (Allaire and Cefalo, 1998). Preventive measures for *Toxoplasma* seronegative women are reviewed in table III (Allaire and Cefalo, 1998; Reynolds, 1998).

Table II. — (Lanik; Cefalo et al., 1995; Leuzzi and Scoles, 1996; Reynolds, 1998; Korenbrot et al., 2002; Lu, 2007; Rappaport, 2008): Summary of the contents of PCC.

Domain	Contents
I. Family history	<p>Birth defects, mental retardation, epilepsy, hearing and visual impairments, hypertension, cardiovascular disease, liver disease, thyroid disease, consanguinity, ethnicity of parents, familial genetic diseases, metabolic diseases, thrombo-embolic diseases under the age of 50, 1 family member with early-onset cancer or multiple family members with early- or late-onset cancer, POF or fertility treatment under the age of 40, congenital absence of the vas deferens.</p> <p><i>It is recommended that both the family history of the woman and the man (sexual partner) are investigated, until second degree relatives.</i></p>
II. Medical history	<p>CHRONIC DISEASES: autoimmune diseases, diabetes mellitus, hypertension, epilepsy, phenylketonuria, allergies, thyroid disease, asthma, cardiovascular disease, (sickle cell) anemia, thrombo-embolic diseases under the age of 50, cancer, kidney disease, depression and anxiety disorders.</p> <p>OPERATIONS</p>
III. Infections	<p>IMMUNIZATION: measles / mumps / rubella, poliomyelitis, diphtheria, tetanus, pertussis, influenza and HBV</p> <p>HISTORY: STDs, toxoplasmosis ⁽¹⁾, varicella, tuberculosis, CMV, parvovirus B19, hepatitis ⁽²⁾ and exposure to blood / blood transfusions.</p> <p>⁽¹⁾ See Table III.</p> <p>⁽²⁾ mainly HBV is a major risk during pregnancy, given the frequent occurrence.</p>
IV. Gynecologic/obstetric history	<p>Contraception, family planning, infertility, menstrual cycle, Caesarean section, history of gynecological surgery, pre-eclampsia, outcome of previous pregnancies ⁽¹⁾.</p> <p>⁽¹⁾ prematurity, birth weight, spontaneous abortion, congenital abnormalities in the newborn or admission of the neonate in the intensive care unit.</p>
V. Environmental factors	<p>BIOPSYCHOSOCIAL STATUS: mother's age, medication ⁽¹⁾ and use of herbs, caffeine intake, smoking, alcohol consumption, drug use, physical activity, domestic violence, financial status, exposure to harmful substances (at home and at work, e.g. heavy metals, radiation), pets.</p> <p><i>It is recommended that both the environmental factors of the woman and the man (sexual partner) are investigated.</i></p> <p>⁽¹⁾ See Table IV.</p>
VI. Nutrition	<p>Dietary habits, BMI calculation, eating disorder, use of dietary supplements ⁽¹⁾, dietary restrictions, fish consumption, caffeine consumption.</p> <p>⁽¹⁾ Vitamin A and other supplements can be teratogenic at high doses.</p>
VII. Clinical examination	<p>General clinical examination of the organ systems with a more extensive examination if considered necessary, given the medical history.</p>
VIII. Laboratory investigations	<p>Screening for diabetes mellitus, full blood count with blood group, Rhesus factor determination and investigation for irregular antibodies, rubella titer, a more detailed examination if considered necessary given the medical history ⁽¹⁾.</p> <p>⁽¹⁾ hematological tests: hemoglobin electrophoresis genetic testing: cystic fibrosis, sickle cell anemia, thalassemia, Tay-Sachs disease and PKU microbiological / serological tests: syphilis, tuberculosis, hepatitis, HBsAg, varicella immunity, HIV, Gonorrhoea, Chlamydia, CMV and toxoplasmosis</p>

Cytomegalovirus

Cytomegalovirus (CMV) infection usually is asymptomatic. For immunocompromised or pregnant women, infection can have major effects (Reynolds, 1998). During pregnancy, about 2% of women

experience a primo CMV infection and about 1% of women experience a reactivation of the virus. In 30% of pregnant women who experience a CMV infection, the virus can be transmitted to the fetus, causing damage to the central nervous system (Konchak, 2001). One percent of all newborn

Table III. — (Allaire and Cefalo, 1998; Reynolds, 1998): Intervention for Toxoplasma seronegative women to prevent Toxoplasma infection during pregnancy.

Preventive measures
Avoiding contact with cats
Washing uncooked fruits and vegetables
Wearing gloves while gardening
Avoid eating raw meat
Well-cooking meat
Avoid cleaning litter boxes
Using dust-free litter
Keeping a domestic cat inside during pregnancy

fetuses is affected with congenital CMV anomalies like vision and hearing loss (Reynolds, 1998; Konchak, 2001). It is not recommended to test pre-conceptionally for CMV as there is no therapy, no vaccine and the presence of antibodies does not mean immunity as reactivation and reinfection with a different genotype occur. Preventive measures to avoid primo infection during pregnancy include universal precautions like washing hands frequently (before dinner, after contact with kids) and taking hygienic measurement when working in a daycare, a children's nursing home or a pediatric health care (Reynolds, 1998; Konchak, 2001).

Vaccination status

Every woman of childbearing age should be vaccinated against: measles, mumps, rubella (MMR vaccine), poliomyelitis, tetanus, pertussis and diphtheria. If not the case, it is best to get vaccinated before becoming pregnant (Leuzzi and Scoles, 1996; Berghella et al., 2010). For future parents it is recommended to receive a revaccination against pertussis in adulthood, before their child is born. If preconceptional or prenatal revaccination couldn't be managed, vaccination should be administered immediately after delivery. Once revaccination in adulthood has been administered, no revaccination should be considered for future pregnancies (Berghella et al., 2010).

If a woman is pregnant during the annual influenza epidemic (November to April), an influenza vaccination is advised (Freda et al., 2006; Konchak, 2006).

If the woman is at increased risk of infection with hepatitis B and is not yet vaccinated it is recommended to administer Hep B vaccine. High risk groups include: health care workers, people who

receive dialysis, people who get multiple blood transfusions, hemophiliacs, users of intravenous drugs, people who have many different sexual partners, people with a sexual partner who is infected with the hepatitis B virus (HBV), people with home contacts who are infected with HBV and those living in intermediate and high endemic regions of HBV (Berghella et al., 2010).

Gottesman (Gottesman, 2004) also recommends vaccinating a woman with a pregnancy desire against varicella if she has never been infected with chickenpox (Varicella zoster). The Varicella zoster vaccine is a live attenuated vaccine. Caution should be taken with an attenuated vaccine (MMR or Varicella zoster vaccine) as the vaccine should be administered at least 4 to 8 weeks before conception and is preferably not administered during pregnancy (Lanik, 2012; Cefalo et al., 1995; Leuzzi and Scoles, 1996; Reynolds, 1998; Korenbrot et al., 2002; Lu, 2007; Rappaport, 2008).

Genetic diseases

A woman with a pregnancy desire should preferably be referred to a geneticist in case she is older than 40 years, or one of the prospective parents is a known carrier of a genetic disease. Also a family or personal history suggestive for a genetic problem should prompt genetic counseling (Freda et al., 2006).

If the prospective father is older than 40 years, there is an increased risk of new dominant mutations in his future children (Cefalo et al., 1995), an increased risk of structural and single-gene disorders in offspring from men older than 45 has also been reported (Rappaport, 2008).

If one of both future parents has Eastern European Jewish ancestors, one should screen for cystic fibrosis, sickle cell anemia, thalassemia, Tay-Sachs disease, phenylketonuria (PKU), Canavan disease and familial dysautonomia. Less prevalent disorders in this population are Fanconi anemia, Neimann-Pick disease, mucopolidosis IV and Bloom syndrome. Hemoglobinopathies on the other hand, are more common in individuals of African, South-east Asian, Chinese, or Mediterranean descent, but preconceptional screening is not advised (Rappaport, 2008).

Advantages of PCC

In 1998, Reynolds (1998) mentioned the potential benefits of PCC that might occur if PCC was offered to women of childbearing age. If women were aware of their unhealthy lifestyles, they would change their behavior before, during, before and

Table IV. — (Reynolds, 1998; Brundage, 2002): Medication that should be reviewed and changed if necessary during pregnancy.

Drugs known to be (possibly) teratogenic	
ACE inhibitors	Androgenic hormones
Anticonvulsants	Antidiabetics
Antineoplastic drugs	Benzodiazepines
Busulfan	Carbamazepine
Colchicine	Coumarins
Diethylstilbestrol	Disulfiram
Ergotamine	Fluconazole (high doses)
Glucocorticoids	Isotretinoin
Lithium	Methimazole
Methotrexate	Misoprostol
Penicillamine	Primidone
Quinine	Quinolones
Selective serotonin re-uptake inhibitors (SSRI)	Statins
Streptomycin	Tetracyclines
Thalidomide	Vitamin A (high doses)
Zidovudine (AZT)	

after their pregnancy, and the quality of life and general health of these women would rise. There would be fewer unwanted pregnancies and pregnancy outcomes would improve by decreasing mortality and morbidity in both mother and child. This can be explained because PCC intervenes before the critical period of organogenesis (day 17 to 56 after conception), in contrast to prenatal care, which is nowadays often the only care that is given, and which interferes later in pregnancy (Leuzzi and Scoles, 1996; Allaire and Cefalo, 1998). In addition, by the application of PCC there is a shift from acute care to counseling-based preventive care, which could be cost saving in the long term (Berghella et al., 2010). However, none of the reviewed studies could prove the cost-effectiveness of PCC.

Disadvantages of and barriers to PCC

While reviewing the literature we didn't encounter any disadvantages of PCC. A potential negative effect could be the medicalization of pregnancy, but according to Gaytant et al. the majority of GPs (74%) didn't believe that PCC would lead to medicalization (Gaytant et al., 1998).

Various articles did mention barriers. Not all pregnancies are planned. In the Netherlands unplanned pregnancies account for 10 to 20% (Wallace and Hurwitz, 1998; de Jong-Potjer et al., 2006), in the UK this rises to 30% and in the United States even

up to 50% (Schrandt-Stumpel, 1999; Curtis et al., 2006).

Doubts remain about who has to offer PCC. Options include gynecologists, general practitioners (GPs) and midwives. In practice, we mainly find that they are all understaffed (Heyes et al., 2004) and have too little time (Curtis et al., 2006) to offer PCC.

Another obstacle is the level of knowledge in health care providers (Gaytant et al., 1998; Schrandt-Stumpel, 1999). If one focuses on the domain 'genetics and hereditary diseases', there appears to be a low level of knowledge among GPs (Mann, 2003). There is no consistency, neither are there any guidelines about supplying PCC by health care professionals (Riskin-Mashiah, 2004; Delvoye et al., 2009). If guidelines do exist, they are rarely used. Berghella et al. demonstrated in 2010 that 1 in 6 obstetricians-gynecologists (OB/GYNs) or GPs provided PCC to women for whom they did supply prenatal care (Berghella et al., 2010).

Health care professionals also often think they have too little time to provide PCC. This applies to GPs (Gaytant et al., 1998) and OB/GYNs (Morgan et al., 2006) as well as to midwives (Curtis et al., 2006). Although PCC can be time consuming for GPs, it saves time during the first postconceptional consultation at the GP (Heyes et al., 2004). Nevertheless, GP's rarely consider PCC a priority (Heyes et al., 2004; Curtis et al., 2006).

Another reason why PCC is not provided frequently is the failure of the reimbursement of PCC (Heyes et al., 2004; Morgan et al., 2006). One has to bear in mind that there are costs linked to the delivery of PCC, both for the community as for the individual who receives PCC (Atrash et al., 2006). Therefore, in a poor reimbursement system, a socio-economic gap can appear (Elsinga et al., 2008), which explains the urgent need for political support, the establishment of funds and adequate insurance coverage for PCC to be implemented in daily health care (Berghella et al., 2010). To make this possible, there's still the need for further research to determine the best content and form of implementation (Berghella et al., 2010).

Furthermore there is too little problem recognition. Physicians and midwives often don't take notice of the demand and need for PCC (Curtis et al., 2006). It has been shown that GPs and midwives often feel that the target population shows little to no interest in PCC (Heyes et al., 2004; Morgan et al., 2006). Finally, it sometimes is difficult to reach the women who really need or want PCC (Heyes et al., 2004; Morgan et al., 2006).

Point of view of health professionals regarding PCC and current implementation of PCC

PCC is preferably provided by GPs, nurses, midwives or obstetricians (Poppelaars et al., 2004).

The Netherlands

According to Gaytant et al. 93% of Dutch GPs think PCC is one of the tasks GPs should complete. Ninety-one percent of the GPs were prepared to provide PCC in the future (Gaytant et al., 1998). This stands in contrast to the study of Poppelaars et al., in which half of the GPs who favored introduction of PCC, thought this task should be completed by GPs (Poppelaars et al., 2004).

The study performed by Gaytant et al. showed that 70% of GPs found there is enough time to provide PCC in daily practice. Fifty-nine percent of GPs would refer patients to an outpatient clinic, whereas only 42% felt they had enough knowledge to provide PCC and therefore 84% stated there was need for better education and postgraduate training covering this subject. About 34% of the GPs thought that he or she had enough brochures about PCC at his or her disposal (Gaytant et al., 1998).

Midwives also provide PCC, but they usually don't provide this care on a structural basis, and only perform it in the first trimester of pregnancy. So, strictly this is part of prenatal care. A Dutch study among 102 midwives showed that 93% of

them were familiar with the concept of PCC. Seventy-one percent offered some kind of PCC. Fifty-seven percent had received requests for more information regarding PCC from their patients. The midwives seemed eager to play an active role in providing PCC in the future (83%), 55% considered themselves responsible to do so, but 90% felt there is a great need for additional training. Seventy-nine percent thought they were unable to provide PCC in the current prenatal setting. Eighty-six percent encountered situations that should have been addressed before conception (van Heesch et al., 2006).

Among obstetricians, 78% thought PCC was a valuable care. Seventy percent of them felt that PCC should be provided by GPs if it was going to be introduced systematically (de Weerd et al., 2001).

USA

According to Curtis et al. 37% of GPs claimed to offer PCC to more than 75% of women of child-bearing age. Seventy percent of them claimed to be willing to provide PCC to at least 75% of these women. However, willingness to provide PCC is not necessarily the same as counseling in an effective way. Among the caregivers who provided PCC, one third reported that they were successful in helping patients for at least 75% of the time (Curtis et al., 2006).

A study among 579 (obstetricians-) gynecologists who were members of ACOG (American College of Obstetricians and Gynecologists), showed that 87.3% of them considered PCC to be important (Morgan et al., 2006). 83.5 % of gynecologists thought PCC had a positive effect on pregnancy outcome, but 20.7% felt this was an important part of their daily task as an OB/GYN. Seventy-six point eight percent felt they had received a good training to provide PCC. According to 51.4%, there was not enough time to provide PCC, and 49.8% felt that the time spent on PCC, was not reimbursed.

Point of view of the general population regarding PCC

PCC should be voluntary. Patients should have the choice to pursue information about their reproductive risks, the choice to know the acquired information about these risks and the choice to continue or discontinue their pregnancy after receiving this information (Bombard et al., 2010).

The Netherlands

A Dutch study performed by de Jong-Potjer et al. in 2003 (de Jong-Potjer et al., 2006) showed that

women might not actively seek information because they are not aware of risks, or because they do not know that the first period of pregnancy is crucial. Therefore, it is important that the health care worker himself takes the initiative to provide PCC in order to reach every woman in time. Today, health care workers do provide information on risk factors and prevention, but only during the first prenatal consultation. This study showed that up to the age of 29 at least 80% of the surveyed women were interested in PCC if they were to decide to have children. The percentage of non-interested women increased with age, but with increasing age women were more likely to know when they wanted to become pregnant, more so than the younger women did. More than 70% of the respondents reported to be interested in PCC if it would be offered by their GP. People with higher levels of education were more likely to search information about PCC, and were more self-assured they could find enough information by themselves. Migrants seemed to be harder to reach (de Jong-Potjer et al., 2006).

According to another study performed in 2003 (Boulet et al., 2006), 70% of Dutch women of child-bearing age were interested in PCC.

Another study in the Netherlands (Poppelaars et al., 2004) showed that 93% of its respondents thought routine cystic fibrosis (CF) carrier screenings should be offered to future parents. However, 56% would agree to test for CF if such test would be available, 27% would decline to participate, and 27% were unsure. This demonstrates that a willingness to receive PCC is not the same as participating in it.

USA

In 2003, a study by Rosenberg et al. (2003) showed that women with intended pregnancies were more likely to consume folic acid during the periconceptional period than those with unintended pregnancies.

A study (Delgado, 2008) in American undergraduates showed that the average student answered 64% of the questions on the content of PCC correctly. There was a small but significant difference between the scores of men and women, women scored slightly better. This difference was confirmed by a study performed by Mitchell et al. (2010). Respondents who had already had a lecture about the content of PCC scored significantly better. There was a high knowledge level (80%) about substance use during pregnancy, an intermediate level (60-80%) about STDs and PCC, and a low knowledge level (<60%) about folic acid, prenatal fetal development, health and the optimal time between 2 pregnancies.

The study performed by Mitchell et al. in 2012 showed that both men and women are not really aware of PCC. When the respondents were asked if they had somewhere heard, read or seen any recommendations about PCC, 52% of men and 43% of women answered negatively. The main sources of information about PCC were television (25.5-30.6%), magazines (19.9-29.5%) and the GP (11.1% in men and 22.2% in women). When questioned about specific components of PCC, there was also a noticeable difference between men and women. These differences were reflected in terms of knowledge about the negative effects of smoking (83.6% in men and 90.8% in women), the negative effects of illegal drugs (81.2% and 89.3%), the negative effects of alcohol (80.5% and 86.9%), the importance of a healthy diet (76.7% and 77.8%), when to consult a physician (68.0% and 77.3%), the importance of family medical history (61.2% and 71.2%), the importance of folic acid intake (52.1% and 72.0%), vaccinations (40.1% and 48.8%) and influenza vaccination (18.5% and 22.3%). These results showed that both men and women thought the avoidance of cigarettes, illegal drugs and alcohol to be the most important. The biggest difference between men and women was the knowledge about folic acid.

A study performed by Coonrod et al. (Coonrod et al. (2009) in a population of mostly Hispanic (88%) and pregnant (68%) women showed that 89% thought that improving preconception health benefits pregnancy. Seventy-seven percent of these women were interested in PCC. They preferred OB-GYNs as providers of PCC. The only significant determinant of knowledge and attitude towards PCC seemed to be age, increasing knowledge with increasing age.

United Kingdom

A study by Wallace and Hurwitz in 1998 (Wallace and Hurwitz, 1998) showed that women from the target group of PCC generally were reasonably well informed about PCC. The average score on the questionnaire regarding the content of PCC was 74%. The main determinants of knowledge appeared to be previous pregnancies (minor knowledge in women who have not had been pregnant), birthplace (minor knowledge when born outside the UK), and ethnicity (minor knowledge in Asian women). Women who had had no education after the age of 18 seemed to be less informed. A less important determinant of knowledge was the age of the respondents. Most women did not want to receive advice regarding PCC when they went to the doctor for a consultation about a non-gynecological problem. Forty percent of women ought PCC to be

essential, the majority of them would not look for this advice themselves.

Recommendations to stimulate the implementation of PCC

Health care workers

It is often recommended to offer readings and postgraduate courses to GPs (Schrandt-Stumpel, 1999; Heyes et al., 2004; Delvoe et al., 2009). Mann found that postgraduate courses dealing with the topic of 'genetics and hereditary diseases' were well received by practitioners and led to a better knowledge of this topic (Mann, 2003). Furthermore, specific guidelines should be developed regarding the implementation and application of PCC (Morgan et al., 2006; Delvoe et al., 2009). It is also possible to create check lists for doctors regarding the content of PCC (Riskin-Mashiah, 2004). These checklists could then be used by GPs and gynecologists. This way, the most important aspects of PCC would be addressed during the preconceptional consultation. Another good initiative would be a solid reimbursement system for PCC consultations. One could create a bonus system, paying a doctor per consultation regarding PCC.

General population

Delgado (Delgado, 2008) concluded that awareness of PCC should be increased in the general population. One should pay more attention to family planning, and put an emphasis on the crucial period of organogenesis, the benefits of folic acid intake and the importance of health and chronic disease during pregnancy.

Berghella et al. (2010) stressed that the repayment of PCC consultations by health insurance would be a very good initiative. Consumer's discounts on insurance in exchange for getting PCC could be another good initiative.

According to Boulet et al. (2006) there are a number of potential domains that could provide information about PCC.

- *School*. During sex education classes teachers could emphasize the importance of PCC, and integrate this with STD prevention, information related to oral contraception,... Reynolds stresses the need for teaching teenagers the basics of PCC (Reynolds, 1998). Another study by Heavey (2010) stressed that teens should get proper education about smoking cessation, body weight control, interpersonal violence, and the need for folic acid before conception.

- *Employer and workplace*. At the workplace one could promote smoking cessation, seeking the assistance of a physician,... (this was confirmed by Lu (2007))

- *Media*. The media, currently provide an unrealistic picture about pregnancy and health. Fashion models are often too thin, there is too much emphasis on the rapid loss of extra pregnancy pounds, alcohol and smoking are a trend and sometimes considered as a social obligation... The media should however instead focus on spreading the right messages in order to raise awareness about PCC.

- *GP*. They would be the ideal person to provide PCC as they know the family history of the couple as well as there is a low threshold to consult a GP. As mentioned, there is still a controversy about who has to bear the costs for the PCC consultation. This could be the health insurance, the government or the couple itself. Another study (Lu, 2007) claimed that the interconceptional period is an excellent moment for the GP to discuss PCC for a subsequent pregnancy. GPs could raise the awareness about PCC and encourage the population to take part in family planning. Heavy (2010) claims that adolescents are an important target group of preconception education at every healthcare visit. At every routine primary care visit, pregnancy desire and risk should be assessed in high-risk populations. These populations include among others: women consuming alcohol or cigarettes, women suffering from type I diabetes,... If necessary, there should be an interdisciplinary involvement including nutrition consultations, social work intervention, and support group referrals.

- *Community*. Both the health system and the government can take initiatives at national level or at the level of communities to promote PCC (Lu, 2007). Elsinga et al. (Elsinga et al., 2008) agree that measures should be taken at national level.

Through all of these resources, one can still spread the information about PCC in a lot of different ways.

Delvoe et al. (2009) proposed to raise the awareness regarding PCC with brochures and posters. They concluded that these resources are more effective than TV spots in raising the knowledge about PCC in the general population. Schrandt-Stumpel (Schrandt-Stumpel, 1999) recommended to put a sticker on oral contraception containing the recommendation to see a doctor for more information about taking folic acid when stopping contraception. Another way to inform the general population is the use of online resources (Poppelaars et al., 2004). Finally, one can create screening questionnaires that can be completed by women who wish to become pregnant (de Weerd et al., 2001).

Possible occasions to offer PCC include the first gynecological examination of an adolescent, youth health care, each visit to a doctor during the reproductive period (15-44 years), the annual gynecological examination, whenever prescribing contraception, after a pregnancy (especially when it was negative), postpartum, through occupational health services, ... (Berghella et al., 2010). One should also pay attention to reach the fathers, relevant community groups and medical students in particular (Boulet et al., 2006).

In Belgium, more specifically in the French-speaking community, ONE (Office de la Naissance et de l'Enfance) proposed a campaign in 2005 to raise the awareness regarding PCC through prenatal care, pediatric and gynecological clinics, GPs, genetic centers and counseling centers (www.excellencis-one.be/documentation.php). This campaign was meant both for the general public and for health care providers, aiming to achieve an introduction of PCC in primary care. During the first phase of their campaign, they sent leaflets, posters and letters to health care providers. Then they focused on men and women of reproductive age, trying to reach them through posters, leaflets, radio and television. They also suggested guidelines for healthcare providers. During the last phase of their campaign, they reviewed the resulting behavioral changes at the level of the community and the health care providers (Ebrahim et al., 2006). The results of this campaign were discussed by Delvoye et al. (2009). As mentioned earlier, they concluded that posters and leaflets are more efficient than TV commercials. They also proved that health providers applied the proposed guidelines in an inconsistent manner. The proposed guidelines dealt with the same subjects as mentioned in Table II.

A study by Sillender and Pring (2000) showed that folic acid consumption rose between 12.4 and 25.3% after public health campaigns. According to Garcia-Fragoso et al. (2008) the media were the most efficient way of informing the general population. Healthcare workers were the second most efficient way. Finally also friends and relatives could provide some information, especially those with a child with a neural tube defect (Byrne, 2003; Rasmussen and Clemmensen, 2010).

Discussion

Advantages of PCC

As mentioned, Reynolds (Reynolds, 1998) summarized the potential benefits of PCC. However, in this study there was no solid evidence to prove these potential benefits. In 2008 Elsinga et al. (Elsinga et

al., 2008) tried to prove in a Dutch study that providing PCC leads to better pregnancy outcomes. PCC did indeed improve pregnancy outcomes, but the differences with the control group were not statistically significant (OR: 0.77 and 95% confidence interval: 0.48 to 1.22). Elsinga et al. mentioned in this study that the numbers were probably not significant because the study population was too small and there was no correction for demographic differences.

Disadvantages of and barriers to PCC

As described above, a potential negative effect of PCC could be the medicalization of pregnancy. According to Gaytant et al. the majority of GPs (74%) didn't believe that PCC would lead to medicalization (Gaytant et al., 1998). However, we believe that PCC might lead to stigmatization. Strict rules might put a lot of pressure on women who want to become pregnant, possibly leading to fear of failing these rules. Women might for example fear that they won't be able to quit smoking, lose weight,...

Point of view of health professionals and general population regarding PCC and current application of PCC

GPs. We found results that contradicted each other with regard to the opinion of GPs in the Netherlands. In 1998 Gaytant et al. (1998) reported that among the 100 GPs they questioned, 93% of them felt that PCC was part of the job of the GP. Ninety-one percent of them were willing to provide PCC in the future. However, in 2004 Poppelaars et al. (2004) concluded that half of the GPs favoring an introduction of PCC, thought this task should be completed by GPs. These two results are therefore in contrast with each other. This contradiction might be caused because there is a period of six years between these 2 studies. However, we would rather expect that during these six years the opinion of doctors would evolve in a positive sense, and that GPs would be more willing to provide PCC than in 1994. It might be possible that this discrepancy is caused by a difference in motivation of doctors between the two groups. This assumption might be confirmed by the difference in response rate. The study of Gaytant et al. had a response rate of 89%, while the study of Poppelaars, Cornel et al. had a response rate of 52%, although the random sample populations were similarly composed.

Population. The Dutch study of de Jong-Potjer et al. (2003) showed that until the age of 29, at least 80% of the surveyed women, were interested in PCC if

they were to decide to have children. Another study (Wallace and Hurwitz, 1998) in the United Kingdom showed that 40% of respondents felt PCC was essential. This discrepancy can be explained either because two totally different populations were questioned in these studies, or because the first-mentioned study took place in 2003, while the other study was conducted in 1998. Possibly the general population in the year 1998 was not yet aware of the concept of PCC and might have been more interested in the year 2003. Furthermore there was a different way of questioning the participants in these 2 studies. The first study asked if the respondent was somewhat interested in receiving PCC, while the second study asked if the respondent felt that PCC was really essential.

The study of de Jong-Potjer et al. (2003) also showed that 70% of respondents would be interested in PCC if it would be offered by the GP. Since the health system in the Netherlands links each citizen to one specific GP, the GP is probably the ideal person to offer PCC. The GP knows the couple and their medical history, and is often a person of trust. Moreover, about 90% of pregnancies in the Netherlands are planned, which creates an ideal setting for GPs to offer PCC.

Recommendations to stimulate implementation of PCC

We support the recommendation suggested by van Heesch et al. in 2006 (van Heesch et al., 2006) to develop a screening questionnaire, which can be completed by the patient herself. We do so because we believe this is a very efficient way to offer PCC in circumstances where currently no PCC is provided due to a lack of knowledge or an excessive workload for the caregiver. Through a screening questionnaire the personal risks of one specific patient are identified in a structural manner, which might save time during the consultation itself. A questionnaire might focus on the main problems, and help avoiding certain risks to be forgotten during the consultation. Moreover, a questionnaire can facilitate later investigations regarding the effectiveness of the counseling. These investigations might indicate problems in the current implementation of PCC in order to improve the counseling in the future. The effectiveness of such a screening questionnaire was proven by de Weerd et al. (2002).

In their publication, Poppelaars et al. (2004) stress that a positive attitude towards PCC does not mean that people also participate in PCC. One should therefore take this into account when interpreting results regarding interest in PCC.

According to de Weerd et al. (2001) there is a need for further structuring PCC including registration of additional investigation and recording of data in a (national) database. We support this recommendation, as this might improve the evaluation of the current implementation of PCC. It might help recognizing problem situations and finding measures that might improve them. One can identify positive effects of PCC more easily, ensuring they will remain in the future.

Brundage (2002) and the 'ACOG technical bulletin. Preconceptional care' (ACOG, 2004) claim that one should seize every opportunity to provide PCC. At each routine visit to any woman who could become pregnant at that time, one must emphasize the importance of PCC. This could be at an occupational health service, but also at a follow-up consultation for chronic diseases. We think this is maybe a little too extreme since the study of Wallace and Hurwitz in 1998 (1998) showed that most women in their study did not want to receive advice regarding PCC when they came for other than a gynecological consultation. This seems plausible to us. We believe that health care should find a balance between these two options and we therefore believe it is essential to check the woman's desire or need for PCC. If women themselves ask questions regarding PCC topics during a consultation, health care workers should seize this opportunity and answer their questions, giving them even more extensive information regarding PCC.

Limitations of the reviewed studies

None of the studies showed inconsistencies, but it remains difficult to compare the different studies. There is sufficient knowledge about what PCC must provide (see Table II), but it is difficult to have a structured overall view about the knowledge, perception and implementation of this kind of care in the Western world. There are no standardized tests to examine the implementation of PCC, neither are there any tests to examine the current knowledge and perception of PCC for/of both GPs and the general population.

There was no standard questionnaire which was used in the different surveys. Many studies focus on a different subgroup. E.g. the following populations were examined in different studies: university students, GPs, gynecologists, general population,...

Recommendations for further research

The study of Schrandt-Stumpel (1999) gave rise to the question of how one had to reach women and couples to provide PCC. They asked themselves

who had to provide the PCC. To date, there is still no definitive answer to this question. However, a possible suggestion which was made following the above study, was to let PCC be provided by GPs and nurses in primary care. Midwives, gynecologists and geneticists would be useful in providing further information.

The study of de Jong-Potjer et al. (2006) showed that PCC depends on ethnic background and social situation. Migrants are hard to reach, while they would benefit the most from PCC according to researchers. Therefore, specific methods should be designed to reach this group, after the favorable effect of PCC has been proven.

Atrash et al. (2006) wondered what motivated women and couples to receive PCC, and which factors might influence this motivation. We think these factors should be investigated. This way, one can adjust future guidelines to them.

The effect of systematic implementation of PCC needs to be investigated for example through the observance of preconception health indicators, such as the use of folic acid, smoking (cessation), obesity in pregnant women, vaccination status and other clinical relevant indicators (de Jong-Potjer et al., 2006). This way, one can successfully monitor progress, and try to maintain a positive evolution in the implementation of PCC. One can also compare PCC programs and recommendations between different regions or countries and examine the impact of these recommendations on the indicators of maternal and perinatal health (Boulet et al., 2006).

Conclusions

Since there are strong indications that PCC is cost saving and yields better pregnancy outcomes, we are convinced that further research is needed. Only when these assumptions have been proven, one should promote and invest in PCC.

The advantages, disadvantages and barriers regarding PCC are known, but during our literature review, we found that little is known about the most effective method for the implementation of PCC. The role of the OB/GYN and GP is very different between countries. In some countries the OB/GYN is also a primary care physician for women, in others this role is played by the GP and OB/GYNs only perform problem-oriented specialized care. These differences should be kept in mind when developing implementation guidelines. Furthermore, there are initiatives to be taken by the entire healthcare to promote PCC, there is an urgent need for political support and it is necessary to develop an efficient reimbursement system (Berghella et al., 2010).

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