



An observational study of the impact of an antenatal asthma management service on asthma control during pregnancy



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ABSTRACT

Objective: We sought to investigate the impact of introducing an antenatal asthma management service (AMS) on asthma control during pregnancy and subsequent perinatal outcomes.

Study design: Prospective, observational cohort study of pregnant asthmatic women attending a tertiary hospital antenatal clinic. Asthmatic women were recruited from the antenatal clinic and were followed prospectively with visits at 12, 20, 28 and 36 weeks gestation. A new nurse-led AMS was introduced offering asthma self-management education and support. Outcomes were compared between women recruited before and after the AMS was introduced ($n = 89$ and 80 , respectively) and included; prevalence of exacerbations during pregnancy, asthma control throughout pregnancy and perinatal outcomes, including preterm birth and small-for-gestational-age (SGA).

Results: The relative risk for exacerbations (0.69; CI: 0.33–1.42), loss of control (0.67; CI 0.46–0.99) and persistent uncontrolled asthma (0.48; CI 0.26–0.9) were all reduced with attendance to AMS during pregnancy. AMS was associated with non-statistically significant reductions in asthma exacerbations (19.1–15.0%; $p = 0.480$) and uncontrolled asthma at ≥ 2 study visits (21.3–11.3%; $p = 0.078$).

Conclusions: These findings demonstrate the potential impact of an AMS in improving asthma control during pregnancy, supporting the need for an adequately powered RCT to determine its clinical- and cost-effectiveness.

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Introduction

Pregnancy is recognised as a major challenge in the management of asthma as it can alter the course of asthma severity and its treatment, which in turn can affect pregnancy outcomes. Maternal asthma is associated with numerous adverse perinatal outcomes, including increased risk of low birth weight (RR 1.46; 95%CI 1.22, 1.75), small-for-gestational age (RR 1.22; 1.14, 1.31), preterm birth (RR 1.41; 1.22, 1.61) [1] and neonatal hospitalisations (RR 1.50; 1.03, 2.20) [2]. Existing guidelines recommend managing asthma during pregnancy in the same manner as a non-pregnant adult, including management of asthma medications. Despite guidelines and awareness of the substantial adverse effects associated with asthma during pregnancy, little has been done to improve its

management and reduce associated perinatal morbidity and mortality. While a small number of women with very severe asthma receive monitoring during pregnancy in the antenatal clinic with respiratory specialist support, treatment is often limited to women self-managing their asthma with support from their GP. Current asthma management appears to be focused on a reactive, not proactive, approach. This is demonstrated by only 15% of asthmatic pregnant women involved in our previous prospective study having an asthma action plan [3]. The evidence is that current care of asthmatic pregnant women could be significantly improved and there is an immediate need for evidence based approaches for improving clinical practice [4].

In non-pregnant adults, Cochrane reviews have identified that the provision of asthma self-management education compared to usual care reduces asthma exacerbations [5] and that nurse-led asthma care is as effective as physician-led care and likely more cost-effective [5]. Whether these interventions translate to the antenatal setting remains undetermined [4]. Recent trials in pregnant asthmatic women indicate use of exhaled fraction of nitric oxide (FeNO), as a measure of inflammation, to adjust asthma

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management during pregnancy, was associated with a significant reduction in the prevalence of women experiencing an exacerbation [2] and supports the concept that active management can significantly improve maternal asthma. However the generalizability of FeNO based management of asthma to all clinical settings may be limited [2] and raises the question of whether nurse-led asthma management in the antenatal setting could be a more generalisable option. We have piloted the introduction of an antenatal nurse-led asthma management service within a socially disadvantaged population. We aimed to determine whether antenatal asthma management and education within this setting could improve asthma control during pregnancy, reduce the number of exacerbations and improve perinatal outcome.

Methods

Approval for the study was provided by the The Queen Elizabeth Hospital, Lyell McEwin Hospital, and Modbury Hospital Human Research Ethics Committee and The University of Adelaide Human Research Ethics Committee. All women gave written informed consent.

Prospective asthma study and standard-care

Pregnant women with a doctor diagnosis of asthma ($n = 169$) were recruited through the Lyell McEwin Hospital antenatal clinics (South Australia, Australia) between May 2009 and May 2012 to take part in a non-interventional prospective cohort study evaluating the impact of maternal asthma on perinatal outcomes. Women were assessed by a midwife, with additional respiratory training, at 12, 20, 28, and 36 weeks gestation. The midwife utilised a standardised data collection tool to collect demographic data including maternal weight, height, previous obstetric history, medical history. Maternal smoking was assessed by maternal self-report, with women classified according to smoking status during the first antenatal visit. Socioeconomic status for each woman was determined using her residential postcode at the time of delivery. Women were then ranked according to their level of advantage, or relative disadvantage, based on data from the Socio-Economic Indexes for Areas, calculated from the Australian Bureau of Statistics' 5-yearly Census of Population and Housing. These indexes are widely used measures of relative socioeconomic status.[6] In addition to demographic variables, data were collected to determine current asthma therapy and control, current asthma triggers, co-morbidities and past history including frequency of oral corticosteroid use and hospital admissions for asthma. Asthma control was assessed using the Asthma Control Questionnaire (ACQ). The ACQ is a 7-item validated questionnaire which covers asthma symptoms and lung function, with scores >1.5 indicative of uncontrolled asthma [7]. Forced expiratory volume at 1 s (FEV1) and forced vital capacity (FVC) was measured by an Easy One spirometer before and after administration of salbutamol. FEV1% predicted was calculated based on the patient's age, ethnicity and height using the equations of Gore et al. [8]. Data was prospectively collected on asthma medications (dose, frequency and duration across trimesters). The same midwife saw women for each of their respective visits. Patients assessed as unstable and requiring medical review were referred to their primary care physician or to a respiratory physician.

Nurse-led antenatal asthma management service

Half-way during this prospective study in, January 2011, a new nurse-led antenatal asthma management service was introduced, with asthmatic women offered two visits with a respiratory nurse,

alongside their routine study visits with the midwife. The Antenatal Asthma Management Service was led by a respiratory nurse with qualifications in asthma self-management education and spirometry. Asthma self-management education was provided over a series of 30–60 min visits using a standardised 'managing asthma in pregnancy resource manual' to ensure a systematic approach to delivering care. This manual was developed based on previous experience in managing maternal asthma and has been adapted from evidence-based guidelines and adult-based recommendations for asthma self-management education. Key aspects of asthma self-management education are presented in Table 1. Additional counselling was provided on the importance of smoking cessation in relation to their asthma and the health of their baby with direct referrals made to QuitSA for additional cessation support. Women in this group received an individualised written asthma action plan, developed according to evidence based principles by the asthma educator using a standardised template following National Asthma Council recommendations [10]. In addition, current asthma management therapies were evaluated and recommendations regarding optimal therapy were made, with close collaboration with the women's primary healthcare practitioner. At each visit, recommendations for step-up therapy were made in women with uncontrolled asthma ($ACQ > 1.5$), where appropriate, in accordance with well-established clinical guidelines and previous studies [3]. Detailed asthma management reports were written by the respiratory nurse and provided to the chosen GP and/or respiratory specialist for collaborative management. This encompassed the review and approval of the written asthma action plan and any required changes to medication management. Between visits, women were encouraged to follow their asthma action plan closely and see their GP if their asthma worsened.

Outcomes were compared between 89 women who received standard care only and 80 women who took part in the antenatal asthma management service.

Maternal asthma and perinatal outcomes

Details of the exacerbations were obtained from the study visit notes and confirmed by consulting the medical record if necessary. An exacerbation event was defined as moderate/severe if it required a hospital admission, emergency department presentation, an unscheduled doctor visit, or a course of oral steroids due to asthma. An exacerbation was defined as mild (loss of control) if it required increased medication use or was characterized by increased symptoms or decreased peak flow, which was managed by the subject and did not require medical intervention. Additional asthma outcomes included persistent uncontrolled asthma, defined as an ACQ score greater than 1.5 during two or more study visits, and commencement of new inhaled corticosteroid (ICS) during pregnancy. Data was prospectively collected at each study visit across both groups. Data on perinatal outcomes were collected at delivery from the medical records, including infant sex, gestational age, birthweight, birth length, head circumference, method of delivery, and Apgar scores. Gestational age was

Table 1
Asthma self-management education content.

Impact of pregnancy on asthma control
Impact of asthma on pregnancy and pregnancy outcomes
Medication use (including safety in pregnancy; medication adherence; inhaler technique)
Recognition of asthma deterioration/symptoms
Provision and use of AAP
Trigger identification and avoidance
Smoking cessation

determined by date of the last menstrual period and confirmed by ultrasound at 18 weeks. Preterm birth was defined as <37 weeks gestation, while small for gestational age (SGA) was defined according to birthweight <10th percentile for gestational age).

Statistical analysis

Differences between study groups were evaluated using independent *t*-tests for parametric continuous variables, Mann–Whitney *U* test for non-parametric variables, and Chi-Square test for categorical variables. The relative risk of asthma and perinatal binary outcomes was evaluated using a generalised linear model, generating relative risks and 95% confidence intervals. Analyses were undertaken adjusting for potential confounders, including maternal age, maternal BMI, smoking status (never/former, quit in pregnancy/current), socioeconomic status (level 1 or ≥2), asthma status (yes/no), parity (parity 0 or parity ≥1) and ethnicity (Caucasian/other). All reported *P* values were two-tailed, and a *P* value of <0.05 was considered to be statistically significant. All statistical procedures were carried out using SPSS version 19 (SPSS Inc., Chicago, IL, USA).

Results

Pregnant asthmatic women enrolled in the study who received standard care (*n* = 89) or attended the asthma management service (*n* = 80) were not significantly different in relation to age, BMI, SES, smoking status, or parity (Table 2).

At study entry the baseline asthma characteristics of the women were also not significantly different (Table 2) in relation to ACQ score, exacerbations prior to study entry, lung function and ICS use.

Women who attended the asthma management service were significantly less likely to have a loss of control during pregnancy and less likely to have persistent uncontrolled asthma throughout gestation relative to the women who attended standard antenatal care (Table 3). Interestingly there was no significant reduction in moderate/severe exacerbations between the two groups (Table 3).

Access to the asthma management service during pregnancy was protective against a loss of control, moderate/severe exacerbations or persistent uncontrolled asthma during pregnancy as demonstrated by the relative risk (Table 4).

There were no significant differences in perinatal outcomes between the groups though there were non-significant reductions in preterm births and elective and emergency Caesarean sections with the antenatal asthma management service (Table 3). Asthmatic women receiving standard care relative to women receiving asthma management had an overall relative risk of delivering preterm of 1.50 (CI: 0.57–3.94) and for SGA 1.54 (CI: 0.64–3.72).

Discussion

This pilot study of the effectiveness of a nurse-led antenatal asthma management service provides data that suggests this type of basic intervention for pregnant women would be beneficial in improving asthma outcomes that include the prevention of a loss of control of asthma and prevention of persistent uncontrolled asthma during gestation. When examining relative risks it appears the asthma management service also reduced the risk of a moderate/severe exacerbation during pregnancy. The study was not powered to examine perinatal outcomes however it does show a difference between standard care and the asthma management service in relation to the relative risk of preterm delivery and SGA

Table 2

Maternal demographics and asthma history.

	Standard-care (<i>N</i> = 89)	Antenatal asthma management service (<i>N</i> = 80)	<i>p</i> -Value
Demographics			
Maternal age, mean (SD)	26.29 (6.0)	26.00 (5.0)	0.732
BMI (kg/m ²), mean (SD)	28.72 (7.0)	28.09 (6.8)	0.559
Ethnicity			0.339
Caucasian	84 (94)	74 (93)	0.339
Other	5 (6)	6 (7)	
Socioeconomic status			0.183
1 (lowest)	50 (56.2)	38 (47.5)	
2	28 (31.5)	31 (38.8)	
3	0 (0.0)	4 (5.0)	
4	5 (5.6)	3 (3.8)	
5 (highest)	6 (6.7)	4 (5.0)	
Parity			0.569
0	34 (38.2)	34 (42.5)	
≥1	55 (61.8)	46 (57.5)	
Smoking status			0.312
Non-smoker	44 (49.4)	41 (51.2)	
Former smoker	17 (19.1)	15 (18.8)	
Quit during pregnancy	8 (9.0)	13 (16.2)	
Current smoker	20 (22.5)	11 (13.8)	
Asthma history			
Baseline ACQ6 Score, mean (SD)	0.91 (0.87)	0.75 (0.69)	0.186
Baseline Asthma Control (ACQ6 > 1.5)			0.131
ACQ ≤ 1.5	57 (79.2)	54 (87.1)	
ACQ > 1.5	15 (20.8)	8 (12.9)	
Moderate/severe exacerbation prior to first visit			0.683
No	82 (92.1)	75 (93.8)	
Yes	7 (7.9)	5 (6.2)	
Spirometry			0.020
FEV1 (L)	2.87 (0.42)	3.10 (0.39)	0.020
FEV1Perc/predicted	0.91 (0.12)	0.94 (0.10)	0.280
FVC (L)	3.61 (0.52)	3.75 (0.49)	0.233
FEV1/FVC Ratio	0.80 (0.07)	0.83 (0.05)	0.031
Baseline ICS Use			0.718
No	60 (67.4)	56 (70.0)	
Yes	29 (32.6)	24 (30.0)	
Baseline ICS dose category			0.088
Low	5 (41.7)	4 (28.6)	
Medium	5 (41.7)	2 (14.3)	
High	2 (16.7)	8 (57.1)	

Abbreviations: SD, standard deviation; BMI, body mass index; ACQ, asthma control questionnaire.

indicating women in standard care are more at risk of these outcomes. Based on the current evidence, an asthma management service situated within an antenatal clinic is an effective clinical approach for caring for pregnant women with asthma to reduce the risk of uncontrolled asthma during pregnancy.

We have previously demonstrated the effectiveness of nurse-led self-management education in improving skills and knowledge about asthma during pregnancy [3]. This service was built on successful adult programmes incorporating education, self-monitoring, regular review with optimisation of pharmacotherapy and a written plan for the management of unstable asthma [3]. Through this work we identified that the majority of women have poor asthma self-management skills and knowledge, regardless of the severity of their disease [3]. Additional evidence in support of asthma self-management education is provided through a recent small-scale (*n* = 60) RCT that compared to usual care, the provision of asthma self-management education was associated with a significant reduction in Asthma Control Questionnaire (ACQ)

Table 3

Impact of antenatal asthma management service intervention on asthma and perinatal outcomes.

	Standard-Care (N = 89)	Antenatal Asthma Management Service (N = 80)	p-value
Asthma related outcomes			
Moderate/severe exacerbation, n (%)			0.242
No	72 (80.9)	70 (87.5)	
Yes	17 (19.1)	10 (12.5)	
Loss of control, n (%)			0.020
No	48 (53.9)	57 (71.2)	
Yes	41 (46.1)	23 (28.7)	
Persistent uncontrolled asthma (ACQ6 > 1.5 on ≥2 study visit), n (%)			0.016
No	66 (74.2)	71 (88.8)	
Yes	23 (25.8)	9 (11.2)	
Commenced ICS in pregnancy			0.507
No	50 (56.2)	42 (52.5)	
Yes	10 (11.2)	14 (17.5)	
Already on ICS	29 (32.6)	24 (30.0)	
Perinatal outcomes			
Gestational age (days), mean (SD)	274 (14)	274 (13)	0.913
Birthweight centile, mean (SD)	48.3 (32.4)	50.8 (28.2)	0.603
Infant sex, n (%)			0.814
Male	44 (49.4)	41 (51.2)	
Female	45 (50.6)	39 (48.8)	
Birth weight (g), mean (SD)	3367 (635)	3420 (568)	0.573
Delivery method, n (%)			0.786
Vaginal	59 (66.3)	57 (71.2)	
Elective LSCS	13 (14.6)	10 (12.5)	
Emergency LSCS	17 (19.1)	13 (16.2)	
Birth length (cm), mean (SD)	49.8 (2.5)	49.9 (2.6)	0.878
Head circumference (cm), mean (SD)	34.6 (1.7)	34.7 (1.7)	0.514
Preterm birth			0.408
No	79 (88.8)	74 (92.5)	
Yes	10 (11.2)	6 (7.5)	
Small for gestational age			0.331
No	77 (86.5)	73 (91.2)	
Yes	12 (13.5)	7 (8.8)	
Apgar score			
1 min	8 (1.5)	8 (1.6)	0.505
5 min	9 (0.9)	9 (1.0)	0.757

Abbreviations: ACQ, asthma control questionnaire; SD, standard deviation; IQR, inter quartile range.

scores between the two groups (−0.60; −0.85, −0.36) at follow-up [9]. Uncertainty remains, however, whether a reduction in ACQ scores at a single time-point reflects asthma control throughout pregnancy. We have continued to improve and pilot the provision of an antenatal asthma management service with the current study, demonstrating that nurse-led care can be effective in improving asthma control and reducing the risk of asthma exacerbations during pregnancy. These promising findings need to be validated through a randomised controlled trial.

Exacerbations are a key feature of asthma and our previous research demonstrated that 55% of asthmatic women had at least one exacerbation during pregnancy and is associated with poor perinatal outcomes [10]. Meta-analyses of the impact of exacerbation and oral corticosteroid use during pregnancy on perinatal outcomes indicate an increased risk of preterm delivery and SGA outcomes [11]. Limited information reports 5.8% of pregnant, asthmatic women are hospitalized for a severe exacerbation [12],

Table 4

Relative risk of asthma exacerbations and persistent uncontrolled asthma form women in the antenatal asthma management service group compared to standard care.

	RR	95% CI	aRR	95% CI
Moderate/severe exacerbation	0.65	0.32–1.35	0.69	0.33–1.42
Loss of control	0.62	0.41–0.94	0.67	0.46–0.99
Persistent uncontrolled asthma (ACQ6 > 1.5 on ≥2 study visit)	0.44	0.21–0.89	0.48	0.26–0.90

Abbreviations: RR, relative risk; ACQ, asthma control questionnaire Adjusted for maternal age, smoking status, parity, BMI, and baseline ICS use.

and 20% have a severe exacerbation during pregnancy requiring medical intervention. Exacerbations increased with increasing asthma severity, with 52% of severe asthmatics having an exacerbation [6]. Risk factors associated with asthma exacerbations during pregnancy include respiratory viral infections and a lack of appropriate treatment with inhaled corticosteroids [10]. This suggests that the combination of asthma and pregnancy may significantly increase the risk of infection and result in acute asthma exacerbations during pregnancy. Given the seriousness of an exacerbation for the mother and fetus, the prevention of these acute events are an important focus of asthma management. Our study indicated the risk of exacerbation was reduced by 25% with the asthma management service.

A major co-morbidity of pregnant women with asthma is cigarette use. Women with asthma who smoke are more likely to have severe exacerbations during pregnancy than women who are asthmatic and do not smoke [13]. The combination of asthma and cigarette use significantly increased the incidence of preterm birth with the risk increasing as the number of cigarettes consumed also increased [14]. Furthermore smoking can reduce the effectiveness of inhaled glucocorticoid treatment [15] which could further impact on maternal and neonatal wellbeing. Smoking was a major confounder in the current study affecting 22% of women in standard care and 14% of women in the asthma management service. The asthma management nurses were trained to provide adequate support and counselling to quit smoking for pregnant asthmatic women in the current study and there was an increase in the numbers of women who quit smoking in the intervention arm of the study which is a positive outcome that could be examined in future studies.

Studies of women with well controlled asthma, which involves the regular use of inhaled glucocorticoids to inhibit inflammatory mechanisms at a systemic level, seldom demonstrate adverse effects on fetal outcome [12,16]. However regular use of oral glucocorticoids for the treatment of asthma during pregnancy has been known to be associated with an increased incidence of low birthweight babies and preterm births [17]. We previously reported that inhaled glucocorticoids for the treatment of asthma did not affect fetal growth and that maternal asthma without treatment had the greatest impact on the fetus and placenta [18]. We have subsequently shown that acute asthma exacerbations affect fetal morbidity and mortality [10,19]. Our current data shows poor asthma control can be significantly reduced with antenatal asthma management. Furthermore we have identified asthma management may potentially reduce preterm deliveries and this is an important benefit of this model of care that should be examined further with an appropriately powered study.

The nurse-led care model developed for the management of asthma is similar to a continuity of care model of midwifery that has been successful in improving perinatal outcomes [20]. Furthermore this approach may be advantageous in a socially

disadvantaged population of women who often need trusting relationships in their health care to improve health behaviours [21]. More than 80% of the women in this study were from a socially disadvantaged population who have reduced levels of health literacy and are economically restricted in their access to medications and health care. Studies of this particular population report a high incidence of social stress and mental illness in pregnant women [22]. The use of a continuity of care model for asthma education and management may be effective in this population given each visit can be tailored to the woman's level of education and health literacy. A recent Cochrane review of midwifery-led continuity of care models identified that women who randomized to continuity of care were more likely to deliver vaginally, less likely to deliver preterm and less likely to miscarry before 24 weeks gestation [20]. We have observed similar outcomes with the pilot data from this project suggesting this model of care may be suited to this particular population of disadvantaged women.

Despite some deficiencies in study design, the analysis indicated that the introduction of an antenatal asthma service can significantly improve asthma control during pregnancy and may lead to resultant improvements in maternal and neonatal outcomes. While the lack of a concurrent randomized control group represents a clear limitation, there are obvious challenges associated with blinding women towards an intervention that involves additional asthma education and support, suggesting that randomization alone may not be sufficient for overcoming potential sources of bias. Further, we took the lack of randomization into account in adjusting the primary outcomes for important maternal characteristics that may have potential to bias the results, with these adjustments only resulting in a slight attenuation of the treatment effect seen. An additional limitation was that this study was not powered to detect any differences with respect to perinatal outcomes, with further appropriately powered RCT's is required in order to confirm these findings and to examine the cost effectiveness of this approach to health care [23].

Asthma management approaches that are portable and transferable across healthcare settings are essential to improve asthma management during pregnancy. Women receive antenatal care in numerous settings that include hospitals, family doctor clinics, midwifery clinics and rural antenatal services all of which have varying degrees of resources and time. Most women have varying levels of health literacy and education and would benefit from a continuity of care model which appears to be effective in the antenatal setting. The antenatal asthma management service is a service that is generalizable to any setting and would be more effective than current standard care. Asthma management during pregnancy does not need to be limited to a respiratory nurse but could also become an area of specialisation in midwifery. The current study provides evidence that this type of antenatal asthma management service has some clinical benefit for mother and baby and should be considered as basic care in any antenatal setting.

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Authors' contribution

VLC, LG, BS conceived the idea, analysed the data and wrote the paper. GD, BS and AR supervised the clinical aspects of the study, interpreted the analysis and wrote the paper.

Conflict of interests

None to declare.

Ethical approval

The study was approved 6 May 2009 by The Queen Elizabeth and Lyell McEwin Hospitals Human Research Ethics Committee under the title of "Effect of asthma during pregnancy on maternal health, placental function, fetal growth and childhood development." HREC ID 2009045.

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