Clinical Research

Referral to Cardiology Following Postpartum Cardiovascular Risk Screening at the Maternal Health Clinic in Kingston, Ontario

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See editorial by Dayan and Nerenberg, pages 701−704 of this issue.

ABSTRACT

Background: Cardiovascular disease (CVD) is the leading cause of death globally among women, and certain pregnancy complications can be the earliest indicators of increased CVD risk. Nonetheless, there is no recommendation for follow-up of cardiovascular risk factors identified through postpartum screening programs. This study describes current referral practices and clinical course from the Maternal Health Clinic in Kingston, Ontario, for women deemed at high cardiovascular risk postpartum.

Methods: We investigated the cohort of women referred from the postpartum Maternal Health Clinic to cardiology for further assessment and management, specifically examining timing and recommended interventions to reduce CVD risk.

Results: Women referred to cardiology differed significantly from those not referred in history of hypertensive disorders of pregnancy ($P < 0.05$) and demonstrated a significantly worse CVD risk profile at 6 months postpartum ($P < 0.0001$). Life expectancy by the cardiometabolic model for women referred was 5 years shorter

RÉSUMÉ

Contexte : La maladie cardiovasculaire (MCV) est la première cause de décès dans le monde chez les femmes, et certaines complications de la grossesse peuvent être les indicateurs les plus précoces d'un risque accru de cette affection. Malgré cela, il n'existe aucune recommandation de suivi des facteurs de risque cardiovasculaire décelés dans le cadre de programmes de dépistage post-partum. Cette étude décrit les pratiques en matière d'orientation et l'évolution clinique des patientes de la Postpartum Maternal Health Clinic de Kingston (Ontario) considérées comme présentant un risque cardiovasculaire élevé après l'accouchement.

Méthodologie : Nous avons étudié la cohorte de femmes orientées vers un service de cardiologie par la Postpartum Maternal Health Clinic à des fins d'évaluation et de prise en charge, en nous arrêtant plus particulièrement au moment de cette orientation et aux interventions recommandées pour réduire le risque de MCV.

Résultats : Les femmes orientées vers un service de cardiologie présentaient des différences significatives avec celles qui ne l'avaient

Cardiovascular disease (CVD) is the leading cause of death globally[1] and is responsible for the greatest proportion of premature death among Canadian women.[2] Although the disease is largely preventable with lifestyle modification and pharmacotherapy,[3] CVD-related mortality is increasing for women below 55 years.[4] Approximately 1 in 12 Canadians above age 20 live with CVD,[5] the number one cause of hospitalization in Canada.[6] Thus, there is a need for innovative ways for earlier

detection and treatment of underlying CVD risk factors to improve health outcomes for women.

Pregnancy is considered a cardiovascular stress test.[7-9] Certain pregnancy complications, including hypertensive disorders of pregnancy (HDP), gestational diabetes, and preterm delivery, identify an increased risk for the subsequent development of CVD in women.[4,7,10-18] One of the highest-risk populations for premature CVD is comprised of women with a history of HDP, who have been shown to have reduced life expectancy and earlier onset of CVD compared with women with normotensive pregnancies.[15,19-22] Women with gestational hypertension are twice as likely to develop CVD within just the first 14 years postpartum.[23] Some studies have proposed that endothelial dysfunction mediates the development of these pregnancy disorders.[24] Although the mechanism remains unclear, it appears as though the development of

($P < 0.0001$). Only half of the women referred to cardiology scheduled a visit; the median time to the scheduled appointment was 12 months. Of women seen by cardiology, 60% were deemed eligible for cardiac rehabilitation.

Conclusions: Although women at highest risk for CVD are being identified and referred to cardiology, the existing system is not designed for this demographic. Too many women are missing their appointments or being seen beyond 1 year postpartum. To initiate lifestyle changes and/or therapeutic interventions, we suggest that CVD prevention programming begins within 1 year of delivery. Future studies should investigate the viability of traditional cardiac rehabilitation programs among this unique population.

pas été sur le plan des antécédents de troubles hypertensifs de la grossesse ($p < 0,05$) et affichaient un profil de risque de MCV significativement plus élevé 6 mois après leur accouchement ($p < 0,0001$). L'expérience de vie des femmes orientées vers un service de cardiologie, calculée par le modèle cardiométabolique, était inférieure de 5 ans ($p < 0,0001$) à celle des autres femmes. La moitié seulement des femmes orientées vers un service de cardiologie ont pris un rendez-vous; le délai moyen avant le rendez-vous pris était de 12 mois. Parmi les femmes vues en cardiologie, 60 % ont été jugées comme répondant aux critères pour suivre un programme de réadaptation cardiaque.

Conclusions : Même si les femmes présentant un risque plus élevé de MCV sont repérées et orientées vers un service de cardiologie, le système existant n'est pas adapté à cette catégorie de la population. Les femmes sont trop nombreuses à ne pas se présenter à leur rendez-vous ou à être vues plus d'un an après leur accouchement. Pour permettre d'amorcer des changements aux habitudes de vie ou des interventions thérapeutiques, nous recommandons que les programmes de prévention des MCV commencent dans l'année suivant l'accouchement. Les recherches futures devraient porter sur la viabilité des programmes classiques de réadaptation cardiaque dans cette catégorie de la population aux besoins particuliers.

these conditions is in itself a risk factor for CVD, serving as potentially the earliest clinical indicator of increased risk.[25] HDP are now recognized as independent, sex-specific CVD risk factors.[4,19]

Pregnancy-related CVD risk factors present not only earlier in life than classic CVD risk factors,[11] but also at a time when a woman is likely interacting with the health care system on a regular basis.[10] In Kingston, Ontario, nearly all pregnant women have access to pre- and postnatal care; even for patients without provincial insurance, options exist. During pregnancy and up to 1 year postpartum, women have regular contact with medical providers, whether for their own care or that of their infants. Pregnancy and the postpartum period, therefore, serve as an ideal starting point for primary prevention of premature cardiovascular morbidity and mortality among women.[7,22]

Although the risk of CVD after pregnancy complications has been recognized for years, the most effective long-term prevention strategy in this young, female population with low imminent CVD risk remains to be determined.[26,27] There is also a need for improved CVD risk screening algorithms, beyond pregnancy outcome alone, to identify high-risk women at the time of delivery.[28] As of 2011, the American Heart Association's Guidelines for Prevention of Cardiovascular Disease in Women recommended referral to a primary care physician or cardiologist for risk factor monitoring after an HDP.[4] Women at high risk for CVD with a recent cardiovascular event, procedure, or congestive heart failure should be referred to cardiac rehabilitation.[4] The 2016 Canadian Cardiovascular Society Guidelines for the Management of Dyslipidemia for the Prevention of Cardiovascular Disease in the Adult included for the first time pregnancy complications in the determination of CVD risk in women.[19] The guidelines proposed lipid screening for all women with a history of HDP. Initiation of lipid pharmacotherapy should be guided by either Modified Framingham Risk Score[29] or Cardiometabolic Age,[30] though the former may be unreliable in young women.

The Maternal Health Clinic (MHC) at Kingston Health Sciences Centre (KHSC) began in November 2011, becoming the first care centre in North America to introduce a structured, postpartum initiative to identify and promote modification of CVD risk. All patients who deliver at KHSC and have been diagnosed with specific pregnancy complications are routinely referred at the time of delivery for a 6-month MHC follow-up, where they undergo CVD risk screening based on historical, physical, and biochemical risk factors.[7] After the 6-month visit, women found to be at high risk for CVD are referred to the Maternal Cardiovascular Risk Reduction Clinic (MCRRC) for further assessment and longer-term follow-up, as indicated. This study aims to describe current MHC referral practices and the clinical course of women referred for cardiovascular follow-up, in the interest of determining areas for improvement in this early primary prevention initiative.

Materials and Methods

Populations

The MHC includes all patients who deliver at KHSC, live within 1 hour of the hospital, and have been diagnosed with specific pregnancy complications (HDP, gestational diabetes, placental abruption, idiopathic preterm delivery, and intrauterine growth restriction). Women are routinely referred at the time of delivery for a 6-month clinic follow-up, where they undergo CVD risk screening based on history, physical, and biochemical risk factors. An overview of MHC procedures and measurements has been previously published.[7]

Clinical judgement primarily informed referral to the MCRRC. For example, women with high CVD risk scores and dyslipidemia or elevated high-sensitivity C-reactive protein (CRP) were sent for further cardiac assessment. However, women with increased CVD risk scores primarily due to current smoking status were not referred to the MCRRC, as

Gladstone et al.
Postpartum Cardiology Referral and Assessment

763

the reduction of CVD risk could be achieved with smoking cessation outside of the specialist setting. Similarly, referral to cardiac rehabilitation was at the discretion of the MCRRC physician. Indications for cardiac rehabilitation included prior myocardial infarction, prior coronary artery disease, angina, or congestive heart failure, prior cardiac surgery, prior percutaneous coronary intervention, or greater than 2 cardiac risk factors. Contraindications included inability to exercise or comply with instructions. This analysis includes all women who have attended the MHC from its inception in November 2011 until December 2016.

Data collection

Clinical data collected at delivery, at the time of the MHC visit (6 months postpartum), at the MCRRC, and at the Cardiac Rehabilitation Centre visits were used in this analysis. Weight, blood pressure, and heart rate were measured at the MCRRC and the Cardiac Rehabilitation Centre. Updated blood work (lipid profile, high-sensitivity CRP, fasting glucose, creatinine) was not routinely ordered before the MCRRC visit, though occasionally it was requested at the physician's discretion after the appointment. At the cardiac rehabilitation intake and discharge visits, the following measurements were taken: weight, waist circumference, blood pressure, lipid panel, high-sensitivity CRP, fasting glucose, exercise metabolic equivalents. Data on barriers to participation were not systematically collected from women who declined cardiac rehabilitation; rationale was determined from MCRRC notes.

Data from the MHC visit were applied to the 30-Year (lipids or body mass index [BMI])[31] and Lifetime Risk scores,[32] as well as the cardiometabolic model of life expectancy.[30] Family history data for cardiometabolic life expectancy modelling were gathered from patient records. If age of diagnosis or event in a relative was reported nonspecifically, a conservative estimate of age was recorded. For example, if a participant mentioned that a parent suffered a myocardial infarction in "his 50s," age 59 was used. If a positive family history was reported without degree of relation, it was assumed that the relative was not first degree. These assumptions and estimates were made so as not to falsely overestimate risk.

Statistical analyses

Categorical variables are presented as count and percentage. The χ^2 test was used to compare categorical variables between groups, whereas Fisher's exact test was used when cell counts were less than 5. Continuous variables are presented as a median and interquartile range (IQR) and were compared using the Mann-Whitney U test. The Friedman test of 1-way analysis of variance for repeated measures was used to analyse change in BMI and blood pressure over time from delivery to the MCRRC, among women who attended their cardiology appointment. Three pairwise comparisons were completed, comparing each of the 3 time points with each other. Dunn's multiple comparisons test was used to control for family-wise error rate ($P < 0.0167$ [0.05/3] used to determine significance for each of the pairwise comparisons). The Kaplan-Meier method was used to generate the time from delivery to scheduled appointment curves and to calculate the median time to appointment. A cancelled appointment was considered a censored observation. Those who failed to book an appointment were excluded from the analysis.

Statistical analyses were performed using SPSS [version 24] and GraphPad Prism 7. Statistical significance was defined as a P value < 0.05. Queen's University and affiliated teaching hospitals Health Sciences Research Ethics Board approved this study before its initiation (OBGY-204-10).

Results

Between November 2011 and December 2016, 557 women attended the MHC. Of these women, 97 (17.4%) were referred to the MCRRC at KHSC, for further evaluation of CVD risk. The yearly referral rate to cardiology ranged from 10% to 30% of all women seen at the MHC. The clinical structure and care pathway are outlined in Figure 1.

As shown in Table 1, women referred to the MCRRC did not differ significantly from those not referred in terms of age, parity, household income, education, smoking status, or prevalence of diabetes. A significantly greater proportion of the referred cohort had a history of both pre-existing hypertension ($P < 0.005$) and hypertensive disorders of pregnancy (gestational hypertension, $P < 0.01$; pre-eclampsia, eclampsia, and HELLP (hemolysis, elevated liver enzymes, and low platelet count) syndrome, $P < 0.05$). The incidence of intrauterine growth restriction was significantly lower among the referred cohort ($P < 0.05$). There were no stillbirths in either cohort during the study period.

The referred cohort demonstrated significantly poorer physical and biochemical markers of health at the MHC visit compared with those not referred (Table 2). Women referred had significantly higher blood pressure, BMI, waist circumference, total cholesterol, low-density lipoprotein cholesterol (LDL-C), and non–high-density lipoprotein than those not referred ($P < 0.0001$ for all). Not only was the incidence of metabolic syndrome significantly higher in the referred cohort ($P < 0.0001$), but both the 30-Year and Lifetime Risks of CVD were also significantly elevated among women referred ($P < 0.0001$ for both). By the cardiometabolic model, the median life expectancy was 5 years shorter among women referred ($P < 0.0001$), with median predicted onset of CVD nearly 8 years earlier ($P < 0.0001$).

Figure 2 depicts the timing of the MHC and MCRRC visits relative to the date of delivery. The median time from delivery to the MHC visit was 6.1 months (IQR, 5.7-6.7 months), and from delivery to the MCRRC visit, 12.0 months (IQR, 9.5-15.5 months). The median time from the MHC visit to the scheduled MCRRC visit was 5.4 months (IQR, 3.3-8.3 months).

Of the 97 women referred, 48 (49.5%) completed the MCRRC visit, 9 (9.3%) either cancelled or did not attend their scheduled appointment, and 40 (41.2%) failed to schedule an appointment. There was no significant difference in age, socioeconomic status, number of living children, BMI, smoking status, prevalence of chronic hypertension, metabolic syndrome or diabetes, or 30-Year and Lifetime Risk of CVD between the women who attended the cardiology appointment and those who did not (data not shown).

Orders placed after the MCRRC visit are documented in Figure 3. Of the 48 women seen by cardiology, 29 (60.4%) were prescribed some form of further follow-up visit, some through the cardiology rehabilitation centre (n = 19). The orders placed included blood work, medication change,
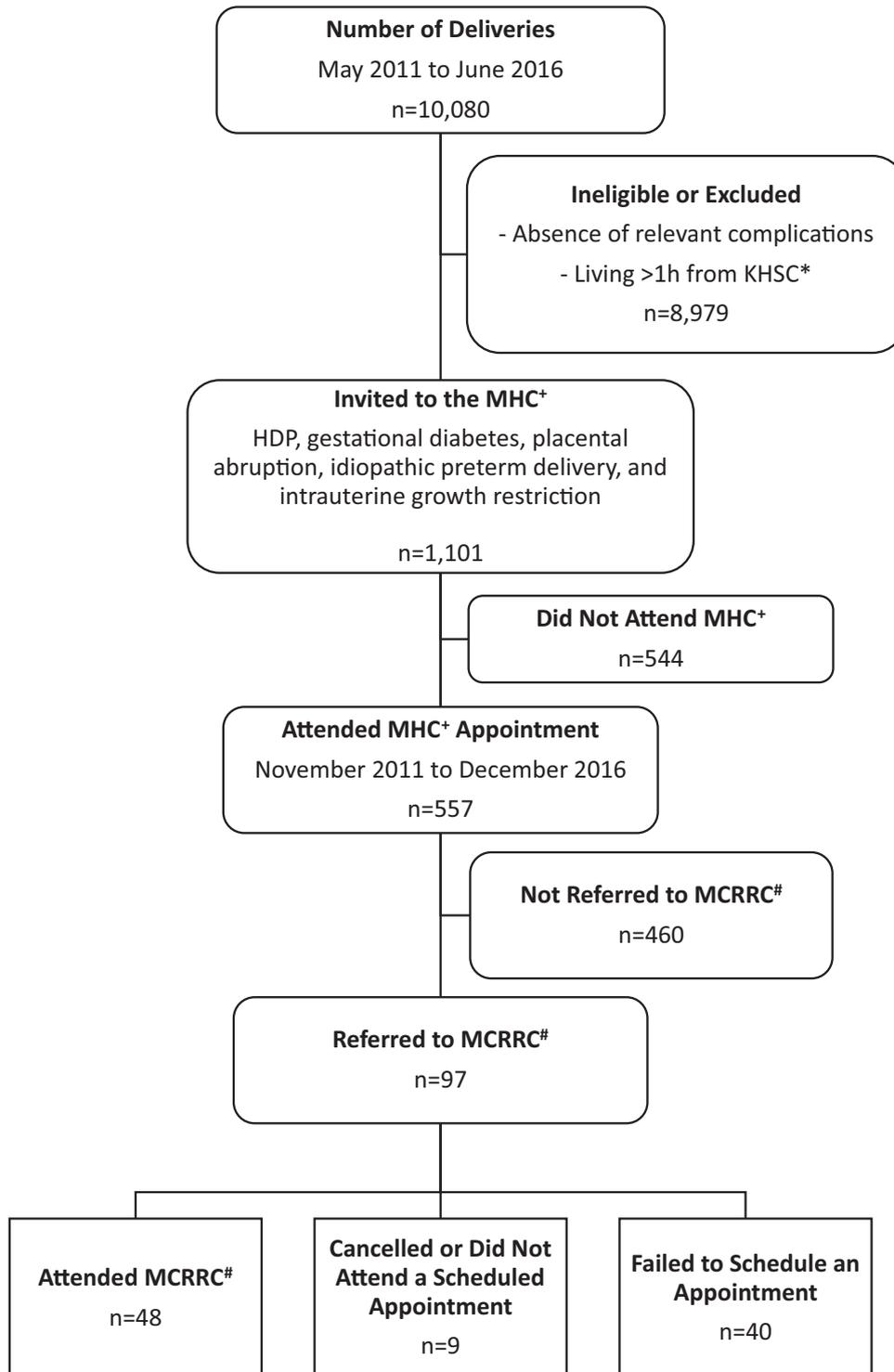
Figure 1. Flow diagram of eligible participants. *Kingston Health Sciences Centre; [+]Maternal Health Clinic; [#]Maternal Cardiovascular Risk Reduction Clinic.

dietician referral, cardiac investigations, and cardiac rehabilitation referral. Of note, 28 (58.3%) women seen at the MCRRC were deemed eligible for cardiac rehabilitation for prevention of CVD.

Figure 4 shows changes in BMI and blood pressure for the 43 women seen by cardiology who had complete data for all time points (delivery, MHC, and MCRRC). Compared with at delivery, BMI and systolic blood pressure at the MHC and MCRRC were significantly reduced ($P < 0.05$). No significant change was seen between the MHC and the MCRRC. Diastolic blood pressure at the MCRRC visit was significantly lower than at delivery ($P < 0.05$) and at the MHC visit ($P < 0.05$).

Gladstone et al.
Postpartum Cardiology Referral and Assessment

765

Table 1. Characteristics of women referred to cardiology for further follow-up after the MHC visit, compared with those not referred

	Referred (n = 97)	Not referred (n = 460)	P value
Age (y), median (IQR)	32 (27-36)	32 (28-35)	NS
Parity, n (%)			
1	52 (53.6%)	282 (62.3%)	NS
2	26 (26.8%)	106 (23.4%)	
≥ 3	19 (19.6%)	65 (14.3%)	
Household income, n (%)			
≤ $29,000	12 (12.6%)	39 (9.1%)	NS
$30,000-$59,000	22 (23.2%)	97 (22.5%)	
$60,000-$89,000	24 (25.3%)	124 (28.8%)	
≥ $90,000	37 (38.9%)	171 (39.7%)	
Unknown or declined, n	2	27	
Education, n (%)			
Grade or high school	19 (20.0%)	51 (11.1%)	NS
Postsecondary not completed	4 (4.2%)	30 (6.6%)	
Postsecondary completed	72 (75.8%)	376 (82.3%)	
Unknown or declined, n	2	3	
Smoking, n (%)	17 (17.5%)	49 (10.7%)	NS
Pre-existing hypertension, n (%)	10 (10.3%)	14 (3.0%)	< 0.005
Type I or II diabetes, n (%)	2 (2.1%)	3 (0.7%)	NS
Pregnancy complication history, n (%)			
Gestational diabetes	27 (27.8%)	138 (29.9%)	NS
Gestational hypertension	33 (34.0%)	97 (21.0%)	< 0.01
Intrauterine growth restriction	4 (4.1%)	54 (11.7%)	< 0.05
Pre-eclampsia, eclampsia, HELLP syndrome	42 (43.3%)	146 (31.7%)	< 0.05
Placental abruption	4 (4.1%)	21 (4.6%)	NS
Preterm birth	9 (9.3%)	78 (16.9%)	NS

HELLP, hemolysis, elevated liver enzymes, and low platelet count; IQR, interquartile range; MHC, Maternal Health Clinic; NS, not significant.

However, no significant change was seen between delivery and MHC.

Of the 28 women eligible for cardiac rehabilitation after the MCRRC visit, 19 were ultimately referred to the program. Those who declined referral cited distance and professional or personal obligations among the barriers to participation. Only 5 of the women referred to cardiac rehabilitation attended the admission visit. Those who attended at least the admission visit did not differ significantly from those who did not (n = 14) in the following variables: age at delivery, BMI, blood pressure, total cholesterol, LDL-C, socioeconomic status, number of living children, relationship status, smoking status, incidence of metabolic syndrome, or Lifetime Risk of CVD (data not shown). Only 2 women completed the cardiac rehabilitation program.

Discussion

At present, referral practices from the MHC are guided by clinical judgement in the context of 30-Year and Lifetime Risk

Table 2. Physical and biochemical measures and cardiovascular disease risk assessments from the Maternal Health Clinic of women referred to cardiology for further follow-up, compared with those not referred

	Referred (n = 97)	Not referred (n = 460)	P value
Physical and biochemical measures			
SBP (mm Hg), median (IQR)	127 (118-134)	115 (109-122)*	< 0.0001
DBP (mm Hg), median (IQR)	86 (80-95)	79 (73-85)*	< 0.0001
BMI (kg/m²), median (IQR)	34.14 (28.9-39.1)	27.51 (24.0-33.0)[†]	< 0.0001
Waist circumference (cm), median (IQR)	104.2 (92.4-119.9)	90.7 (81.8-103.5)[‡]	< 0.0001
Total cholesterol (mmol/L), median (IQR)	5.1 (4.4-5.9)[†]	4.49 (4.0-5.0)[§]	< 0.0001
LDL-C (mmol/L), median (IQR)	3.105 (2.5-3.6)[‡]	2.59 (2.1-3.0)[§]	< 0.0001
Non-HDL (mmol/L), median (IQR)	3.87 (3.2-4.52)[‖]	2.99 (2.5-3.5)[§]	< 0.0001
Risk assessments			
Metabolic syndrome, n (%)	59 (60.8%)	23 (5.0%)	< 0.0001
30-Year Risk score, median (IQR)	10.8 (7.5-17.0)[†]	6.5 (5.0-10.0)[¶]	< 0.0001
Lifetime Risk score, n (%)			
All optimal	2 (2.1%)[‖]	91 (27.7%)**	< 0.0001
≥1 Not optimal	12 (12.6%)	120 (36.6%)	
≥1 Elevated	62 (65.3%)	112 (34.1%)	
≥1 Major	19 (20.0%)	5 (1.6%)	
Life expectancy (y), median (IQR)	79.2 (75.6-81.9)[††]	84.2 (81.9-85.7)[‡‡]	< 0.0001
CVD free life expectancy (y), median (IQR)	65.8 (61.3-68.6)[††]	73.2 (69.3-76.7)[‡‡]	< 0.0001

BMI, body mass index; CVD, cardiovascular disease; DBP, diastolic blood pressure; HDL, high-density lipoprotein IQR, interquartile range; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure.

*3 missing; [†]1 missing; [‡]5 missing; [§]125 missing; [‖]2 missing; [¶]136 missing; **132 missing; [††]4 missing; [‡‡]141 missing.
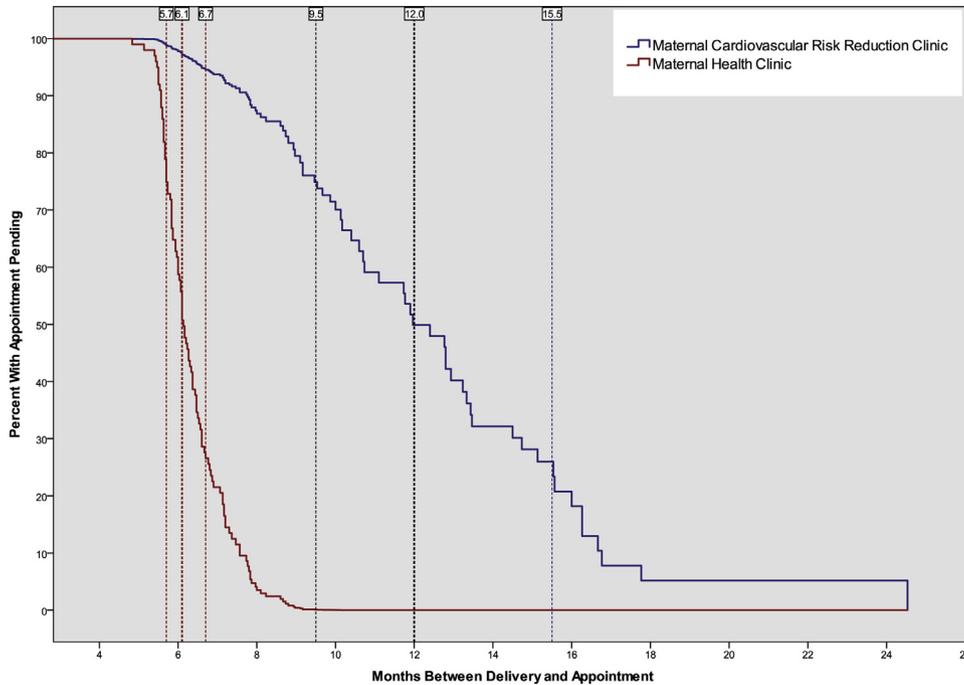
Figure 2. Date of delivery to Maternal Health Clinic and Maternal Cardiovascular Risk Reduction Clinic (delivery to Maternal Health Clinic, n = 97; delivery to Maternal Cardiovascular Risk Reduction Clinic, n = 57).

of CVD, lipid profile, and other CVD risk factors. Our data suggest that, in the absence of formal guidelines on whom to refer for tailored primary prevention, current MHC referral practices are selecting women at significantly higher risk for CVD who would benefit most from targeted prevention efforts. However, the system is not tailored to suit the needs of postpartum women; too many women were lost to follow-up, either between their MHC visit and cardiology consult or in subsequent recommended appointments.

The cohort of women referred to the MCRRC is inherently biased due to the clinical judgement used in the referral process. For example, it does not include women referred to their family physicians for risk factor monitoring. For some women, this was the optimal strategy because of strong, pre-existing relationships with their primary care providers. Furthermore, there were women who did not qualify for cardiology referral, but who were sent for other interventions, such as dietician consult, and were, thus, excluded from our analysis. The sample size is a major limitation of this study, due in large part to its observational nature and associated loss to follow-up over time. Similarly, some findings, such as the decreased prevalence of intrauterine growth restriction (IUGR) in the referred cohort, cannot be adequately explained with our data. A full investigation would likely involve an analysis of weight gain in pregnancy, smoking status, prepregnancy weight, incidence of early-onset pre-eclampsia, and other maternal risk factors for IUGR; this study is not designed for this purpose. Lastly, timing of cardiology follow-up was contingent on availability in an otherwise busy clinic; thus, days from delivery to MCRRC visit and, by extension, timing of biophysical measurements varied significantly within our cohort. Nonetheless, this study presents comprehensive longitudinal data from one of the first

CVD prevention initiatives in North America for postpartum women. The findings described herein can inspire and inform future work in this emerging field of great importance.

Ideally, there would be an opportunity to engage in risk reduction interventions within 1 year of delivery, during maternity leave. The current MHC practices result in only 50% of referred women being seen by cardiology; half of them within the 1-year window, and half after 1 year postpartum. The remaining 50% of referred women were lost to follow-up.
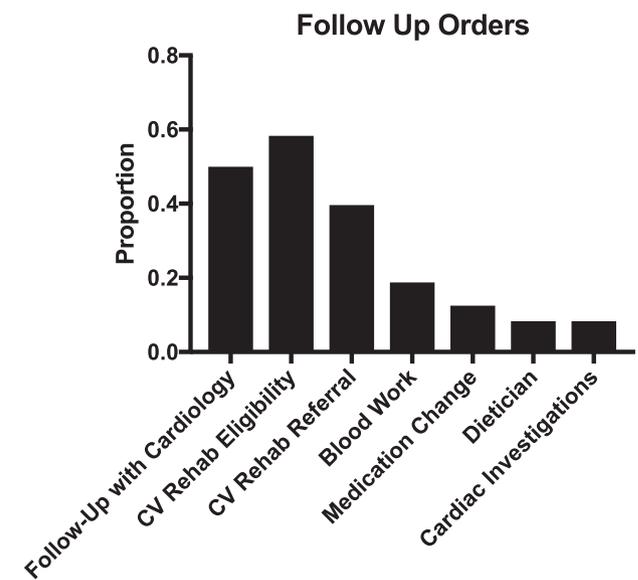

Figure 3. Orders after the Maternal Cardiovascular Risk Reduction Clinic visit (n = 48 visits). CV, cardiovascular.

Gladstone et al.
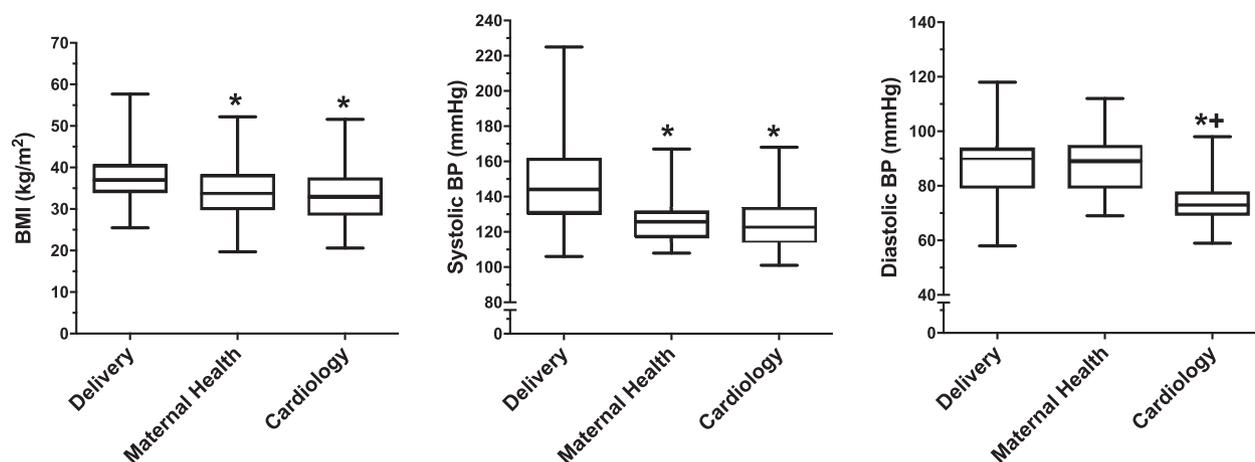Postpartum Cardiology Referral and Assessment

767

Figure 4. Changes in body mass index (BMI), systolic blood pressure (BP), and diastolic (BP) from admission for delivery, to Maternal Health Clinic appointment, to Maternal Cardiovascular Risk Reduction Clinic appointment for participants with complete data for all time points (n = 43). The Friedman test of 1-way analysis of variance for repeated measures used for analysis. Three pairwise comparisons were completed, with Dunn's multiple comparisons test used to control for family-wise error rate ($P < 0.0167$ [0.05/3] used to determine significance for each of the pairwise comparisons). $*P < 0.0167$ Maternal Health Clinic or Maternal Cardiovascular Risk Reduction Clinic values significantly lower than delivery values. $+P < 0.0167$ Maternal Cardiovascular Risk Reduction Clinic values significantly lower than Maternal Health Clinic values.

This appointment timing makes sense in the context of the MCRRC; these women are at low imminent risk of cardiovascular events, compared with the majority of patients being referred for cardiac assessment. Nonetheless, we propose that earlier, targeted primary prevention would be beneficial for 2 reasons: (1) women would have the opportunity to institute lifestyle changes before the added burden of work resumes, and (2) future pregnancy complications could potentially be avoided.[33] Women identified as being at high risk of future CVD and whose risk profiles fail to improve after 6 to 12 months of lifestyle changes may benefit from further follow-up and intervention, such as statin therapy for persistently elevated LDL-C.

Although the majority of women seen in the MCRRC were eligible for and could have benefited from cardiac rehabilitation, that so few actually attended suggests that the current prevention efforts are not appropriate in this population. Cardiac rehabilitation efforts traditionally target patients after myocardial infarction or cardiovascular surgery. Although information on barriers to participation was not routinely recorded in patient charts, it is possible that issues unique to the new mother, such as a postpartum mood disorder, the adjustment of new motherhood, or lack of access to childcare may contribute to decreased motivation and ability to attend traditional cardiac rehabilitation. Furthermore, women of any age are 50% less likely than men to participate in cardiac rehabilitation.[2] Future studies should systematically collect data on such limitations to participation to better understand the unique needs of this cohort of at-risk women. Gaps in the literature include issues of race and socioeconomic status on CVD risk and risk reduction outcomes.

Generally speaking, cardiac rehabilitation is proven effective at reducing CVD-related mortality and improving weight, blood pressure, and other CVD risk factors;[2,34-39] however, with just 2 women from our cohort completing the program, we cannot comment on the effectiveness of the intervention in this distinct population. As shown in Figure 4, there was a significant downward trend in BMI and blood pressure from delivery to the MCRRC visit, but, without a sufficient control, it cannot be determined whether primary prevention efforts were the cause. It is conceivable, nonetheless, that referral for specialist management instills enough motivation among high-risk women to at least initiate important lifestyle changes, even in the absence of formalized cardiac rehabilitation.

Future research should evaluate the potential of alternative, community-based CVD prevention initiatives previously employed among older adults.[40] Some such programs, including the Stanford Three Community[41] and Five Cities[42] studies and the North Karelia project in Finland,[43] proved highly effective at modifying CVD risk profiles and improving outcomes. The Three Community study used mass media: television, radio, newspapers, to deliver health education to men and women in rural Northern California; the 3-year campaign resulted in healthier diets and improved cholesterol profiles.[41] The subsequent Five Cities study used a similar approach and demonstrated decreased total mortality and coronary heart disease risk scores among participants in the cost-effective initiative.[42] The North Karelia study in Finland concluded that this same mass media education strategy could be effective in a separate population.[43] Other risk reduction approaches with proven benefit include partnerships with existing community resources, such as the Young Men's Christian Association and its diabetes prevention program.[40]

The postpartum population requires special consideration in CVD prevention strategies, due to the unique constraints of returning to work after maternity leave, childcare burden, and repeat pregnancies. The introduction of cardiac rehabilitation-inspired risk reduction programs designed for postpartum women with young children may improve attendance and health outcomes. The Postpartum Preeclampsia Clinic in Edmonton, Alberta, for example, offers a multidisciplinary approach to CVD prevention among postpartum women.[44] The care team comprises a dietician, a nurse practitioner, a

pharmacist, and an obstetric medicine specialist. At the initial visit, women view an educational video on future heart health and meet with each team member, devising individualized action plans centred on CVD risk factors. This approach resulted in significant improvement in physical activity among participants and could present an alternative to traditional cardiac rehabilitation programming.[44] Long-term risk factor monitoring and CVD prevention efforts could certainly be spearheaded by primary care physicians or nurse practitioners, rather than by obstetricians, in the future. A recent meta-analysis of eHealth technologies in weight management during and after pregnancy found a significant reduction in weight among postpartum women;[45] this strategy could complement in-person programming and may prove uniquely effective in new mothers with the above-mentioned barriers to implementing lifestyle changes. A prescription physiotherapy-based exercise intervention is currently being piloted from the MHC as an alternative to cardiac rehabilitation referral.

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Disclosures

The authors declare that they have no relevant conflicts of interest to disclose.

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Gladstone et al.
Postpartum Cardiology Referral and Assessment

769

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