



Measuring antenatal care use in Europe: is the content and timing of care in pregnancy tool applicable?

Katrien Beeckman^{1,5} · Lucy Frith² · Helga Gottfreðsdóttir³ · Annette Bernloehr⁴

Received: 26 September 2016 / Revised: 6 February 2017 / Accepted: 15 February 2017
© Swiss School of Public Health (SSPH+) 2017

Abstract

Objectives Measuring of antenatal care utilisation is important from a public health perspective. The Content and Timing of care in Pregnancy tool (CTP) focuses on the care process and includes aspects on quality of care. The aim of the study is to gain insight in the applicability of the CTP tool across Europe.

Methods National guidelines for routine antenatal care were examined, analysing the degree to which the four items in the CTP tool were included in these guidelines.

Results From the 30 countries, 22 had a national guideline for routine antenatal care. The CTP tool is applicable in over 60% of the European countries with a national guideline.

Conclusions The CTP tool can be used to measure antenatal care delivery in Europe. The tool is useful to evaluate the care process, focusing on rates of interventions as the closest approximation to the delivery of health care, with a focus on content of visits rather than simply the number of visits. Together with indicators measuring structure and outcome of health care, conclusions about the quality of care can be made.

Keywords Quality of care · Antenatal care · Health services research · Content of care · Care process indicators · Clinical guidelines

Introduction

The provision of antenatal care is universally accepted to be of great importance in preventing poor pregnancy outcomes (Taylor et al. 2005). Different aspects of antenatal care have been used as a measure of uptake in the literature. Some focus on single aspects of the received care e.g. initiation of care (Nothnagle et al. 2000), number of visits (Petrou et al. 2001; Raatikainen et al. 2007), others include a combination of initiation of care, number of visits and at what point of the pregnancy these take place, such as the Adequacy of Prenatal Care index (Kotelchuck 1994). The Adequacy of Prenatal Care Use (APNCU) index and the Kessner Index are the most frequently used measures (Ng et al. 2015; Partridge et al. 2012; Tayebi et al. 2013; Vanderweele et al. 2008). With these measures the more visits a woman receives the better the care use is judged to be. These tools, therefore, are not applicable to high-risk women because they necessarily generate more visits assigning them automatically to the most adequate care group (Vanderweele et al. 2008). Another critique of these

✉ Katrien Beeckman
katrien.beeckman@uzbrussel.be

Lucy Frith
L.J.Frith@liverpool.ac.uk

Helga Gottfreðsdóttir
helgagot@hi.is

Annette Bernloehr
annette.bernloehr@hs-gesundheit.de

¹ Department of Public Health, Faculty of Medicine and Pharmacy, Nursing and Midwifery Research unit, Vrije Universiteit Brussel, Brussel, Belgium

² Department of Health Services Research, The University of Liverpool, Liverpool, UK

³ Faculty of Nursing-Department of Midwifery, University of Iceland Reykjavik, Reykjavik, Iceland

⁴ Hannover Medical School, Midwifery Research and Education Unit, Hannover, Germany

⁵ Department of Nursing and Midwifery, Nursing and Midwifery research group, Universitair Ziekenhuis Brussel, Laarbeeklaan 101, 1090 Brussel, Belgium

tools is that one can receive the same content of care in fewer visits (McDuffie et al. 1996). A reduced number of visits does not necessarily lead to poor outcome when the content of care is good (McDuffie et al. 1996). Therefore only focussing on pregnancy duration and number of visits is not enough in itself to adequately evaluate the quality of care received in pregnancy (Alexander and Kotelchuck 2001; Kogan et al. 1998). Internationally the need for tools that consider more qualitative, content aspects of antenatal care has been expressed (Handler et al. 2012; Kogan et al. 1998; Korenbrot et al. 2005; Ricketts et al. 2005; White et al. 2006). For example, EURO-Peristat, a group that has defined perinatal indicators, concluded that indicators measuring ‘content of care’ needed further development (EURO-PERISTAT project 2008). In order to evaluate the care use and include the content dimension of care (that is what kind of care and or intervention is offered), a tool was developed by the first author that included both the content and timing of healthcare interventions during pregnancy (Beeckman et al. 2011). The development of the Content and Timing of Care in Pregnancy (CTP) tool has been described in detail in Beeckman et al. (Beeckman et al. 2011). The tool was developed by examining the evidence for different key antenatal interventions during pregnancy and drew on two international robust and representative guidelines for antenatal care, (the National Institute for Health and Care Excellence (NICE 2008); the American College of Obstetrics and Gynaecologists (ACOG) guidelines, American Academy of Pediatrics and the American College of Obstetricians and Gynecologists 2007). In order to include pregnant women regardless of parity or risk status, the Content and Timing of Care in Pregnancy (CTP) tool focuses on a minimal care package recommended for every woman. The CTP tool includes four items:

1. The initiation of care in pregnancy and the number and timing of three interventions in pregnancy;
2. Blood samples
3. Ultrasound
4. Blood pressure measurement

The CTP tool is an ordinal scale representing four categories going from inadequate, intermediate, and sufficient to appropriate antenatal care. The CTP tool, therefore, provides a useful starting point for evaluating the quality of antenatal care use.

The CTP tool has been found to more accurately evaluate antenatal care trajectories compared to tools that only focus on the number of visits corrected for the pregnancy duration (Beeckman et al. 2011). Beeckman et al. showed a significantly higher predictive value of the tool with regard to preterm birth (Beeckman et al. 2013a). Women in the appropriate care category are at least at the risk of preterm

birth (Adjusted OR 0.21, 95% CI 0.06–0.68) compared with women in the inadequate care group. Further, the CTP tool was used in a Belgian study to examine social determinants of antenatal care use. Women of Maghreb origin (adjusted OR 0.38; 95% CI 0.22–0.66) and those without higher education (adjusted OR 0.58; 95% CI 0.37–0.92) were less likely to have an appropriate antenatal care trajectory (Beeckman et al. 2013b). Besides these applications, the CTP tool is relevant to the evaluation of the impact of actions/interventions developed to improve the uptake of care in disadvantaged women for example. Furthermore, the CTP tool can be used to compare the appropriateness of antenatal care use between or within countries and evaluate implementation strategies to augment adherence to guidelines for antenatal care.

This study aims to gain insight in the applicability of the CTP tool across Europe. National guidelines for routine antenatal care were examined and we looked at the degree to which the four items in the CTP tool were included in the national guidelines for antenatal care in the member states of the European Union.

Methods

A structured questionnaire on the existence and content of national guidelines for routine antenatal care was sent to national experts from the current 28 member states of the European Union plus Norway and Iceland. The questionnaire included three tables with pre-suggested screening tests in which the expert could tick the tests recommended by their national guideline and at what time(s) during pregnancy (boxes with ‘first visit’ and gestational weeks 6 to week 40 as a timeline in the row were provided). This was to map the recommendations in the guidelines. Three separate tables were included for recommendations for physical tests, such as the measurement of blood pressure, technical tests, such as abdominal or vaginal ultrasound, and laboratory tests, such as taking blood samples for a HIV test to be logged. The questionnaire is based on a questionnaire used in previous studies (Bernloehr et al. 2005) and is available on request from the authors.

Data collection

National experts on antenatal care were approached through a snowball sampling method using international organisations (EURO-PERISTAT project, the European Midwives Organisation (EMA) and the European Board and College of Obstetricians and Gynaecologists (EBCOG)) to distribute the survey invitations. By the end of January 2014, the responses covered the 30 countries, 28 member states of the European Union, plus Norway and Iceland. No ethical

approval for this study was required according to the rules and regulations for ethical clearance in the country, Belgium, where the lead author is based.

Data preparation

After data collection (end of January 2014) all responses were checked for completeness and plausibility. Incomplete responses were removed from the dataset. In case of multiple responses for one country, the responses were compared. In the case of inconsistencies, the differences in the answers were sent for clarification to a national contact person, identified through a number of routes: the COST action IS0907, 'Childbirth Cultures, Concerns and Consequences: Creating a dynamic EU framework for optimal maternity care'; the EBCOG; and international personal contacts of the investigators. After this process of checking and cross-checking, a complete and approved dataset was obtained.

Data analysis

In order to examine the applicability of the CTP tool, we investigated the similarities and dissimilarities across the countries in recommendations relating to the four items in the CTP tool (1. initiation of care, and number and timing of: 2. blood samples taken, 3. ultrasound and 4. blood pressure measurement). Figure 1 provides details of the construction of the CTP tool. Item one, initiation of care is defined in the first step of the construction of the CTP tool. Items two, three and four can be read off as the last step of the construction. For example, with regard to the first item we examined the degree to which initiation of care is advised before the 14th week of gestation in the guidelines. Countries without any national guidelines were excluded from the analysis.

The aim of this analysis was to determine if the recommendations in the national guidelines for antenatal care corresponds with the content of the CTP tool. The main question was whether all four items from the CTP tool were recommended in all national guidelines on antenatal care. The first item we checked was whether the initiation of care was recommended before 13 weeks + 6 days of gestation. The second item was the similarity with recommendations for ultrasound scans (is one recommended in the first and second trimester), thirdly we checked recommendations for blood samples taken (is one advised in the first and second trimester) and fourth we evaluated recommendations for blood pressure measurement (is at least one in the first, two in the second and three measurements in the third trimester advised).

In the first step of the data analysis, we extracted all the variables related to the four items from the CTP tool. With regard to the recommendations for both initiation of care and blood pressure measurement, respondents were asked to mark the recommended gestational age limit for

a first antenatal visit. For the recommendations for blood pressure measurement, respondents were asked to mark the gestational weeks when a blood pressure measurement should occur in pregnancy. In order to analyse the recommendations for ultrasound screening we included three questions: recommendations for the number and timing of Doppler ultrasound, abdominal ultrasound and transvaginal ultrasound during the course of the pregnancy. In order to count the number and timing of blood samples recommended in pregnancy, the following questions were included in the analysis: atypical red cell antibodies, blood group and haemoglobin screening.

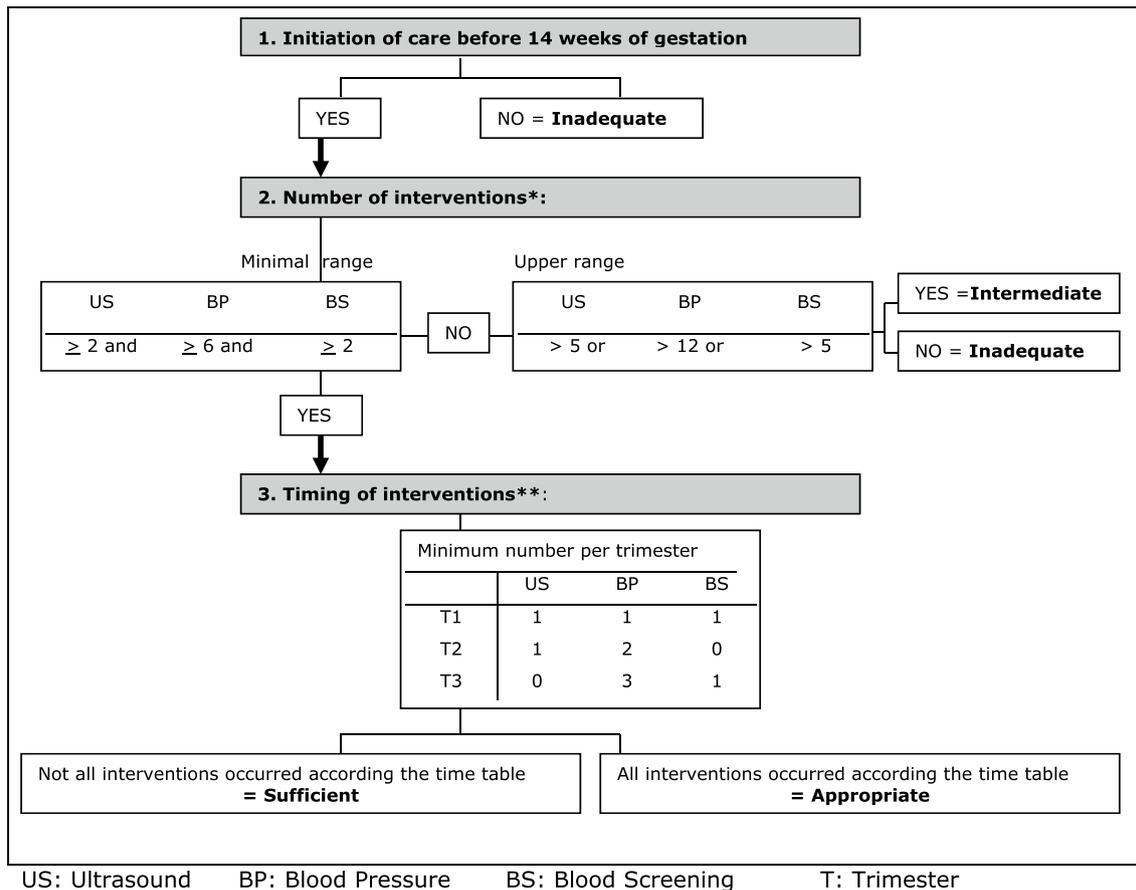
While this first step in the analysis was sufficient to define the country-specific recommendations for initiation of care in pregnancy, a second step was necessary for the analysis of the other variables in order to compare their correspondence with the three other items of the CTP tool (number and timing of blood sample taken, ultrasound and blood pressure measurement). For each pregnancy trimester (trim 1, trim 2 and trim 3) we counted the recommended number of blood pressure measurements, doppler ultrasounds, abdominal ultrasounds, transvaginal ultrasounds, tests for atypical red cell antibodies, determination of the maternal blood group and haemoglobin measures. In accordance with the definitions used to construct the CTP tool, the end of the first trimester is defined at 13 weeks + 6 days of gestation and the third trimester starts at week 27.

In a final step, for each country we examined whether the recommended number of the three interventions (ultrasound, blood sample and blood pressure) per trimester, defined in the second step of the analysis, were similar to the minimum numbers set in the CTP tool. When all four items of the CTP tool were in line with the recommendations in the national guideline, it can be concluded that the tool is applicable in that specific European country. This means that the CTP tool can be used to measure antenatal care uptake and check adherence to the national guidelines. Further, the CTP tool can be used to measure antenatal care use within these countries, enabling (inter)national comparison of health care utilisation, analyses of determinants of uptake of care and evaluation of the impact of antenatal care use on different outcome measures.

Results

Countries with a national guideline for routine care in a normal pregnancy

We received responses from 30 countries; eight have no national guideline for routine antenatal care in low-risk



US: Ultrasound BP: Blood Pressure BS: Blood Screening T: Trimester
 *Ranges: lower value based on the NICE(2008) and Belgian guideline (Lodewyckx, 2004), upper value based on national data(De Gauquier K., 2007 68 /id)
 **based on the NICE(2008)

Fig. 1 Construction of the content and timing of care in pregnancy (CTP) tool; *Inadequate* initiation of care after first trimester OR the number of at least one intervention is less than the lower range and none of the interventions occurred more than the range, *Intermediate* initiation of care in the first trimester, the number of at least one intervention occurred less than the lower range and at least one intervention exceeded the range; *Sufficient* initiation of care in the first trimester, the number of all interventions equals at least the respective lower range but timing of at least one intervention is not as recommended;

Appropriate initiation of care in the first trimester, the number of the interventions equals at least the respective lower range and timing of the actions of all basic interventions is as recommended; *US* Ultrasound, *BP* Blood pressure, *BS* Blood screening, *T* trimester, *US* ultrasound, *BP* blood pressure, *BS* blood screening, *T* trimester *Ranges: lower value based on the NICE (2008) and Belgian guideline (Lodewyckx 2004), upper value based on national data (De Gauquier and Remacle 2007 68 /id) **based on the NICE (2008)

women (Austria, Cyprus, Greece, Ireland, Malta, Slovakia, Slovenia and Sweden). All other EU member states, as well as Norway and Iceland have national guidelines; most of these have been issued or revised in 2010 or later.

Congruence between the items of the CTP tool and the recommendations in the guidelines

All 22 national guidelines recommend a first antenatal visit before week 14. With regard to the recommendations on the number of the three selected interventions in

pregnancy, we found that 20 out of the 22 countries recommend at least two ultrasound scans in routine care for normal pregnancies; 18 out of the 22 countries recommended at least two blood samples throughout a routine pregnancy (focusing on atypical red cell antibodies, blood group or haemoglobin levels). All national guidelines of the countries included in the study recommend at least six measures of blood pressure in routine antenatal care programme (the number ranges from six to at every consultation).

When taking into account the timing of these interventions in the respective trimesters, we found that 20

countries recommended at least one ultrasound in the first trimester and 21 countries recommend a second trimester ultrasound scan (Table 1). All countries recommend at least one blood sample in the first trimester and 18/22 in the third trimester. Eighteen out of the 22 countries recommend at least one blood pressure measurement in the first trimester, 21 countries recommend at least two in the second trimester and all 22 at least three in the third trimester.

Table 1 Overview of the number out of the 22 European national guidelines that have recommendations according to the items of the content and timing of care in pregnancy (CTP) tool (Europe, Norway and Iceland 2014)

	Ultrasound	Blood sample	Blood pressure
Trimester 1	At least one 20	At least one 22	At least one 18
Trimester 2	At least one 22	*	At least two 21
Trimester 3	*	At least one 18	At least three 22

*These are not recommended in the CTP tool

Table 1: Overview of the number out of the 22 national guidelines that have recommendations according to the items of the CTP tool.

Applicability of the CTP tool across Europe

At country level we found that the CTP tool can easily be applied in 14 out of the 22 countries with a national guideline, as recommendations for routine antenatal care are in line with the four items (reflected in eight variables) of the tool presented in Table 2. These countries are Belgium, Bulgaria, Czech Republic, Estonia, France, Germany, Hungary, Iceland, Latvia, Lithuania, the Netherlands, Poland, Romania and the United Kingdom.

The main reasons why CTP is not applicable in eight of the 22 countries is that there is no recommendation for a blood sample to be taken in the third pregnancy trimester ($n=4$) and a first trimester blood pressure measurement ($n=4$) is not recommended. In six out the eight countries, the CTP tool does not fit with the recommendations in the guidelines for routine antenatal care because of incompatibility on one item. For Denmark and Italy, respectively three and two items in the CTP tool are not in line with the national recommendations (see Table 2).

Table 2 Overview of the applicability of the content and timing of care in pregnancy (CTP) tool in the 22 European countries with national guidelines for antenatal care (2014)

	First visit <14 w	Ultrasound		Blood sample		Blood pressure			CTP applicable
		Trim 1	Trim 2	Trim 1	Trim 3	Trim 1	Trim 2	Trim 3	
Belgium	Yes	Yes	Yes	Yes	yes	Yes	Yes	yes	Yes
Bulgaria	Yes	Yes	Yes	Yes	yes	Yes	Yes	yes	Yes
Croatia	Yes	Yes	Yes	Yes	No	Yes	Yes	yes	No
Czech Republic	Yes	Yes	Yes	Yes	yes	Yes	Yes	yes	Yes
Denmark	Yes	Yes	Yes	Yes	No	No	No	yes	No
Estonia	Yes	Yes	Yes	Yes	yes	Yes	Yes	yes	Yes
Finland	Yes	Yes	Yes	Yes	yes	Yes	Yes	yes	Yes
France	Yes	Yes	Yes	Yes	yes	Yes	Yes	yes	Yes
Germany	Yes	Yes	Yes	Yes	yes	Yes	Yes	yes	Yes
Hungary	Yes	Yes	Yes	Yes	yes	Yes	Yes	yes	Yes
Iceland	Yes	Yes	Yes	Yes	yes	Yes	Yes	yes	Yes
Italy	Yes	No	Yes	Yes	yes	No	Yes	yes	No
Latvia	Yes	Yes	Yes	Yes	yes	Yes	Yes	yes	Yes
Lithuania	Yes	Yes	Yes	Yes	yes	No	Yes	yes	No
Luxembourg	Yes	Yes	Yes	Yes	No	Yes	Yes	yes	No
Netherlands	Yes	Yes	Yes	Yes	yes	Yes	Yes	yes	Yes
Norway	Yes	No	Yes	Yes	yes	Yes	Yes	yes	No
Poland	Yes	Yes	Yes	yes	yes	Yes	Yes	yes	Yes
Portugal	Yes	Yes	Yes	yes	yes	No	Yes	yes	No
Romania	Yes	Yes	Yes	yes	yes	Yes	Yes	yes	Yes
Spain	Yes	Yes	Yes	yes	No	Yes	Yes	yes	No
United Kingdom	Yes	Yes	Yes	yes	yes	Yes	Yes	yes	Yes
Total	22	19	22	22	18	18	21	22	14

Discussion

Health in pregnancy and appropriate follow-up influence health in later life, both for the mother and the baby (Braeken et al. 2013; Loomans et al. 2013, 2014; Otte et al. 2015). Measuring adequacy of antenatal care use, especially with a focus on content, is important from a public health perspective. This paper evaluated the degree to which the CTP tool, including elements of content of care can be applied across Europe.

Our results show that in 14 countries out of the 22 (63%) European countries with guidelines, the CTP tool can be used to measure antenatal care use because the elements to construct the tool reflect the national recommendations for antenatal care. In those countries the antenatal care trajectories can be measured and compared using the CTP tool. This information can be used to hypothesise differences in health outcomes for example. Furthermore, determinants of health care utilisation can be analysed and compared between countries. Differences in the organisation of antenatal care between the countries could help to explain the findings and inspire care providers and policy makers to develop strategies for improvement (Catling et al. 2015). When evaluating the CTP items in depth, we found that in four of the guidelines a third trimester blood sample, which is recommended for screening for anaemia, was not advised. The WHO states that iron deficiency is the most common cause of anaemia in pregnancy worldwide (Reveiz et al. 2007). Low and very low levels of haemoglobin are related to worse pregnancy outcomes for mother and baby (National Institute for Health and Clinical Excellence 2008). Severe iron deficiency anaemia can lead to cardiac failure and less tolerance of blood loss associated with birth (Lodewyckx 2004). Therefore screening in the third pregnancy trimester for anaemia is a strong recommendation according to the GRADE tool (Guyatt et al. 2011). Secondly, a first trimester blood pressure measurement was only recommended in 18 out of the 22 countries, while a third trimester blood pressure measurement was advised in all guidelines. This finding is somewhat surprising since measurement of the blood pressure at the first visit can detect chronic hypertension (Australian Health Ministers' Advisory Council. Clinical Practice Guidelines 2015). Furthermore, higher blood pressure at the first booking visit was found to be significantly associated with an increased incidence of pre-eclampsia (Odegard et al. 2000; Sibai et al. 1995; Stamilio et al. 2000). Routine measuring of the blood pressure is crucial for identifying the new onset of hypertension (National Institute for Health and Clinical Excellence 2008; Australian Health Ministers' Advisory Council. Clinical Practice Guidelines 2015; Gyselaers et al. 2015; Lodewyckx 2004) and hypertension in pregnancy is related to morbidity such as preterm labour (Australian

Health Ministers' Advisory Council. Clinical Practice Guidelines 2015; Gyselaers et al. 2015; Lodewyckx 2004).

The CTP tool includes content of care, reflecting service delivery and as such measures the care process. These service processes and the structure of the service delivery characterise the way in which care is organised and are two key components in determining quality of care (Al-Qutob et al. 1996; Donabedian 1997). Donabedian's categorisation of health care indicators is one of the earliest described and most widely applied, emphasising the importance of examining structure, process and outcome (Donabedian 1997). The resources available for service delivery relate to structural indicators according to Donabedian. The activities within a service, and how these are performed, such as rates of interventions and the use of protocols, are examples of process indicators. These process indicators represent the closest approximation to how actual health care is delivered (Donabedian 2003, 1997), and therefore are important when measuring health care utilisation. Inclusion of process indicators in the CTP tool enables the measurement of one component of quality of care. While both outcomes and the measurement of the structure of care are important in the evaluation of quality of care, they were outside the main focus of this paper.

A limitation of the study was that due to language restrictions, the researchers were unable to review all 22 national guidelines themselves, and this could have introduced some misunderstanding. However, we attempted to overcome this by involving obstetricians and midwives who were native speakers, recruited through national professional organisations across Europe to cross-check the interpretation of the guidelines and we argue that this is a robust strategy to gain insight in the content of national guidelines. Moreover, the intra-rater, as well as the inter-rater reliability was found to be sufficiently robust to justify the selection of the instrument (Bernloehr 2007). Contacting representatives of the specific countries to address concrete questions the responses was a quality check up we set up, therefore we argue our analysis can be seen as accurate representation of the national guidelines' content.

In order to evaluate whether the CTP tool is applicable across Europe, we focused on national guidelines. Although audits of national guidelines are often missing or not available in the international literature, it can be argued that national guidelines reflect the care use that is most likely to be standard practice in that country. Secondly, guidelines often describe the minimal care that should be offered strengthening the choice of using them in our examination. Furthermore, data on actual care provision are not often routinely collected and as a result cannot be used for instrument development. So examining national guidelines is a way of assessing what antenatal care is provided, while recognising the limitations of

this—how far provision complies with the guidance—and the degree to which economic costs of antenatal care use affect the uptake of (different) recommendations in the national guidelines. For eight of the 30 countries that participated in the study (28 member states of the European Union plus Norway and Iceland), there are no national guidelines for routine antenatal care. Therefore we are not able to conclude if the CTP tool is applicable in these countries. If however there is evidence that the items in the CTP tool are in line with the current practice, regional or institutional guidelines, the CTP tool can be applied in these countries, regions, institutions as well. We did not examine the reasons for not having a national guideline on routine antenatal care, it might be that those countries use other guidelines such as the NICE guideline and in these cases the CTP is applicable. To conclude we acknowledge that there are more aspects of antenatal care, compared to the content dimension of care delivery, that reflect the quality of the antenatal care. Aspects such as information provision, informed decision making, satisfaction, continuity of care etc. are process indicators that are not included in the CTP tool. Such a comprehensive tool however would ask for a lot of details that are often not routinely registered and collected and therefore would be difficult to implement on a large scale or used for international comparisons. The pregnancy duration at the first visit, the timing of the first and second ultrasound scan, the timing of blood analyses and the dates of blood pressure measurement in pregnancy however are variables available in the pregnant women's medical records and therefore the CTP tool is an easy and practical way to assess practice.

This study shows that the CTP tool is applicable in over 60% of the European countries with a national guideline for routine antenatal care, as the items of the CTP tool are part of the national guidelines. The CTP tool therefore is valuable for measuring and comparing antenatal care delivery. The tool is a first attempt to evaluate the care process, focusing on rates of interventions as the closest approximation to the delivery of health care, with a focus on content of visits rather than simply the number of visits (that was the sole measure in earlier measurement tools). Together with indicators measuring structure and outcome as defined in Donabedian's categorisation of health care (Donabedian 1997), conclusions about the quality of care can be made. Research that includes process, structure and outcome indicators is a challenge for the future. Insights about the relationship between quality of antenatal care and pregnancy outcome of care could be used to inform the organisation of care in practice. Tools such as CTP enable comparisons of antenatal care use over time, between care settings and countries. Since the CTP tool reflects a minimal care package that every women regardless of parity or risk status

should receive, the tool can be used alongside medical records and applied in the whole pregnant population.

Acknowledgements This paper is part of the COST Action IS0907, 'Childbirth Cultures, Concerns and Consequences: Creating a dynamic EU framework for optimal maternity care'. The Action aimed to advance scientific knowledge about ways of providing optimum maternity care provision and outcomes for mothers, babies and families across Europe (see http://www.cost.eu/COST_Actions/isch/Actions/IS0907.) Furthermore we want to thank EURO-PERISTAT, the European Midwives Organisation (EMA) and the European Board and College of Obstetricians and Gynaecologists (EBCOG) for their willingness to participate in our study and spread the questionnaire to their members. Finally, we want to thank the respondents and data validators to take time to fill out the questionnaire.

Compliance with ethical standards

Conflict of interest There are no conflicts of interest to declare.

References

- Alexander GR, Kotelchuck M (2001) Assessing the role and effectiveness of prenatal care: history, challenges, and directions for future research. *Public Health Rep* 116:306–316
- Al-Qutob R, Mawajdeh S, Bin RF (1996) The assessment of reproductive health services: a conceptual framework for prenatal care. *Health Care Women Int* 17:423–434
- American Academy of Pediatrics, the American College of Obstetricians and Gynecologists (2007) Antepartum Care. In: Lockwood CJ, Lemons JA (eds) *Guidelines for Perinatal Care*, 6th edn Washington, pp 83–137
- Australian Health Ministers' Advisory Council. Clinical Practice-Guidelines (2015) Antenatal Care – Module II. Australian Government Department of Health.
- Beeckman K, Louckx F, Masuy-Stroobant G, Downe S, Putman K (2011) The development and application of a new tool to assess the adequacy of the content and timing of antenatal care. *BMC Health Serv Res* 11:213
- Beeckman K, Louckx F, Downe S, Putman K (2013a) The relationship between antenatal care and preterm birth: the importance of content of care. *Eur J Public Health* 23:366–371
- Beeckman K, Louckx F, Putman K (2013b) Content and timing of antenatal care: predisposing, enabling and pregnancy-related determinants of antenatal care trajectories. *Eur J Public Health* 23:67–73
- Bernloehr A (2007) Antenatal care in the European Union: Equal chances for all new citizens of the community. University of Surrey, Guildford
- Bernloehr A, Smith P, Vydellingum V (2005) Antenatal care in the European Union: a survey on guidelines in all 25 member states of the Community. *Eur J Obstet Gynecol Reprod Biol* 122:22–32
- Braeken MA, Kemp A, Outhred T, Otte R, Monsieur G, Jones A, Van den Bergh BR (2013) Pregnant mothers with resolved anxiety disorders and their offspring have reduced heart rate variability: implications for the health of children. *PLoS ONE* 8,12: e83186
- Catling CJ, Medley N, Foureur M, Ryan C, Leap N, Teate A, Homer CS (2015) Group versus conventional antenatal care for women. *Cochrane Database Syst Rev* 2:CD007622
- De Gauquier K, Remacle A (2007) Prenatale zorg in België in 2005, studie van het Intermutualistisch Agentschap, Intermutualistisch

- Agenschap, p 61. <http://www.nic-ima.be/IMG/pdf/prenatale-zorg-in-2005---ima.pdf>
- Donabedian A (1997) The quality of care. How can it be assessed? 1988. *Arch Pathol Lab Med* 121:1145–1150
- Donabedian A (2003) An introduction to quality assurance in health care. Oxford University Press, Oxford
- EURO-PERISTAT project (2008) European Perinatal Health Report. Better statistics for better health for pregnant women and their babies. <http://www.europeristat.com/images/doc/EPHR/european-perinatal-health-report.pdf>
- Guyatt GH, Oxman AD, Sultan S, Glasziou P, Akl EA, Alonso-Coello P, Atkins D, Kunz R, Brozek J, Montori V, Jaeschke R, Rind D, Dahm P, Meerpohl J, Vist G, Berliner E, Norris S, Falck-Ytter Y, Murad MH, Schunemann HJ (2011) GRADE guidelines: 9. Rating up the quality of evidence. *J Clin Epidemiol* 64:1311–1316
- Gyselaers W, Jonckheer P, Ahmadzai N, Ansari MT, Carville S, Dworzynski K, Gaudet J, Jones K, Miller P, Terzclaff JM, Alexander S, Allegaert K, Beeckman K, Ceusens G, Christiane Y, de Ronne N, de Thysebaert B, Dekker N, Denys A, Eeckeleers P, Hernandez A, Mathieu E, Seuntjens L, Verleye L, Stordeur S (2015) What are the recommended clinical assessment and screening tests during pregnancy? Good Clinical Practice (GCP). Belgian Health Care Knowledge Centre (KCE), KCE Reports 248. D/2015/10.273/58, Brussels
- Handler A, Rankin k, Rosenberg D, Sinha K (2012) Extent of documented adherence to recommended prenatal care content: provider site differences and effect on outcomes among low-income women. *Matern Child Health J* 16:393–405
- Kogan MD, Martin JA, Alexander GR, Kotelchuck M, Ventura SJ, Frigoletto FD (1998) The changing pattern of prenatal care utilization in the United States, 1981–1995, using different prenatal care indices. *JAMA* 279:1623–1628
- Korenbrott CC, Wong S, Steward A (2005) Health promotion and psychosocial services and women's assessments of interpersonal prenatal care in Medicaid managed care. *Matern Child Health J* 9:135–149
- Kotelchuck M (1994) An evaluation of the Kessner adequacy of prenatal care index and a proposed adequacy of prenatal care utilization index. *Am J Public Health* 84:1414–1420
- Lodewyckx (2004) Nationale richtlijn prenatale zorg: een basis voor een klinisch pad voor de opvolging van zwangerschappen. KCE reports Vol. 6 A
- Loomans EM, Van dijk E, Vrijkotte T, van Eijnsden M, Stronks K, Gemke R, Van den Bergh BR (2013) Psychosocial stress during pregnancy is related to adverse birth outcomes: results from a large multi-ethnic community-based birth cohort. *Eur J Public Health* 23:485–491
- Loomans EM, Van den Bergh BR, Schelling M, Vrijkotte T, van Eijnsden M (2014) Maternal long-chain polyunsaturated fatty acid status during early pregnancy and children's risk of problem behavior at age 5–6 years. *J Pediatr* 164:762–768
- McDuffie RS Jr, Beck A, Bischoff K, Cross J, Orleans M (1996) Effect of frequency of prenatal care visits on perinatal outcome among low-risk women. A randomized controlled trial. *JAMA* 275:847–851
- National Institute for Health and Clinical Excellence (NICE) (2008). Antenatal care. Routine care for the healthy pregnant woman. <https://www.nice.org.uk/guidance/cg62>
- Ng R, Macdonald E, Loutfy M, Yudin M, Raboud J, Masinde K, Bayoumi A, Tharao W, Brophy J, Glazier R, Antoniou T (2015) Adequacy of prenatal care among women living with human immunodeficiency virus: a population-based study. *BMC Public Health* 15:514
- Nothnagle M, Marchi K, Egerter S, Braveman P (2000) Risk factors for late or no prenatal care following Medicaid expansions in California. *Matern Child Health J* 4:251–259
- Odegard RA, Vatten LJ, Nilsen ST, Salvesen KA, Austgulen R (2000) Risk factors and clinical manifestations of pre-eclampsia. *BJOG* 107:1410–1416
- Otte RA, Donkers F, Braeken M, Van den Bergh B (2015) Multimodal processing of emotional information in 9-month-old infants II: prenatal exposure to maternal anxiety. *Brain Cogn* 95:107–117
- Partridge S, Balayla J, Holcroft C, Abenheim H (2012) Inadequate prenatal care utilization and risks of infant mortality and poor birth outcome: a retrospective analysis of 28,729,765 U.S. deliveries over 8 years. *Am J Perinatol* 29:787–793
- Petrou S, Kupek E, Vause S, Maresh M (2001) Clinical, provider and sociodemographic determinants of the number of antenatal visits in England and Wales. *Soc Sci Med* 52:1123–1134
- Raatikainen K, Heiskanen N, Heinonen S (2007) Under-attending free antenatal care is associated with adverse pregnancy outcomes. *BMC Public Health* 7:268
- Reveiz L, Gyte GML, Uervo LG (2007) Treatments for iron-deficiency anaemia in pregnancy. *Cochrane Database Syst Rev* 2:CD003094
- Ricketts SA, Murray E, Schwalberg R (2005) Reducing low birth-weight by resolving risks: results from Colorado's prenatal plus program. *Am J Public Health* 95:1952–1957
- Sibai BM, Gordon T, Thom E, Caritis SN, Klebanoff M, McNellis D, Paul RH (1995) Risk factors for preeclampsia in healthy nulliparous women: a prospective multicenter study. The National Institute of Child Health and Human Development Network of Maternal-Fetal Medicine Units. *Am J Obstet Gynecol* 172:642–648
- Stamilio DM, Sehdev HM, Morgan MA, Propert K, Macones GA (2000) Can antenatal clinical and biochemical markers predict the development of severe preeclampsia? *Am J Obstet Gynecol* 182:589–594
- Tayebi T, Zahrani S, Mohammadpour R (2013) Relationship between adequacy of prenatal care utilization index and pregnancy outcomes. *Iran J Nurs. Midwifery* 18:360–366
- Taylor CR, Alexander GR, Hepworth JT (2005) Clustering of U.S. women receiving no prenatal care: differences in pregnancy outcomes and implications for targeting interventions. *Matern Child Health J* 9:125–133
- Vanderweele TJ, Iantos J, Siddique J, Lauderdale D (2008) A comparison of four prenatal care indices in birth outcome models: Comparable results for predicting small-for-gestational-age outcome but different results for preterm birth or infant mortality. *J Clin Epidemiol* 62:438–445
- White DE, Fraser-Lee N, Tough S, Newburn-Cook CV (2006) The content of prenatal care and its relationship to preterm birth in Alberta, Canada. *Health Care Women Int* 27:777–792