

# Random Blood Glucose Measurement at Antenatal Booking to Screen for Overt Diabetes in Pregnancy

A retrospective study

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**OBJECTIVE**—To assess random venous blood glucose (RBG) measurement at antenatal booking to detect “overt diabetes in pregnancy” (ODIP).

**RESEARCH DESIGN AND METHODS**—A retrospective analysis of regional hospital obstetric data from 2004–2008 was performed. Universal RBG screening was included at booking. Oral glucose tolerance test (OGTT) was administered if RBG >7.0 mmol/L or other indication, e.g., if a 50-g glucose challenge test was >7.7 mmol/L at 26–28 weeks. ODIP was based upon World Health Organization plasma glucose criteria for diabetes.

**RESULTS**—RBG data were collected from 17,852/26,369 (67.7%) pregnancies around the initial antenatal visit; 3,007 women had an OGTT. The receiver operator curve area under the curve for RBG to detect ODIP was 0.86 (0.80–0.92) (assuming women without an OGTT did not have ODIP).

**CONCLUSIONS**—RBG at booking may provide a sufficiently sensitive screening tool for the detection of ODIP. We recommend further studies and comparison with fasting glucose and HbA<sub>1c</sub>.

Pregnancies among women with hitherto unknown preexisting diabetes have an increased likelihood of adverse outcomes (1–3). The International Association of Diabetes in Pregnancy Study Groups (IADPSG) recommended the term “overt diabetes in pregnancy” (ODIP) be used to describe preexisting diabetes identified during pregnancy (1). The IADPSG suggested HbA<sub>1c</sub> and fasting plasma glucose as screening tests. We have now tested the usefulness of random venous blood glucose (RBG) at booking to detect ODIP.

## RESEARCH DESIGN AND METHODS

A venous plasma RBG measurement at antenatal booking is included in a universal screening program in our hospital (4). Women with a booking RBG >7.0 mmol/L or past history of gestational diabetes (GDM) are offered a 75-g oral glucose tolerance test (OGTT) using either venous or capillary sampling. All women without identified GDM are screened again at 26–28 weeks with a 50-g oral glucose challenge test, with OGTT if the plasma glucose is >7.7

mmol/L. Additional OGTTs are offered where clinically indicated (e.g., macrosomia).

Retrospective demographic, obstetric, glucose, and neonatal data from births in 2004–2008 were obtained from hospital records within an approved service evaluation into the value of RBG screening. Screening RBG were defined as those requested between 0 and 20 weeks' gestation to reflect current practice. If more than one RBG was identified, the highest value was recorded. OGTTs performed at any time during gestation were included. A diagnosis of ODIP by OGTT was defined based upon current World Health Organization plasma glucose criteria for diabetes (fasting  $\geq 7.0$  mmol/L and/or 2 h  $\geq 11.1$  mmol/L), grouping venous and capillary data. Women with known preexisting diabetes recorded were excluded.

Samples were collected using standard fluoride-containing tubes and analyzed in the hospital laboratory using a hexokinase-glucose-6-phosphate dehydrogenase method (Dimension RXL MAX Clinical Chemistry System; provided by Siemens Healthcare Diagnostics).

Receiver operator curves (ROCs) of sensitivity plotted against 1-specificity were constructed. The area under the curve (AUC) of each ROC was calculated with 95% CIs to assess the diagnostic ability of the RBG to predict ODIP. Optimum RBG cutoff points were evaluated using R software (R Foundation for Statistical Computing, Vienna, Austria). All other analyses used SPSS (PASW for Windows, rel. 18.0.3, 2010; SPSS Inc., Chicago, IL).

**RESULTS**—Records were obtained for 26,369 live births. No maternal data could be matched in 506 cases. There were 17,852 screening RBG data, 18.6% of whom had RBG >7.0 mmol/L. Twelve women without OGTT had RBG  $\geq 11.1$  mmol/L; 3,007 women had an antenatal OGTT at some point during the pregnancy. The clinical characteristics of women with and without all data are shown in Supplementary Table 1.

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The first ROC (Fig. 1) included all 17,852 RBG data and assumed that women without a positive OGTT did not have ODIP; 67 women had ODIP. The AUC was 0.86 (0.80–0.92) with a negative predictive value (NPV) of 0.999 and a positive predictive value (PPV) of 0.020. The best RBG cutoff was 7.31–7.40 mmol/L (corresponding to a sensitivity of 0.78 and specificity of 0.85).

To estimate the maximum diagnostic value of the RBG, a second ROC (not shown) was constructed assuming that those with no/incomplete OGTT and an RBG <11.1 mmol/L did not have ODIP, but that the 12 women with no OGTT but RBG  $\geq$ 11.1 mmol/L had ODIP. The AUC was 0.88 (0.83–0.93), NPV was 0.999, PPV was 0.028, and the best RBG cutoff was 7.51–7.59 mmol/L (sensitivity 0.80; specificity 0.88). Although this uses a test (RBG) to predict itself, in clinical practice, RBG can be so high that no OGTT is performed. However, among the 87 women with RBG  $\geq$ 11.1 mmol/L and an OGTT, only 30% had ODIP. To estimate the minimum diagnostic value of the RBG, a third ROC (not shown) was constructed among only those with both RBG and OGTT; 67 had ODIP. AUC was 0.72 (0.64–0.79), NPV was 0.988, PPV was 0.052, and the best RBG cutoff points were 8.60–8.70 mmol/L (sensitivity 0.60; specificity 0.75).

**CONCLUSIONS**—RBG sampling is convenient in high volume antenatal clinics and appears to be a useful test at booking to detect ODIP. Early studies suggested that RBG screening at 28–32 weeks was efficient for detecting GDM (5). However, OGTTs were not performed among women with RBG below their thresholds, thereby enhancing test utility. (In contrast, our study included many women with booking RBG  $\leq$ 7.0 mmol/L who had an OGTT later in pregnancy.) Subsequent studies suggested that third-trimester RBG had limited predictive power to detect GDM (6,7). However, our study aimed to identify ODIP rather than GDM comparable to RBG and HbA<sub>1c</sub> being poor at detecting impaired glucose tolerance but much better at identifying those with OGTT-defined diabetes in the nonpregnant state (8).

Our retrospective data collection has limitations. We assumed that OGTTs were performed according to the standard hospital protocol, including confirmation of fasting and ideal sample handling/timing (9). Standard preservatives might not inhibit glycolysis completely (10). Some OGTT used capillary plasma (e.g., for ease of collection), and capillary results are slightly higher than venous glucose (11). The lack of homogeneity in blood sample handling is a limitation but may also reflect routine clinical practice.

The assumption that a woman without a positive OGTT did not have ODIP probably resulted in the exclusion of a few women. To assess the impact of significant hyperglycemia warranting immediate treatment, the second ROC assumed that all women with RBG  $\geq$ 11.1 mmol/L had ODIP; the AUC effect was negligible. Bias may exist in the ROC as some women with booking RBG  $\leq$ 7.0 mmol/L did not have an OGTT; this may overestimate the NPV of the ODIP testing strategy.

We cannot account for the low proportion of women with RBG  $\geq$ 11.1 mmol/L and diabetes by OGTT, unless it reflects the nonfasting state and limitations in the reproducibility of RBG/OGTT. This supports the necessity for clearly defined criteria for ODIP diagnosis.

RBG at antenatal booking may provide a sensitive screening tool for the detection of ODIP. Although the RBG cutoff >7.0 mmol/L was reasonable, we do not feel our retrospective observational data are adequate to recommend changing the RBG action limit to proceed to OGTT. We recommend further studies and comparison with fasting glucose and HbA<sub>1c</sub>.

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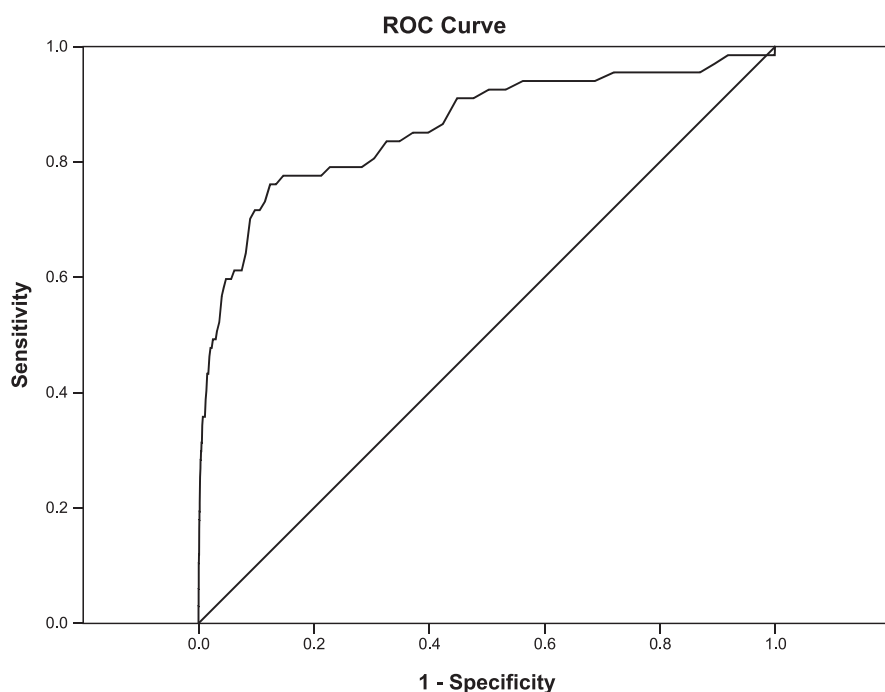
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D.C. contributed to study design and methods, collected and collated data, and wrote the manuscript. D.H. contributed to methodology and reviewed and contributed to the manuscript. C.M. collated data and wrote the manuscript. R.A.P. contributed to methods, collated data, performed statistical analyses, and interpreted data. H.R.M. reviewed and advised on significant modifications to the manuscript. D.S. conceived the study design and contributed to methodology, made significant contribution to data analysis, and wrote the manuscript.

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**Figure 1**—ROC using random glucose to screen for ODIP assuming that those without an OGTT did not have diabetes.

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