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References: 1.UNDESA, World Family Planning 2022. 2. Lammers P, op ten Berg M. AOGS 1991;70:497–500. 3. Foidart, JM et al. The European Journal of Contraception and Reproductive Health Care 2000;5:124-34. 4. Anttila L, et al. Clin Drug Investig 2011;31(8):519-25. 5. Anttila L, et al. Contraception 2009;80:445-51. 6. Bilotta P, Favilli S. Arzneimittelforschung 1988;38(7):932-934. 7. Endrikat J, et al. Contraception 1999;60(5):269-274. doi:10.1016/s0010-7824(99)00097-9. 8. Gan J, et al. J Ethnopharmacol 2024;318(Pt B):116975. doi:10.1016/j.jep.2023.116975.

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2. Redwine DB, Perez JJ. Pelvic pain syndrome: endometriosis and mid-line dysmenorrhea. In: Arregui MW, Fitzgibbons RJ, Katkhouda N, McKerman JB, Reich H, editors. Principles of Laparoscopic Surgery – Basic and Advanced Techniques. *New York: Springer Verlag*; 1995: 545-58.

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3. Varney H. Nurse Midwifery. *Boston: Blackwell Scientific Publications*; 1987: 23-32.

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Editorial
New curriculum of Hong Kong College of Obstetricians and Gynaecologists

Much progress has been made since the publication of an editorial[1] calling for adaptation of more competency-based medical education (CBME) and an all-round approach in our training and evaluation, based on the curriculum of the Royal College of Obstetricians and Gynaecologists. In January 2023, the Hong Kong College of Obstetricians and Gynaecologists Education Committee convened a taskforce to review our current curriculum and formulate proposals to address this trend. Members of the committee included a young fellow from each training unit, a representative from the Online Education Subcommittee, and an educator familiar with CBME. The proposals were endorsed by the College Council and then the Education Committee of the Hong Kong Academy of Medicine in mid-2024.

To address the growing demand from the general public on skill and knowledge as well as non-technical attributes, the new curriculum sets out 14 Capabilities in Practice, which are high-level statements of the characteristics that a trainee should attain to be a specialist. Modules are refined to allow gradual demonstration of progress at three time points: before the SOE (Structured Oral Examination), upon entry into higher training, and before the Exit Assessment. Trainees are required to acquire the corresponding competencies (observation, direct supervision, and independent practice) by the designated time points with confirmation by their trainers. For some important but rare conditions that may not be encountered during the training period, the option of 'other methodologies' is introduced to allow trainees to provide evidence of training by participation in training courses, drills, or attachments.

Workplace-based assessment (WBA) has a significant role in the evaluation of trainees' daily work performance. OSATS (Objective Structured Assessment of Technical Skills) is designed for formal provision of constructive feedback by both higher trainees and specialist trainers. Higher trainees are particularly encouraged to participate and serve in training towards education of juniors. This is conducted regularly before two summative OSATSs by two different specialist trainers to certify competency. Trainees are introduced the concept of classifying clinical procedures into 'core skills' and 'for exposure' in which certain procedures are considered essential skills regardless of their special interest or future development plans.

Other WBA tools are also introduced, including the mini-CEX (mini-clinical evaluation exercise), CbD (case-based discussion), NOTSS (non-technical skills for surgeons), TO (team observation) form, and SO (self-observation) form. The mini-CEX is a half-yearly assessment of history-taking, clinical examination, formulation of management plans, patient communication, and professional and interpersonal skills. The CbD is a half-yearly assessment of higher trainees by specialist trainers on clinical decision-making, knowledge, and application. The NOTSS are related to situation awareness, decision making, communication, teamwork, and leadership in the labour ward and gynaecological surgery settings; evaluation of trainees is conducted by specialist trainers once every 2 years in both basic and higher training. The TO form is used by various colleagues (seniors, juniors, and nursing) to evaluate trainees on different non-technical skills. Similarly, the SO form is used for self-reflection. Both forms should be completed at three specified time points during the training.

As a result of the inclusion of these WBA tools, the required number of case summaries is reduced to 10 (five in obstetrics and five in gynaecology). It should be emphasised that writing case summaries is an exercise to train the analytical and critical review skills required for case management, literature review, and exploring ways to improve and reduce future complications. This should not be simply a topic review. Trainees may be required to revise the case summaries to fulfil the requirement before they are allowed to sit for the Exit Assessment.

The number of logged procedures is also adjusted to reflect the changes in patient demographics and surgical management trends. The numbers of cases of operative vaginal delivery, evacuation of uterus / termination of pregnancy, hysteroscopy, and colposcopy are reduced, while requirement of laparoscopic procedures is increased to level III rather than level II. The log of the experience

of cases encountered is extended to include basic training periods to reflect progression.

Mandatory courses are extended to reflect the increased breadth of our specialty, including genetics and genomics, and ultrasonography, on top of the current required courses. Flexible training with part-time work and extension of training duration can be considered in a case-by-case manner.

To equip our future trainers with the mindset and skill of CBME, higher trainees need to attend courses regularly held by the College. These courses have been well received by the specialists attended. Although it is not mandatory for current specialists to undergo formal training to become trainers (unlike other colleges), they are highly encouraged to keep abreast of the latest development in medical education by active participation in the courses.

The Information Technology Committee has embarked on the task of refining our e-logbook to accommodate the necessary changes. It is anticipated that trainees who enter training in and after July 2025 will follow the new curriculum and the new e-logbook. During the transition period, existing trainees can opt to follow some specified measures introduced in the new curriculum with a declaration form to complete before the Exit Assessment.

I must take this opportunity to acknowledge the effort of the task force members who not only collect ideas from training units and relay our discussion for better preparation of the updated curriculum, but also review the new curriculum of the Royal College of Obstetricians and Gynaecologists and determine statements that can be used or modified to suit local needs. We must also appreciate the comments and support received from experienced fellows, trainees, and members of the Education Committee so that the update process could proceed smoothly. The College is ours and trainees are our future. We are confident that the new curriculum will achieve sustainability and all-round training for the best interest of both patients and ourselves.

Dr Daniel LW CHAN
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Reference

1. Chan DLW. Recent changes in the Royal College of Obstetricians and Gynaecologists core curriculum. Hong Kong J Gynaecol Obstet Midwifery 2020;20:60-1. Crossref

Hong Kong J Gynaecol Obstet Midwifery 2025;25(1):7-14 | https://doi.org/10.12809/hkjgom.24.2.377

Predictors for adverse outcomes in pregnant women with COVID-19 infection: a retrospective study

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Objectives: We aimed to identify predictors associated with adverse maternal and neonatal outcomes in women with COVID-19 infection.
Methods: Medical records of women with a singleton pregnancy who were diagnosed with COVID-19 infection at any gestational age and delivered in Tuen Mun Hospital between 1 January 2022 and 31 December 2022 were retrospectively reviewed. Pregnant women with COVID-19 infection who had or had no composite adverse outcomes were compared. Risk factors associated with COVID-19 disease severity and maternal and neonatal outcomes were determined.
Results: In total, 233 pregnant women were included in the analysis. Women with composite adverse outcomes from COVID-19 infection were more likely to have advanced maternal age (adjusted odds ratio [aOR]=4.19, p=0.013) and no prior COVID-19 vaccination (aOR=0.27, p=0.019). Women with composite adverse maternal outcomes were more likely to have advanced maternal age (aOR=2.25, p=0.009), an abnormal body mass index (aOR=1.76, p=0.040), and active COVID-19 infection at the time of delivery (aOR=1.81, p=0.045). Neonates with composite adverse outcomes were more likely to have been born to mothers with comorbidities (aOR=3.13, p=0.007).
Conclusion: Risk factors for severe COVID-19 disease and adverse maternal and neonatal outcomes include advanced maternal age, pre-existing comorbidities, abnormal body mass index, active COVID-19 infection at delivery, and no prior COVID-19 vaccination.

Keywords: COVID-19; Pregnancy outcome; Vaccination

Introduction

As of 1 September 2024, COVID-19 has caused more than seven million deaths[1]. Pregnant women with COVID-19 infection are at higher risk of adverse events, compared with the general population[2-5]. COVID-19 infection is associated with adverse maternal and neonatal outcomes[4,6,7]. In a systematic review of 435 studies, pregnant women with COVID-19 infection are more likely to require intensive care unit (ICU) admission, invasive ventilation, and preterm deliveries, and are at higher risk of maternal death, whereas their babies are more likely to require neonatal ICU admission[4]. Risk factors associated with severe disease in pregnant women with COVID-19 infection include older maternal age, higher body mass index (BMI), and pre-existing maternal comorbidities[4,8-10]. We aimed to identify predictors associated with adverse maternal and neonatal outcomes in women with COVID-19 infection.

Methods

Medical records of women with a singleton pregnancy who were diagnosed with COVID-19 infection at any gestational age and delivered in Tuen Mun Hospital between 1 January 2022 and 31 December 2022 were retrospectively reviewed. The diagnosis was defined as a positive result on real-time reverse transcriptase polymerase chain reaction (RT-PCR) assay of a nasopharyngeal swab or deep throat saliva specimen. Women were excluded if they had incomplete clinical data, a positive result from the rapid antigen test only, multiple pregnancy, or infection after delivery.

Data retrieved included maternal age at delivery,

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BMI at booking visit, ethnicity, education level, smoking and drinking habits, comorbidities (asthma, pre-existing diabetes mellitus, chronic hypertension, renal disease, cardiovascular disease, autoimmune disease, obstructive sleep apnoea, chronic lung disease, chronic liver disease, thyroid disease, and haematological disease), parity, anaemia at booking visit, COVID-19 vaccination status, pregnancy complication (antepartum haemorrhage, gestational diabetes, placenta praevia, amniotic fluid complications including oligohydramnios and polyhydramnios, and fetal growth restriction), gestational age at COVID-19 infection, presence of symptoms of COVID-19 infection, laboratory and imaging test results, length of hospitalisation, oxygen therapy, organ derangement, venous thromboembolism, ICU admission, and maternal death.

Obstetric complications recorded included hypertensive disorder of pregnancy, preterm delivery before 37 weeks of gestation, abnormal cardiotocography, placental abruption, mode of delivery, primary postpartum haemorrhage (blood loss ≥500 mL), and maternal ICU admission after delivery. Neonatal outcomes recorded included birthweight, neonatal ICU admission, Apgar scores, arterial umbilical cord blood pH, vertical transmission of COVID-19 infection, stillbirth, and neonatal complications (respiratory distress syndrome, hypoglycaemia, neonatal hyperbilirubinaemia requiring phototherapy, need for assisted ventilation, clinical sepsis, resuscitation at birth, hypoxic-ischaemic encephalopathy, and neonatal death). Definitions of maternal, fetal, and neonatal death and adverse birth outcomes were based on the World Health Organization definitions[11-14]. The composite adverse outcomes from COVID-19 infection were defined by the presence of any of the following: pneumonia, need for oxygen therapy, organ derangement, venous thromboembolism, ICU admission, prolonged hospitalisation for ≥21 days, and maternal death. The composite adverse maternal outcomes were defined by the presence of any of the following: gestational hypertensive disorder, placental abruption, emergency Caesarean section, primary postpartum haemorrhage, and maternal ICU admission after delivery. The composite adverse neonatal outcomes were defined by the presence of any of the following: preterm birth before 37 weeks of gestation, small for gestational age, Apgar score <7 at 5 minutes after birth, arterial cord blood pH <7.0, admission to neonatal ICU, hypoxic-ischaemic encephalopathy, stillbirth, and neonatal death. Small for gestational age was based on updated fetal growth curve references from the Hong Kong Chinese population[15].

Risk factors for severe COVID-19 infection include the following: advanced age ≥35 years, abnormal BMI (<18.5 or ≥23 kg/m^2 for the Asian population), comorbidities, parity, COVID-19 vaccination status, and infection status at the time of delivery[16-18]. Recovery from COVID-19 infection is defined as being asymptomatic for ≥3 days after ≥10 days since the initial positive RT-PCR test[19], or cycle threshold (Ct) value of ≥30 on two consecutive samples for RT-PCR assay, or Ct value of ≥30 on one sample with a positive result on immunoglobulin G assay.

Pregnant women with and without adverse outcomes were compared using the Pearson Chi-squared test or Fisher's exact test, as appropriate. Risk factors associated with COVID-19 disease severity and maternal and neonatal outcomes were determined using multivariate logistic regression analyses with adjustment for confounders (including risk factors for COVID-19 infection severity such as advanced age ≥35 years, abnormal BMI, comorbidities, and COVID-19 vaccination status, as well as pregnancy-related risk factors such as parity and infection status at delivery). These risk factors have been reported to affect the COVID-19 disease severity and maternal and neonatal outcomes[4,10,16,17,20,21]. Statistical analyses were performed using SPSS (Windows version 26.0; IBM Corp, Armonk [NY], United States). A p value of <0.05 was considered statistically significant.

Results

In total, 233 pregnant women (83.3% were Chinese and the rest were Southeast Asians) were included in the analysis (Table 1). The median maternal age at delivery was 32 years; 148 (63.5%) had received at least one dose of COVID-19 vaccine before infection, whereas three (1.3%) had a history of COVID-19 infection. The median Ct value at diagnosis was 23.8; 76 (32.6%) had active COVID-19 infection at delivery. Among 178 (76.4%) women with symptoms of COVID-19 infection, the most common symptoms were cough (48.1%), sore throat (43.3%), fever (35.6%), and runny nose (30.5%). Among 161 (69.1%) women hospitalised during COVID-19 infection, the median length of hospital stay was 5 days. Severe adverse events of COVID-19 infection were organ derangement (5.2%), ICU admission (1.3%), and pneumonia (0.4%). None required oxygen supplementation or had venous thromboembolism or maternal death.

Regarding maternal complications, 21 (9.0%) had hypertensive disorders of pregnancy: gestational hypertension (n=11), pre-eclampsia (n=7), gestational

Table 1. Baseline characteristics of women diagnosed with COVID-19 infection during pregnancy (n=233)

Characteristic	Value*
Maternal age, y	32 (28-35)
Advanced maternal age (≥35 y)	69 (29.6)
Ethnicity	
Chinese	194 (83.3)
Southeast Asian	39 (16.7)
Education level	
Primary	7 (3.0)
Secondary	140 (60.1)
Tertiary	86 (36.9)
Multiparity	141 (60.5)
Previous Caesarean section	49 (21.0)
Smoking	7 (3.0)
Drinking	2 (0.9)
Body mass index, kg/m^2	22.6 (20.5-25.5)
≥23 (overweight/obesity)	103 (44.2)
<18.5 (underweight)	14 (6.0)
Comorbidities	32 (13.7)
Asthma	13 (5.6)
Chronic hypertension	5 (2.1)
Pre-existing diabetes	2 (0.9)
Thyroid disease	5 (2.1)
Cardiac disease	3 (1.3)
Autoimmune disease	3 (1.3)
Haematological disease	2 (0.9)
Liver disease	3 (1.3)
Natural conception	227 (97.4)
Prior COVID-19 vaccination	148 (63.5)
Past COVID-19 infection	3 (1.3)
Gestational age at diagnosis, w	36 (25-38)
First trimester	43 (18.5)
Second trimester	20 (8.6)
Third trimester	170 (73.0)
Active infection at delivery	76 (32.6)
Cycle threshold value at diagnosis	23.8 (18.6-29.4)
Interval between the day with lowest cycle threshold value and delivery, d	9 (1-92)
COVID-19 infection symptom	178 (76.4)
Fever	83 (35.6)
Cough	112 (48.1)
Runny nose	71 (30.5)
Sore throat	101 (43.3)
Dyspnoea	5 (2.1)
Vomiting	20 (8.6)
Diarrhoea	8 (3.4)
Reduced fetal movement	33 (14.2)

* Data are presented as median (interquartile range) or No. (%) of participants

Table 1. (cont'd)

Characteristic	Value*
COVID-19 infection severity	
Pneumonia	1 (0.4)
Oxygen supplement	0
Intensive care unit admission	3 (1.3)
Organ derangement	12 (5.2)
Venous thromboembolism	0
Maternal mortality	0
Haemoglobin, g/dL (n=166)	11.4 (10.4-12.4)
White blood cell count, ×109/L (n=166)	9.1 (7.2-11.5)
Platelet count, ×109/L (n=166)	194 (166-234)
Abnormal liver enzymes (n=152)	9 (5.9)
C-reactive protein, mg/L (n=139)	17 (4.5-36.6)
Hospitalisation	161 (69.1)
Length of hospitalisation, d	5 (4-8)

proteinuria (n=2), and eclampsia (n=1) [Table 2]. The median gestational age at delivery was 38 weeks; 24 (10.3%) had preterm delivery before 37 weeks of gestation. 107 (45.9%) underwent Caesarean sections, of which 73.8% were in an emergency setting. The most common indications for Caesarean section were previous Caesarean section (43.0%) and abnormal cardiotocography (20.6%). Of the women, 49 (21.0%) had primary postpartum haemorrhage, whereas 2.1% required ICU admission after delivery.

Regarding neonatal outcomes, the median birthweight was 3050 g; 16 (6.9%) had low birthweight (<2500 g), whereas 21 (9.0%) were small for their gestational age (Table 3). Only one (0.4%) neonate had hypoxic-ischaemic encephalopathy. Two (0.9%) were stillbirths (one was diagnosed with placental abruption at 32 weeks and the other was diagnosed with fetal congenital leukaemia). Two (0.9%) died within 28 days of life. One who died on the third day of life was delivered at 26 weeks secondary to maternal severe pre-eclampsia, fetal growth restriction, and fetal distress. Another who died 2 hours after birth was delivered at 36 weeks owing to hydrops fetalis. The cause of hydrops was not identified, but the mother had late latent syphilis treated in the second trimester, mild COVID-19 infection treated with antiviral medication at 32 weeks, and gestational diabetes under good control.

The rate of composite adverse outcomes from COVID-19 infection was 7.3% (n=17), whereas the rate of composite adverse maternal outcomes was 45.9% (n=107) and the rate of composite adverse neonatal outcomes was 21.5% (n=50).

Table 2. Pregnancy and delivery characteristics of women diagnosed with COVID-19 infection during pregnancy (n=233)

Characteristic	Value*
Antepartum haemorrhage	20 (8.6)
Gestational diabetes	42 (18.0)
Placenta praevia	6 (2.6)
Oligohydramnios	10 (4.3)
Polyhydramnios	3 (1.3)
Intrauterine growth restriction	4 (1.7)
Any hypertensive disorder of pregnancy	21 (9.0)
Pregnancy-induced hypertension	11 (52.4)
Gestational proteinuria	2 (9.5)
Pre-eclampsia	7 (33.3)
Eclampsia	1 (4.8)
Gestational age at delivery, w	38 (37-39)
Any preterm delivery <37 w	24 (10.3)
Preterm delivery <28 w	1 (4.2)
Preterm delivery 28+0 to 33+6 w	5 (20.8)
Preterm delivery 34+0 to 36+6 w	18 (75.0)
Preterm premature rupture of membranes	8 (3.4)
Abnormal cardiotocography	49 (21.0)
Placental abruption	1 (0.4)
Induction of labour	71 (30.5)
Mode of delivery	
Normal vaginal delivery	108 (46.4)
Instrumental delivery	18 (7.7)
Caesarean section	107 (45.9)
Elective Caesarean section	28 (26.2)
Emergency Caesarean section	79 (73.8)
Indications of Caesarean section	n=107
Previous Caesarean section	46 (43.0)
Abnormal cardiotocography	22 (20.6)
Breech	7 (6.5)
Placenta praevia	7 (6.5)
Failed induction	6 (5.6)
No progress	5 (4.7)
Severe pre-eclampsia	4 (3.7)
Placental abruption	1 (0.9)
Intrauterine infection	1 (0.9)
Others	8 (7.5)
Primary postpartum haemorrhage	49 (21.0)
Need for isolation at delivery	59 (25.3)
Post-delivery maternal intensive care unit admission	5 (2.1)

* Data are presented as median (interquartile range) or No. (%) of participants

Table 3. Neonatal outcomes in women diagnosed with COVID-19 infection during pregnancy (n=233)

Neonatal outcome	Value*
Male sex	142 (60.9)
Birthweight, g	3050 (2830-3315)
Low birthweight <2500 g	16 (6.9)
Very low birthweight <1500 g	2 (0.9)
Small for gestational age	21 (9.0)
Neonatal intensive care unit admission	11 (4.7)
Apgar score at 1 minute	8 (8-8)
Apgar score at 5 minutes	9 (9-9)
Low Apgar score <7 at 5 minutes	5 (2.1)
Umbilical cord arterial pH <7.0	1 (0.4)
COVID-19 positive on nasopharyngeal swab specimen	0
Respiratory distress syndrome	21 (9)
Hypoglycaemia	2 (0.9)
Hyperbilirubinaemia requiring phototherapy	40 (17.2)
Assisted ventilation	17 (7.3)
Clinical sepsis	31 (13.3)
Resuscitation at birth	15 (6.4)
Hypoxic-ischaemic encephalopathy	1 (0.4)
Stillbirth	2 (0.9)
Neonatal death	2 (0.9)

* Data are presented as median (interquartile range) or No. (%) of participants

Women with composite adverse outcomes from COVID-19 infection were more likely to have advanced maternal age (adjusted odds ratio [aOR]=4.19, p=0.013) and no prior COVID-19 vaccination (aOR=0.27, p=0.019) [Table 4]. Women with composite adverse maternal outcomes were more likely to have advanced maternal age (aOR=2.25, p=0.009), an abnormal BMI (aOR=1.76, p=0.040), and active COVID-19 infection at the time of delivery (aOR=1.81, p=0.045). Neonates with composite adverse outcomes were more likely to have been born to mothers with comorbidities (aOR=3.13, p=0.007).

Discussion

The rate of composite adverse outcomes from COVID-19 infection among pregnant women was 7.3%, which is lower than the rate for severe COVID-19 disease of 9% reported in a systematic review of 82 studies involving 31 331 women[4]. In Hong Kong during the early times of the pandemic, the circulation of the Alpha, Beta, and Delta variants was limited[22]. Only eight women were

Table 4. Predictors for adverse outcomes in women diagnosed with COVID-19 infection during pregnancy

Outcome	With adverse outcome*	Without adverse outcome*	Odds ratio (95% confidence interval)	p Value	Adjusted odds ratio (95% confidence interval)	p Value
Composite adverse outcomes from COVID-19 infection	n=17	n=216				
Advanced maternal age	9 (52.9)	60 (27.8)	2.93 (1.08-7.93)	0.029	4.19 (1.36-12.94)	0.013
Abnormal body mass index	9 (52.9)	108 (50.0)	1.13 (0.42-3.03)	0.815	0.95 (0.33-2.73)	0.925
Multiparity	8 (47.1)	133 (61.6)	0.56 (0.21-1.49)	0.238	0.37 (0.12-1.12)	0.079
Prior COVID-19 vaccination	7 (41.2)	141 (65.3)	0.37 (0.14-1.02)	0.047	0.27 (0.09-0.81)	0.019
Comorbidities	4 (23.5)	28 (13.0)	2.07 (0.63-6.78)	0.264	2.34 (0.62-8.89)	0.211
Composite adverse maternal outcomes	n=107	n=126				
Advanced maternal age	40 (37.4)	29 (23.0)	2.00 (1.13-3.53)	0.017	2.25 (1.23-4.14)	0.009
Abnormal body mass index	62 (57.9)	55 (43.7)	1.78 (1.06-2.99)	0.030	1.76 (1.03-3.03)	0.040
Multiparity	61 (57.0)	80 (63.5)	0.76 (0.45-1.29)	0.313	0.60 (0.34-1.06)	0.077
Prior COVID-19 vaccination	66 (61.7)	82 (65.1)	0.86 (0.51-1.48)	0.591	0.90 (0.51-1.59)	0.711
Comorbidities	17 (15.9)	15 (11.9)	1.40 (0.66-2.95)	0.379	1.16 (0.52-2.59)	0.714
Active COVID-19 infection at delivery	42 (39.3)	34 (27.0)	1.75 (1.01-3.04)	0.047	1.81 (1.01-3.23)	0.045
Composite adverse neonatal outcome	n=50	n=183				
Advanced maternal age	16 (32.0)	53 (29.0)	1.15 (0.59-2.27)	0.677	1.06 (0.52-2.17)	0.864
Abnormal body mass index	27 (54.0)	90 (49.2)	1.21 (0.65-2.27)	0.546	1.09 (0.57-2.09)	0.788
Multiparity	29 (58.0)	112 (61.2)	0.88 (0.46-1.65)	0.681	0.84 (0.43-1.62)	0.593
Prior COVID-19 vaccination	32 (64.0)	116 (63.4)	1.03 (0.54-1.97)	0.936	0.87 (0.44-1.72)	0.681
Comorbidities	13 (26.0)	19 (10.4)	3.03 (1.38-6.69)	0.004	3.13 (1.37-7.14)	0.007
Active COVID-infection at delivery	15 (30.0)	61 (33.3)	0.86 (0.44-1.69)	0.656	0.80 (0.40-1.62)	0.544

* Data are presented as No. (%) of participants

diagnosed with COVID-19 infection during pregnancy in our institution between 2020 and 2021. The transmission became rapid in December 2021 after the outbreaks of the Omicron variant, leading to the fifth wave in Hong Kong[23]. The difference in the rate of adverse outcomes from COVID-19 infection may be partly due to different predominant strains at the time of the study, because the Delta variant is associated with more severe disease, compared with the Omicron variant[24-27].

Advanced maternal age was a predictor for adverse events from COVID-19 infection and adverse maternal outcomes, similar to the findings reported in a review[10], which found that advanced maternal age was associated with increased risks of ICU admission, mechanical ventilation, pneumonia, placental abruption, and Caesarean delivery. Our findings also concurred with findings from other studies for pregnant women[4,9] and the general population[16,17,28].

Vaccination is associated with lower risks of severe or critical COVID-19 infection[20,29]. Pregnant women with at least one dose of COVID-19 vaccine were less likely to have adverse outcomes from COVID-19 infection. Vaccination generates robust humoral immunity[30,31]. Severe COVID-19 infection increases the risks of adverse maternal and neonatal outcomes including Caesarean delivery, preterm birth, and neonatal ICU admission[8,32,33]. Vaccination is associated with lower risks of stillbirth, very or extremely preterm birth, and small for gestational age among term babies[34]. Nevertheless, pregnant women commonly have safety concerns and thus vaccine hesitancy. The main adverse effects of vaccination are local reactogenicity events (such as pain, redness, and swelling)

and systemic reactogenicities (such as tiredness, headache, and fever)[35]. In general, symptoms in vaccinated individuals are usually mild to moderate and self-limiting[36]. There is growing evidence that COVID-19 vaccine causes no safety concerns on pregnancy outcomes[37-39]. In our study, only 63.5% of the pregnant women received at least one dose of COVID-19 vaccine. This rate is significantly lower than the vaccination rate of 83.7% among pregnant women reported in a study in Hong Kong[40]. The World Health Organization, the Hong Kong College of Obstetricians and Gynaecologists, the Royal College of Obstetricians and Gynaecologists, and the American College of Obstetricians and Gynaecologists all recommend pregnant women staying up to date with COVID-19 vaccines[41-43]. Therefore, pregnant women should be educated on the efficacy and safety of COVID-19 vaccines and advised to be vaccinated.

Increased BMI is a risk factor for severe COVID-19 complications[4,9,10,44,45]. Pre-pregnancy underweight status is also a risk factor for adverse outcomes from COVID-19 infection in pregnancy[10]. However, we did not find any association between abnormal BMI and adverse outcomes from COVID-19 infection, probably because of the small sample size. However, we found that pregnant women with abnormal BMI were at higher risks of adverse maternal outcomes. This finding is consistent with those reported in a study in Serbia, which showed that overweight and obese pregnant women were more likely to have gestational hypertension[46].

Pre-existing comorbidities are risk factors for severe COVID-19 disease in pregnancy[4,8,10] and adverse neonatal outcomes such as preterm birth[47], consistent with our findings.

The literature shows conflicting results with regard to the association between active COVID-19 infection at delivery and pregnancy outcomes. In our study, active COVID-19 infection at delivery was associated with adverse maternal outcomes including hypertensive disorders and emergency Caesarean delivery. This is in keeping with the findings from a population-based cohort study in England (n=342 080), which showed that active COVID-19 infection at delivery was associated with higher rates of fetal death, preterm birth, pre-eclampsia, and emergency Caesarean delivery[21]. On the contrary, studies in Israel and South Africa demonstrated no associations between active COVID-19 infection at delivery and rates of emergency Caesarean delivery, fetal death, preterm birth, low birthweight, or other pregnancy-induced complications[19,48]. In our study, no association was found between active COVID-19 infection at delivery and adverse neonatal outcomes.

According to our hospital policy, pregnant women with active COVID-19 infection were admitted to a single room with negative pressure or the isolation ward for vaginal delivery, or were transferred to an operating theatre with negative pressure for Caesarean section. Management of labour and delivery was based on standard obstetric indications. However, the operating theatre with negative pressure is far away from the labour ward, so timely delivery in an emergency setting (eg, fetal distress during labour) might become difficult. The prolonged decision-to-delivery interval might have decreased the frontline obstetrician's threshold for arranging emergency Caesarean delivery for fetal wellbeing. Furthermore, some women changed their minds on the mode of delivery and declined a trial of vaginal birth after a previous Caesarean delivery when they were admitted for labour with active COVID-19 infection. This might result in the increased likelihood of adverse maternal outcomes in women with active COVID-19 infection at delivery. Therefore, labour wards and operating rooms with isolation facilities should be set up to facilitate intrapartum care and minimise delay in case an airborne precaution during delivery is required in future pandemics[49].

To the best of our knowledge, this is the first study in Hong Kong to identify predictors of adverse outcomes in pregnant women with COVID-19 infection. There are several limitations to our study. The study design is retrospective and the sample size is small. Analyses for each adverse outcome were not performed because of the small sample size. Sampling frames varied, depending on the time of COVID-19 diagnosis, ranging from universal COVID-19 testing for all pregnant women admitted to hospital in early 2022 to symptom-based testing in late 2022. Pregnant women with COVID-19 infection diagnosed by rapid antigen tests only were excluded. Therefore, the true sample size was probably underestimated, potentially introducing selection bias.

Conclusion

Risk factors for severe COVID-19 disease and adverse maternal and neonatal outcomes include advanced maternal age, pre-existing comorbidities, abnormal BMI, active COVID-19 infection at delivery, and no prior COVID-19 vaccination. COVID-19 vaccine can reduce adverse outcomes and is beneficial to pregnant women. Isolation facilities in labour wards should be set up in preparation for future pandemics.

Contributors

YCN, LTK, and PLS designed the study. YCN, YYL, SYL, and PLS acquired and analysed the data. YCN drafted the manuscript. All authors critically revised the manuscript for important intellectual content. All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

All authors have no conflicts of interest to disclose.

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Data availability

All data generated or analysed during the present study are available from the corresponding author on reasonable request.

Ethics approval

The study was approved by the Central Institutional Review Board of Hospital Authority (reference: CIRB-2023-056-1). The patients were treated in accordance with the tenets of the Declaration of Helsinki. The patients provided written informed consent for all treatments and procedures and for publication.

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Predictors of vaginal delivery after cervical priming using a double balloon catheter

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Objectives: To determine predictors of successful vaginal delivery after induction of labour using a double balloon catheter.
Methods: Medical records of women who underwent induction of labour using a double balloon catheter between 1 September 2017 and 31 August 2024 at a tertiary public hospital in Hong Kong were retrospectively reviewed.
Results: Of 111 women, 32 (28.8%) had a scarred uterus secondary to a previous Caesarean section or a myomectomy, 53 (47.7%) had failed pharmacological priming, and 26 (23.4%) had a contraindication for pharmacological priming. The latter group had lower body mass index and gestational age and comprised most cases of fetal growth restriction. In total, 106 (95.5%) women had successful cervical priming. Subsequently, 56 (50.5%) had vaginal deliveries and 55 (49.5%) underwent Caesarean sections. The rate of vaginal delivery was higher in women with a contraindication of pharmacological priming, compared with women with a scarred uterus and women who failed pharmacological priming (73.1% vs 50.0% vs 39.6%, p=0.02). Predictors of successful vaginal delivery after the use of a double balloon catheter were a body mass index of <30 kg/m^2 (adjusted odds ratio [aOR]=3.10, p=0.019), a history of vaginal delivery (aOR=4.08, p=0.026), and a cervix with an initial modified Bishop score of ≥4 (aOR=4.49, p=0.045). However, larger uterine or vaginal balloon volumes were not associated with higher vaginal delivery rates.
Conclusion: Predictors of vaginal delivery after induction of labour using a double balloon catheter were a non-obese status, a history of vaginal delivery, and a favourable cervical status.

Keywords: Labor, induced; Fetal growth retardation; Vaginal birth after cesarean

Introduction

Indications for induction of labour include hypertension, fetal growth restriction, and decreased fetal movements. When the cervix is unfavourable, cervical priming is required before oxytocin administration to increase the likelihood of a vaginal delivery. Cervical priming can be performed using pharmacological agents or mechanical devices. In a meta-analysis, mechanical priming is superior to pharmacological priming in terms of safety, but both are comparable at achieving vaginal delivery[1]. In women who received pharmacological priming, both the risks of uterine hyperstimulation (risk ratio=10.02) and neonatal intensive care unit admission (risk ratio=1.31) increase[1].

The Royal College of Obstetricians and Gynaecologists advocates the use of mechanical methods for induction of labour in women with a previous birth by Caesarean section, because of a lower risk of scar rupture when compared with the use of prostaglandins[2]. In pregnancies complicated by fetal growth restriction, mechanical methods are associated with a lower occurrence of adverse intrapartum outcomes, probably because of the lower risk of uterine hyperstimulation[3,4]. In addition, mechanical priming may be used as the second-line method when pharmacological priming has failed.

A double balloon catheter consists of a uterine balloon and a vaginal balloon. It ripens the cervix mechanically by exerting pressure to both parts and stimulates the local release of prostaglandins and oxytocin[5]. The Cook Cervical Ripening Balloon (Cook Medical, Bloomington [IN], United States) is approved by the Food and Drug Administration of the United States.

Successful cervical priming is correlated with women's acceptance of the double balloon catheter[6]. Therefore, knowledge about predictors of successful

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cervical priming and subsequent vaginal delivery can help clinicians counsel women on the use of a double balloon catheter and its acceptance. It is not clear whether the volumes of the uterine and vaginal balloons affect the vaginal delivery rate. In Hong Kong, a higher rate of vaginal delivery was associated with an occipital-anterior position of the fetal head at delivery and a lower birth weight[7]. However, these factors cannot be predicted or measured until advanced labour stage or after birth. This study aims to identify predictors of successful vaginal delivery after induction of labour using a double balloon catheter.

Methods

Medical records of women who underwent induction of labour using the Cook Cervical Ripening Balloon at Queen Elizabeth Hospital, Hong Kong between 1 September 2017 and 31 August 2024 were retrospectively reviewed. Women with or without pharmacological priming who had a singleton pregnancy, cephalic presentation, gestational age of ≥37 weeks, a normal cardiotocograph, and an initial cervical status of modified Bishop score (MBS) <6 were included. Those with any contraindication to vaginal delivery or incomplete documentation were excluded. Cervical priming was performed to women with (1) a scarred uterus secondary to a previous Caesarean section or myomectomy, (2) failed pharmacological priming (after two doses of 3 mg vaginal prostaglandin E2 or one dose of a 10-mg dinoprostone controlled-release tablet), or (3) a contraindication for pharmacological priming.

The double balloon catheter was put in place for up to 12 hours, unless it was spontaneously expelled or removed for indications such as prelabour rupture of membranes, spontaneous onset of labour, uterine hyperstimulation, abnormal cardiotocography, or at the woman's request. The uterine balloon was placed at the internal cervical os, whereas the cervicovaginal balloon was placed at the external cervical os. Both balloons were filled with 20 to 80 mL of saline, per the attending obstetrician's discretion and the woman's tolerance. A cut-off volume of 60 mL was used to classify low and high volumes[8].

After insertion, cardiotocography was performed for 1 hour and checked every 2 hours to ensure non-expulsion. Vital signs, uterine activity, vaginal bleeding, and the presence of rupture of membranes were monitored every 4 hours. The cervical favourability was reassessed after removal of the catheter. Those with a favourable cervix (an MBS ≥6) proceeded to induction of labour with amniotomy and oxytocin infusion. Those with an unfavourable cervix (an MBS <6) were offered a Caesarean section or further cervical priming per the attending obstetrician's discretion and the woman's preference.

Data retrieved included maternal age, height, body mass index, obstetric history, gestational age, gestational diabetes mellitus, indications for induction of labour, MBS before and after cervical priming, vaginal and uterine balloon volumes and duration of insertion, mode of delivery, indications for Caesarean section or operative vaginal delivery, neonatal outcomes, birthweight, and complications including heavy bleeding, uterine rupture, and fever (≥37.5°C[9]).

Statistical analysis was performed using the SPSS (Windows version 24; IBM Corp, Armonk [NY], United States). Comparisons of the three groups were made using the Chi-squared test for categorical variables or the Kruskal-Wallis test for continuous variables. Variables for success vaginal delivery after cervical priming were identified using univariate analysis. Variables with a p value of <0.2 were included in the multivariate analysis to identify predictors of vaginal delivery. A p value of <0.05 was considered statistically significant.

Results

Of 113 women identified, two were excluded owing to incomplete documentation of the double balloon catheter insertion procedure and the remaining 111 were included for analysis. Of these 111 women, 32 (28.8%) had a scarred uterus secondary to a previous lower segment Caesarean section (n=31) or a myomectomy (n=1), 53 (47.7%) had failed pharmacological priming, and 26 (23.4%) had a contraindication for pharmacological priming including fetal growth restriction (n=21), grand multiparity (n=2), allergy to prostaglandin (n=1), and personal preference (n=2). The three groups were comparable in terms of baseline characteristics, except that women with a contraindication for pharmacological priming had lower body mass index and gestational age and comprised most cases of fetal growth restriction (Table 1).

The double balloon catheter was put in place for a median duration of 12.0 (interquartile range, 11.0-12.0) hours. The volumes ranged from 30 to 80 mL for the uterine balloon and 20 to 80 mL for the vaginal balloon. The most common indication for induction of labour was fetal growth restriction (84.6%), followed by gestational or pre-existing diabetes mellitus (59.0%) and large-for-gestational age (44.6%) [Table 2].

Table 1. Baseline characteristics of participants

Characteristic	Scarred uterus (n=32)*	Failed pharmacological priming (n=53)*	Contraindicated for pharmacological priming (n=26)*	p Value
Maternal age, y	34 (31-36)	32 (29-35)	33 (30-35)	0.210
Maternal age ≥35 y	14 (43.8)	15 (28.3)	10 (38.5)	0.324
Maternal height, cm	158.0 (153.1-161.5)	158.5 (155.5-161.7)	157.3 (154.0-161.4)	0.575
Body mass index on admission, kg/m^2	28.7 (25.6-32.5)	29.3 (25.1-33.1)	26.6 (22.4-28.9)	0.025
Body mass index ≥30 kg/m^2	13 (40.6)	24 (45.3)	6 (23.1)	0.158
Prior vaginal delivery	5 (15.6)	11 (20.8)	6 (23.1)	0.757
Gestational age, wk	39 (39-41)	39 (38-39)	37 (37-38)	<0.001
Modified Bishop score prior to catheter insertion				0.312
<4	4 (12.5)	4 (7.5)	5 (19.2)	
≥4 to <6	28 (87.5)	49 (92.5)	21 (80.8)	

* Data are presented as median (interquartile range) or No. (%) of participants

Table 2. Indications for induction of labour

Indication	Scarred uterus (n=32)*	Failed pharmacological priming (n=53)*	Contraindicated for pharmacological priming (n=26)*
Current or history of antepartum haemorrhage	2 (6.3)	3 (5.7)	0
Decreased fetal movements	1 (3.1)	3 (5.7)	1 (3.8)
Fetal growth restriction	0	0	21 (80.8)
Gestational or pre-existing diabetes mellitus	11 (34.4)	11 (20.8)	1 (3.8)
Hypertensive disorder	1 (3.1)	3 (5.7)	0
Large-for-gestational age (estimated fetal weight or abdominal circumference >90th percentile)	4 (12.5)	17 (32.1)	0
Oligohydramnios	1 (3.1)	3 (5.7)	2 (7.7)
Past term	10 (31.3)	2 (3.8)	0
Small-for-gestational age (estimated fetal weight or abdominal circumference <10th percentile)	2 (6.3)	10 (18.9)	1 (3.8)
Others	0	1 (1.9)	0

* Data are presented as No. (%) of participants

The time interval from catheter insertion to vaginal delivery ranged from 9 to 29.5 hours. The rate of successful vaginal delivery was higher among women with a contraindication for pharmacological priming, compared with women with a previous Caesarean section or myomectomy and women who failed pharmacological priming (73.1% vs 50.0% vs 39.6%, p=0.02, Table 3). The rate of non-emergency Caesarean section was highest in women who failed pharmacological priming, compared with women with a previous Caesarean section or myomectomy and women with a contraindication of pharmacological priming (58.5% vs 43.8% vs 23.1%, p=0.012); the most common indication was failed induction of labour (Table 3).

Independent predictors of vaginal delivery after the use of a double balloon catheter were a body mass index of <30 kg/m^2 (adjusted odds ratio [aOR]=3.10, p=0.019), a history of vaginal delivery (aOR=4.08, p=0.026), and an initial cervical status of MBS of ≥4 (aOR=4.49,

Table 3. Outcomes of induction of labour using a double balloon catheter

Outcome	Scarred uterus (n=32)	Failed pharmacological priming (n=53)	Contraindicated for pharmacological priming (n=26)	p Value
Balloon expulsion	1 (3.1)	3 (5.7)	2 (7.7)	0.742
Successful priming	32 (100)	50 (94.3)	24 (92.3)	0.397
Labour without amniotomy or oxytocin	1 (3.1)	2 (3.8)	1 (3.8)	0.663
Mode of delivery				
Vaginal	16 (50.0)	21 (39.6)	19 (73.1)	0.020
Operative vaginal	1 (3.1)	3 (5.7)	0	0.441
Caesarean section	16 (50.0)	32 (60.4)	7 (26.9)	0.020
Emergency for fetal distress	2 (6.3)	1 (1.9)	1 (3.8)	0.577
Non-emergency	14 (43.8)	31 (58.5)	6 (23.1)	0.012
Cephalopelvic disproportion	0	1	0	
Failed induction of labour	9	27	4	
Suspicious cardiotocography	2	0	0	
Malpresentation after catheter removal	0	2	1	
Suspected scar dehiscence	3	0	0	
Unfavourable cervix	0	1	1	
Prior delivery	n=5	n=11	n=6	0.387
Vaginal	4 (80.0)	6 (54.5)	5 (83.3)	
Caesarean section	1 (20.0)	5 (45.5)	1 (16.7)	
No prior delivery	n=27	n=42	n=20	0.040
Vaginal	12 (44.4)	15 (35.7)	14 (70.0)	
Caesarean section	15 (55.6)	27 (64.3)	6 (30.0)	
Time from catheter insertion to vaginal delivery, h	20 (14.5-23.75)	23.0 (21.0-25.0)	20.0 (18.0-24.5)	0.959
Birthweight, g	3292.5 (2985.0-3482.5)	3250.0 (2835.0-3470.0)	2400.0 (2242.5-2607.5)	<0.001
Birthweight >4000 g	1 (3.1)	1 (1.9)	0	0.672

* Data are presented as median (interquartile range), No. (%) of participants, or No. of participants

p=0.045) [Table 4]. The area under the receiver operating characteristic curve was 0.647 (Figure), which was within the range of inadequate discrimination (0.5-0.7).

Fourteen women developed primary postpartum haemorrhage, with blood loss ranging from 550 to 1900 mL (Table 5). One woman with a scarred uterus presented with fetal distress necessitating vacuum extraction, which was complicated with postpartum haemorrhage secondary to uterine scar rupture, which was repaired using laparotomy. The neonate developed severe hypoxic-ischaemic encephalopathy and died on day 13 of life. Three women with a scarred uterus complained of Caesarean scar pain and were suspected of having scar dehiscence, but this subsequently was not confirmed during the Caesarean section. One woman with a scarred uterus had uterine hyperstimulation without oxytocin infusion. Nine women developed transient intrapartum fever; one woman had maternal sepsis and four neonates had perinatal sepsis.

Discussion

Predictors of vaginal delivery after induction of labour using a double balloon catheter were a maternal body mass index of <30 kg/m^2, a history of vaginal delivery, and a cervix with an initial MBS of ≥4, all of which are well recognised[10-13]. The rates of successful cervical priming ranged from 92.3% to 100%, but the rates of vaginal delivery ranged from 39.6% to 73.1%, similar to a previous study[14]. The rate of vaginal delivery was highest in women with a contraindication of pharmacological

Table 4. Predictors of vaginal delivery after induction of labour using a double balloon catheter

Variable	Univariable analysis			Multivariate analysis	
	Vaginal delivery (n=56)*	Caesarean section (n=55)*	p Value	Adjusted odds ratio (95% confidence interval)	p Value
Maternal age ≥35 y	22 (39.3)	17 (30.9)	0.468	-	-
Body mass index ≥30 kg/m^2	14 (25.0)	29 (52.7)	0.005	3.10 (1.20-8.02)	0.019
Maternal height, cm	159.0 (156.0-162.9)	157.0 (153.3-160.0)	0.290	-	-
Birthweight >4000 g	1 (1.8)	1 (1.8)	>0.99	-	-
Large-for-gestational age	7 (12.5)	14 (25.5)	0.134	0.51 (0.15-1.69)	0.268
History of vaginal delivery	15 (26.8)	7 (12.7)	0.105	4.08 (1.19-14.06)	0.026
Scarred uterus	16 (28.6)	16 (29.1)	>0.99	-	-
Gestational diabetes mellitus	9 (16.1)	17 (30.9)	0.105	0.47 (0.15-1.46)	0.192
History of pharmacological priming	21 (37.5)	32 (58.2)	0.046	0.43 (0.17-1.08)	0.072
Modified Bishop score			0.071		
<4	3 (5.4)	10 (18.2)		-	-
≥4	53 (94.6)	45 (81.8)		4.49 (1.03-19.49)	0.045
Uterine balloon volume, mL			0.105		
<60	9 (16.1)	17 (30.9)		-	-
≥60	47 (83.9)	38 (69.1)		2.10 (0.74-5.96)	0.166
Vaginal balloon volume, mL			0.636		
<60	16 (28.6)	19 (34.5)		-	-
≥60	40 (71.4)	36 (65.5)		-	-

* Data are presented as median (interquartile range) or No. (%) of participants

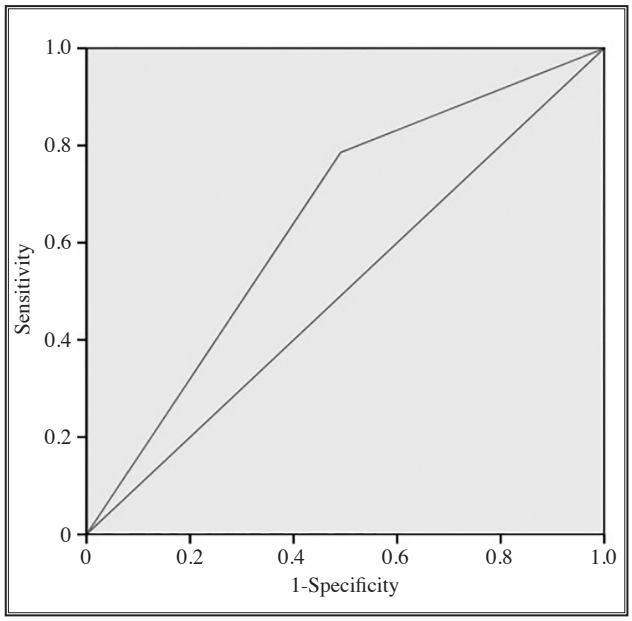

Figure. Receiver operating characteristic curve of successful vaginal delivery after induction of labour using a double balloon catheter.

priming, probably because of their lower body mass index. The higher rate of non-emergency Caesarean section in women with failed pharmacological priming was expected, given the low success rate of induction of labour by double balloon catheters as a second-line method after administration of dinoprostone[7].

Obesity (body mass index of ≥30 kg/m^2) was associated with a higher rate of Caesarean section, consistent with other studies[10,11]. Balloon catheters are more successful than misoprostol at achieving cervical ripening in women with obesity[15]. Therefore, the double balloon catheter remains an acceptable choice for cervical priming in women with obesity. Nonetheless, they should be advised on the lower-than-average successful vaginal delivery rate.

Neither a higher uterine balloon volume nor a higher vaginal balloon volume was associated with a higher vaginal delivery rate, consistent with a study of

Table 5. Complications after induction of labour using a double balloon catheter

Complication	Scarred uterus (n=32)*	Failed pharmacological priming (n=53)*	Contraindicated for pharmacological priming (n=26)*	p Value
Composite adverse intrapartum outcome	10 (31.3)	14 (26.4)	4 (15.4)	0.370
Primary postpartum haemorrhage ≥500 mL	5 (15.6)	8 (15.1)	1 (3.8)	0.305
Primary postpartum haemorrhage ≥1000 mL	3 (9.4)	1 (1.9)	0	0.106
Intrapartum fever	3 (9.4)	4 (7.5)	2 (7.7)	0.958
Maternal sepsis	0	0	1 (3.8)	0.192
Malpresentation after removal of catheter	0	2 (3.8)	1 (3.8)	0.535
Scar rupture	1 (3.1)	0	0	0.288
Uterine hyperstimulation	1 (3.1)	0	0	0.288
Apgar score <7 at 5 min	1 (3.1)	1 (1.9)	0	0.441
Perinatal sepsis	1 (3.1)	2 (3.8)	1 (3.8)	0.985
Neonatal death	1 (3.1)	0	0	0.288

* Data are presented as No. (%) of participants or No. of participants

single balloon catheters that the overall Caesarean section rate did not differ significantly between those using a high-volume (≥60 mL) Foley catheter and those using a low-volume (≤30 mL) Foley catheter[8].

One (0.9%) woman with a scarred uterus had uterine rupture, consistent with the 1% in previous studies[15,16]; the uterine and vaginal balloons were filled with 80 mL of saline. Additionally, one woman with a scarred uterus had uterine hyperstimulation without oxytocin infusion, although the double balloon catheter is associated with a lower risk of uterine hyperstimulation compared with pharmacological priming[17]. We hypothesise that the cervical priming effect of a double balloon catheter was brought about more by the release of endogenous prostaglandins than by the actual pressure exerted. Therefore, women should be advised about the risk of uterine hyperstimulation, and their uterine contractions should be monitored.

Pain is often the reason women decline the use of the double balloon catheter. Nonetheless, there was no report of premature removal of the balloon due to pain or discomfort. The double balloon catheter is considered well tolerated[18]. However, in single balloon catheters larger balloon volumes of 70 mL are associated with higher pain scores at the time of expulsion[19].

There were three cases of fetal malpresentation after removal of the double balloon catheter. We hypothesise that these fetuses were at high stations when the catheter was inserted[20]. All three cases used a large-volume (60-80 mL) uterine balloon. In women using a single balloon catheter, higher volumes (180-250 mL) are associated with a higher risk of cord presentation, compared with lower volumes (70-150 mL)[21]. Smaller uterine balloon volumes may decrease the risk without lowering the vaginal delivery rate. Larger balloon volumes are not associated with a higher vaginal delivery rate but can cause discomfort, malpresentation, and other complications. It is suggested that the balloons be filled to a volume that is tolerable by the woman, up to 80 mL. The volume should be reduced if the woman experiences discomfort.

There were limitations to the present study. The study was retrospective and the sample size was small and from a single hospital. The hospital's protocol on induction of labour may not be generalisable to other settings. The area under the curve was considered inadequate discrimination; the successful vaginal delivery rate after the use of a double balloon catheter may have been affected by intrapartum or other factors that were not investigated. Nonetheless, the knowledge about predictors of successful vaginal delivery after the use of a double ballon catheter enables evidence-based counselling of women and empowers them to make informed decisions about their labour and delivery. Women at higher risk of hyperstimulation or with a contraindication for pharmacological priming were included in the analysis, in addition to the more commonly studied groups of women with a previous Caesarean section or failed pharmacological priming.

Conclusion

Predictors of vaginal delivery after the use a double balloon catheter were a non-obese status, a history of vaginal delivery, and a favourable cervical status. Although the overall successful vaginal delivery rate was about 50%, the successful cervical priming rate was ≥90%.

Contributors

All authors designed the study, acquired the data, analysed the data, drafted the manuscript, and critically revised the manuscript for important intellectual content. The authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

As an executive editor of the journal, KYL was not involved in the peer review process. Other authors have no conflict of interest to disclose.

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Data availability

All data generated or analysed during the present study are available from the corresponding author upon reasonable request.

Ethics approval

This study was approved by the Central Institution Review Board of Hospital Authority, Hong Kong (reference: CIRB-2024-097-1). All patients were treated in accordance with the tenets of the Declaration of Helsinki. The patients provided informed consent for all treatments and procedures and for publication.

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Perinatal deaths in singleton pregnancy in Hong Kong

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In Hong Kong, the perinatal death rate remains low, but the stillbirth rate has fluctuated over the past 12 years. Between 2000 and 2019, the leading causes of perinatal death were fetal growth restriction, chorioamnionitis, congenital malformations and genetic abnormalities, placental abruption, and preeclampsia. However, 43.5% of fetal growth restriction cases were not diagnosed during routine antenatal care, and about one-third of all singleton stillbirths were unexplained. The common causes of early neonatal death were congenital or genetic abnormalities, prematurity, sepsis, and hypoxic-ischaemic encephalopathy. The World Health Organization and the United Nations Children's Fund have called for efforts to end preventable newborn deaths and stillbirths by 2030. This perspective aimed to review the current trend, leading causes, and preventive measures of perinatal death in Hong Kong.

Keywords: Fetal death; Perinatal death; Perinatal mortality; Stillbirth

Introduction

Perinatal deaths include both stillbirths and early neonatal deaths (within 7 days of life); they are devastating for women, their families, and healthcare providers. The World Health Organization and the United Nations Children's Fund have called for efforts to end preventable newborn deaths and stillbirths by 2030[1]. Effective interventions are available to prevent and manage the main causes of perinatal death including prematurity, intrapartum-related deaths (including birth asphyxia), neonatal infections, and congenital anomalies[1]. Saving Babies' Lives Care Bundle (SBLCB) is the evidence-based best practice designed by the United Kingdom's National Health Service to reduce perinatal mortality[2]. This perspective aimed to review the current trend, leading causes, and preventive measures of perinatal death in Hong Kong, and to discuss the six elements of SBLCB and other clinical practices in Hong Kong.

Trend and causes of perinatal mortality

In Hong Kong, the perinatal death rate (per 1000 total births) decreased from 6.98 in 1992 to 2.23 in 2012, but has fluctuated between 2.23 and 4.6 thereafter[3-9]. In particular, the stillbirth rate (per 1000 total births) reduced to 1.6 in 2012 but has fluctuated between 1.6 and 3.7 thereafter, whereas the early neonatal death rate (per 1000 live births) reduced to 0.6 in 2011 and remained unchanged (at approximately 1.0). Despite the COVID-19 pandemic, the perinatal death rate decreased from 4.6 in 2020 to 3.5 in 2022. Fluctuation in the stillbirth rate over the past 12 years could be the result of the delay in childbearing, as a larger proportion of pregnant women were of advanced maternal age, used assisted reproductive techniques, or had complex medical conditions.

In the United States, the perinatal death rate decreased by 30% from 1990 to 2011 and was stable from 2011 to 2016 and then decreased 4% from 5.93 in 2017 to 5.69 in 2019[10]. In 2020, the perinatal death rate was 5.64 in the United States and 4.6 in Hong Kong. However, a direct comparison was inappropriate because the definition of stillbirth differs between these two places[6,10].

In a tertiary obstetric unit in Hong Kong, the perinatal death rate significantly decreased by 16.7% from 5.50 between 2000 and 2009 to 4.59 between 2010 and 2019[11]. The decrease is probably due to improvements in early prenatal diagnosis and treatment of congenital malformations and genetic disorders, as well as in the management of preeclampsia and moderately preterm (31-33 weeks of gestation) neonates[11,12]. The leading causes of stillbirths are fetal growth restriction (FGR), chorioamnionitis, congenital malformations and genetic abnormalities, placental abruption, and preeclampsia[11]. However, FGR is not diagnosed during routine antenatal care in 43.5% of patients, and about one-third of all singleton stillbirths are unexplained[11]. Around 6% of all stillbirths

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are intrapartum and caused by placental abruption, known lethal fetal anomalies, chorioamnionitis, uterine rupture, maternal diabetic ketoacidosis, or umbilical cord accident (eg, cord ulceration)[11]. The low intrapartum stillbirth rate is related to the use of continuous fetal heart rate monitoring, short decision-to-delivery interval, and short bradycardia-to-delivery interval[11]. The leading causes of early neonatal death are congenital or genetic abnormalities, prematurity, sepsis, and hypoxic-ischaemic encephalopathy[12]. Around two-thirds of hypoxic-ischaemic encephalopathy cases are caused by acute perinatal events such as cord prolapse, uterine rupture, vasa praevia, and placental abruption[12]. The rate of early-onset group B streptococcal infection has significantly decreased since the implementation of universal group B *Streptococcus* screening and peripartum antibiotic prophylaxis in 2012[12].

Interventions to reduce perinatal deaths

To reduce avoidable perinatal deaths, continuous care before pregnancy and during pregnancy, labour, and delivery, as well as throughout the neonatal period is required.

Pre-pregnancy advice includes a healthy balanced diet and being physically active at a healthy weight, stopping smoking or exposure to second-hand smoke, reducing or stopping alcohol consumption, taking folic acid supplementation, and having routine vaccinations including rubella and COVID-19 vaccines[2]. Women with pre-existing medical disorders or a family history of genetic disorders require individualised counselling.

During the first antenatal visit, it is important to identify risk factors of stillbirths. Common risk factors include advanced maternal age, age <20 years, obesity, assisted reproduction technology, smoking, pre-existing diabetes mellitus, chronic hypertension, renal disease, systemic lupus erythematosus, previous stillbirth, and multiple pregnancies[13]. In Hong Kong, additional risk factors include nulliparity, non-booked status, and non-Chinese Asian ethnicity[11].

General antenatal interventions to prevent stillbirth include balanced energy/protein supplementation (to enhance fetal growth), particularly in undernourished pregnant women[14]. Periconceptional folic acid supplementation can reduce the perinatal mortality and the risk from major birth defects including neural tube defects[15]. Pregnant women should avoid sleeping on their back after 28 weeks' gestation, as this might be associated with stillbirth[16]. Reducing the number of antenatal care visits may increase the risk of perinatal death[14].

Pregnant women should be advised to maintain oral hygiene, receive vaccinations and boosters (for seasonal flu, pertussis, and COVID-19), and avoid contact with people who have infectious illnesses including *Listeria*, cytomegalovirus, toxoplasmosis, parvovirus, and monkeypox[2].

Reducing smoking in pregnancy

In Hong Kong in 2015, the proportion of women who still smoke during pregnancy was 1.7%; around half of these women continued to smoke throughout their pregnancy[17]. Smoking status should be noted at booking and support given to women who have difficulty quitting smoking. Women should avoid second-hand smoke exposure before and during pregnancy because such exposure may increase the risk of stillbirth by 23% and the risk of congenital malformation by 13%[18].

Electronic cigarettes should not be considered a 'safer alternative' to conventional cigarettes during pregnancy; they are an independent risk factor for adverse outcomes including small for gestational age (SGA), low birthweight, and preterm delivery[19]. The proportion of Hong Kong young smokers (aged ≤25 years) who have used electronic cigarettes or heated tobacco products increased from 57.4% in 2017-2018 to 85.9% in 2019-2020; the reasons for the increase include curiosity, peer influence, and misconceptions[20]. Electronic cigarettes are an increasingly popular tool for drug abuse because the devices can be filled with narcotics or 'space oil'. It is necessary to educate young people and legislate against new tobacco products.

Congenital malformation and genetic abnormalities

Prenatal screening for severe fetal abnormalities should be offered to all pregnant women. At present, the universal, combined, first-trimester screening for Down syndrome is provided by the Hospital Authority, whereas non-invasive prenatal testing of cell-free DNA for detecting common trisomies and other chromosomal abnormalities is a common practice in the private sectors. Non-invasive prenatal testing is superior to combined first-trimester screening; its universal application in the public sector for common trisomies may be cost-effective as the costs decrease over time[21].

Mid-trimester morphology scanning is the standard

of antenatal care and usual practice in the private sectors, but it is not yet routinely provided by the Hospital Authority. The 2022 International Society of Ultrasound in Obstetrics and Gynecology guidelines added eleven fetal structures/elements in the consideration; nonetheless, extra time, effort, and skills are required[22,23]. Basic scanning is sufficient for pregnant women with no risk factors, but a more detailed ultrasound examination, as recommended by the Institute of Ultrasound in Medicine guidelines, is required when there are risk factors or abnormal or suspicious findings[22].

Chorionic villous sampling or amniocentesis, followed by karyotyping and/or chromosomal microarray analysis for aneuploidy and copy number variants, is common practice for investigating the genetic cause of fetal structural anomalies. Chromosomal microarray analysis cannot detect most single-gene disorders. Low-pass genome sequencing can be used to identify additional and clinically significant information with enhanced resolution and increased sensitivity in detecting mosaicism[24]. Whole-exome sequencing can be considered after careful case selection when chromosomal microarray analysis is negative[25].

Prenatal screening is the usual practice. Alpha or beta thalassaemia is the most common inherited genetic disorder in the Hong Kong population. Other haemoglobinopathies may be encountered in other populations. To identify couples at risk of having babies with other inherited genetic disorders such as spinal muscular atrophy and fetal akinesia syndrome, expanded carrier screening is offered, particularly to those with a history of consanguineous marriage[12]. Non-invasive prenatal testing enables early detection of a set of single-gene disorders, particularly in the presence of abnormal ultrasound findings, a positive family history, or advanced paternal age (≥40 years)[26].

When severe fetal abnormalities are diagnosed, termination of pregnancy before 24 weeks of gestation is an option. Fetal therapy is an alternative for cases of fetal anaemia or congenital diaphragmatic hernia, for example, after careful counselling. Fetal therapy should be performed in specialised centres by a multidisciplinary team to manage both maternal and fetal complications[27].

Fetal growth restriction

Risk assessment, surveillance, and management of FGR are important. In view of the increasing rates of stillbirth related to placental pathologies and FGR, improvements in FGR detection are needed[11]. It is important to differentiate between FGR and SGA and between early-onset and late-onset FGR, as the management is different. Mid-trimester ultrasonography, in combination with maternal risk factors, can be used to screen for early-onset FGR and placental dysfunction by measuring fetal biometry, estimating fetal weight, and checking the uterine artery on Doppler ultrasonography[2]. Early-onset FGR should be monitored and managed in tertiary-level units with the highest-level neonatal care[28].

For late-onset FGR, third-trimester ultrasonography may increase the detection of SGA or FGR but also increase obstetric intervention[29,30]. Screening for SGA/FGR by estimating fetal weight or measuring abdominal circumference is more accurate when the ultrasound examination is performed at 36 rather than 32 weeks[30]. Declining fetal growth velocity from 32 weeks' gestation is at risk for stillbirth from late-onset FGR[2].

In Hong Kong, >40% of FGR cases involving stillbirths without obvious causes of FGR (or in low-risk pregnancies) were not diagnosed until after delivery[11]. Serial measurement of the symphysis-fundal height is used to screen for SGA or FGR in low-risk pregnancies in public hospitals or maternal child health centres, but its detection rate is low. A routine third-trimester scan at 36 weeks' gestation should be offered to low-risk women to improve the detection rate of late-onset FGR.

The middle cerebral artery pulsatile index and the umbilical artery pulsatile index should be used to monitor late-onset FGR[28]. As the median interval between a low middle cerebral artery pulsatile index and stillbirth was ≤5 days, twice-weekly Doppler surveillance may be required after 34 weeks. Delivery should be based on gestational age, fetal size, Doppler studies, biophysical assessments, and maternal conditions. At 38+0 to 39+0 weeks, delivery is indicated if there is evidence of cerebral blood-flow redistribution or any other feature of FGR.

Raising awareness of reduced fetal movement

In the National Institute for Health and Care Excellence guidelines, pregnant women are encouraged to report any reduced fetal movement (RFM) after 24 weeks without delay[16]. Increased awareness of fetal movement may reduce neonatal intensive care unit admissions and cases of Apgar scores of <7 at 5 minutes and may increase maternal-fetal attachment and decrease maternal anxiety when compared with standard care[31]. However, there remained uncertainty about the current evidence regarding

the effect of increased awareness of RFM on stillbirth, probably because RFM may be too late as an indicator in an acute obstetric event[31]. Counting fetal movement may cause great anxiety for some women and hence repeated attendance at maternity units.

If pregnant women are unsure about whether fetal movements are reduced after 28 weeks, they should be advised to lie on their left side and focus on fetal movement for 2 hours[32]. In managing a pregnant woman with RFM, maternal risk factors for stillbirth and FGR as well as fetal size should be assessed. Cardiotocography can be performed to exclude fetal compromise. If RFM persists or recurs or if risk factors for stillbirth/FGR are present, ultrasound should be performed to detect SGA/FGR and fetal abnormalities[32]. A biophysical profile can also be performed[32]. Expediting birth should be discussed from 39+0 weeks[2]. Induction of labour before 39 weeks should be individualised if there is evidence of fetal compromise or concern other than RFM[2].

Therefore, all pregnant women should be encouraged to report RFM, whereas high-risk pregnant women should be advised to count fetal movements. Timely reporting and prompt assessment of RFM are required to reduce stillbirths.

Reducing preterm birth

Improving the predication and prevention of preterm birth and optimising perinatal care when preterm birth cannot be prevented can reduce adverse fetal and neonatal outcomes[2]. Asymptomatic women at intermediate- or high-risk of preterm labour should be offered transvaginal cervix scanning to assess the need for intervention[2]. Both vaginal progesterone and intramuscular 17-hydroxyprogesterone caproate can reduce the risk of birth before 34 weeks' gestation in high-risk singleton pregnancies (including women with a short cervix)[33]. Quantitative assessment of fetal fibronectin can differentiate between very-high and very-low risks of spontaneous preterm birth in asymptomatic pregnancies and thus help guide antenatal management and in-utero transfers[34].

Therefore, screening for a short cervix should be a part of the routine mid-trimester scanning using transabdominal imaging. Although transvaginal imaging is more accurate than transabdominal imaging in measuring cervical length, the former requires a separate consent. However, transvaginal imaging can be used selectively in high-risk cases or when transabdominal imaging shows abnormal or suspected findings.

Acute tocolysis may be used when short-term delay is desirable during in-utero transfer and to ensure that adequate antenatal exposure to corticosteroid/magnesium sulphate is given[2]. A single course of antenatal corticosteroids administered between 22+0 and 34+6 weeks inclusive, with a neonate born within 24 to 48 hours of their administration, has been shown to reduce perinatal and neonatal death and respiratory distress syndrome[35]. Besides, magnesium sulphate should be offered to women between 22+0 and 29+6 weeks and considered for women between 30+0 and 33+6 weeks of pregnancy to reduce the risks of cerebral palsy in their children[36].

Management of medical disorders

Pre-existing diabetes in pregnancy is associated with perinatal death. Multidisciplinary team management and an intensified focus on glucose management, including glycated haemoglobin measurement and continuous glucose monitoring, are recommended[2]. In Hong Kong, pre-existing diabetes, in contrast to gestational diabetes, is not common. Affected women are usually referred to physicians/endocrinologists for diabetic care.

Preeclampsia, especially diagnosed in the preterm period, is associated with a remarkably high risk of fetal death because of the associated FGR and placental abruption[11,37]. Increased preeclampsia prevalence in the Hong Kong population over the years is related to an increased prevalence of advanced maternal age and obesity[11]. Primary prevention via first-trimester screening and aspirin prophylaxis can reduce adverse fetal outcomes[11]. In Asian populations, implementation of the screen-and-prevent strategy for preterm preeclampsia cannot significantly reduce its incidence, but low-dose aspirin effectively can reduce the incidence of preterm preeclampsia by 41% among high-risk women[38]. Therefore, first-trimester screening for preeclampsia should be offered to all pregnant women.

Intrahepatic cholestasis of pregnancy usually presents with pruritus in the third trimester of pregnancy but a normal appearance of the skin. The risk of stillbirth is increased when the peak serum bile acid concentrations are of ≥100 mmol/L[39]. The Royal College of Obstetricians and Gynaecologists recommends considering a planned birth at 35-36 weeks, at 38-39 weeks, and by 40 weeks when peak bile acid levels are ≥100, 40-49, and 19-39 mmol/L, respectively[39]. In clinical practice, when a pregnant woman presents with a generalised pruritus during the second or third trimester, diagnosis of intrahepatic cholestasis of pregnancy should be considered.

Umbilical cord abnormalities

Umbilical cord anomalies are associated with an increased risk of pregnancy and perinatal complications including FGR and stillbirth. Antenatal detection of cord anomalies can help inform perinatal risks and management options and can improve perinatal outcomes by appropriate management[40]. Common anomalies include single umbilical artery and velamentous cord insertion. The former is associated with FGR and other structural anomalies, whereas the latter is associated with FGR and vasa previa. Vasa previa, if undetected, is associated with high perinatal morbidity and mortality because of the risks of rupture or compression of fetal vessels when uterine contractions occur or the membranes rupture.

Most umbilical cord abnormalities can be detected by mid-trimester ultrasound examination. In the presence of risk factors for vasa previa (including twin pregnancy, conception after assisted reproductive technology, a low-lying or bilobed placenta, succenturiate placental lobes, and velamentous cord insertion), a targeted transvaginal ultrasound examination with colour Doppler imaging is recommended to detect vasa previa[23]. If vasa previa is detected, follow-up scans during pregnancy and customised obstetric management are indicated[23].

Therefore, screening for vasa previa should be performed at the mid-trimester scans in all pregnancies with a low-lying placenta, velamentous cord insertion, or a risk factor for vasa previa. Transvaginal scans are particularly useful but require a separate consent, additional scanning time, skill, and resources.

Induction of labour

Pregnancies continuing beyond 41+0 weeks' gestation increase the risks of stillbirth and neonatal death, particularly among women with advanced maternal age, intrahepatic cholestasis of pregnancy, and hypertensive disorders of pregnancy[20,33]. Compared with expectant management, induction of labour at or beyond term is associated with fewer perinatal deaths and fewer Caesarean sections, despite more operative vaginal births[41,42].

In low-risk nulliparous women, induction of labour at 39 weeks is not associated with a decrease in composite adverse perinatal outcomes but is associated with a decrease in rates of Caesarean section delivery and gestational hypertension/preeclampsia[43]. Both elective induction of labour and expectant management are reasonable options at 39 weeks for low-risk nulliparous women because of comparable neonatal outcomes. When counselling women about elective induction of labour at 39 weeks, shared decision-making is vital[44]. Some women may opt for an elective induction of labour because of the benefits of decreased rates of Caesarean section delivery and gestational hypertension/preeclampsia; others may prefer expectant treatment with the possibility of spontaneous labour and vaginal delivery[44]. Elective induction of labour may reduce the risk of an emergency admission for labour, but there are resource implications and logistic difficulties when slots are taken by women with medical or obstetric indications for delivery[44].

Intrapartum care

In Hong Kong, approximately 6% of all stillbirths are intrapartum[11]. A hospital trust in the United Kingdom recommends that hospitals improve the quality and safety of maternity care by focusing on human factors, system issues, effective training and learning, and the provision of sustainable, high-quality maternity, anaesthetic, and neonatal care[29]. Human factors include lack of situational awareness, failure of escalation or acting on risk, and poor communication between professionals[29]. Multidisciplinary obstetric emergency training such as Practical Obstetric Multi-Professional Training is required[29].

Standard protocols can help prevent or reduce intrapartum risks of birth asphyxia, prolonged labour, infection, shoulder dystocia, and difficult vaginal delivery[45,46].

Perinatal asphyxia

Effective fetal monitoring during labour should be provided. All staff responsible for monitoring the fetus should be competent in the techniques that they use (intermittent auscultation and/or cardiotocography) in relation to the clinical situation; they should use the buddy system and escalate accordingly when concerns arise or risks develop[2].

The National Institute for Health and Care Excellence guidelines recommend a physiological approach to cardiotocography interpretation and global overview of the clinical picture[47]. Intrapartum use of fetal blood sampling is no longer recommended because of lack of evidence[47]. Continuous cardiotocography in labour can halve the rate of neonatal seizures, compared with intermittent auscultation, although rates of perinatal death or cerebral palsy are not reduced[48]. A combination of external monitoring cardiotocography and simultaneous maternal heart rate recording is recommended to decrease rates of neonatal encephalopathy and severe neonatal acidaemia, compared with monitoring without maternal heart rate recording[49].

During intrapartum, clinicians should review previous fetal heart monitoring results and antenatal or intrapartum risk factors including FGR and infection to determine whether there are any changes in baseline fetal heart rate, variability, or decelerations[47]. Acute hypoxic event such as placental abruption, cord prolapse, and uterine rupture may present with prolonged bradycardia, which can be easily recognised. Immediate delivery, preferably within 30 minutes, is required to prevent fetal death or neonatal hypoxic sequelae.

Slowly evolving hypoxia may develop in response to intermittent episodes of oxygen deprivation (such as cord compression and hypoxaemia) and excessive oxytocin infusion. Slowly evolving hypoxic changes in cardiotocography throughout a long labour may be too subtle to identify. For instance, a rise in baseline fetal heart rate may represent either infection or hypoxia[47]. A combination of reduction in variability and a rise in the baseline fetal heart rate indicates fetal compromise[47].

Oxytocin is commonly used in the first and second stage of labour. However, oxytocin-induced uterine hyperstimulation can cause oxygen desaturation, non-reassuring fetal heart rate characteristics[50], and adverse neonatal outcomes including hypoxic-ischaemic encephalopathy. Oxytocin should thus be used with caution to avoid hyperstimulation, especially among at-risk women. Once occurring, hyperstimulation should be treated in a timely manner until the fetal heart rate pattern becomes non-reassuring[50].

Fetuses with chronic hypoxia may present with a silent or absent baseline variability together with shallow decelerations[47]; these fetuses can deteriorate and die within a short time. Early delivery is indicated.

Infection

Despite the reduced risk of neonatal group B streptococcal infection, clinicians should remain vigilant about the presence of chorioamnionitis and risk factors for sepsis. Early-onset neonatal infection is a major cause of morbidity and mortality; any new risk factors throughout labour such as fever should be monitored[51]. To prevent early-onset neonatal infection, intrapartum antibiotic prophylaxis should be given to women with maternal group B streptococcal colonisation, preterm labour, prolonged prelabour rupture of membranes, or other risk factors[51].

Whenever intra-amniotic infection or chorioamnionitis is suspected, intrapartum antibiotics should be administered, followed by communication with the neonatal care team to optimise subsequent neonatal management[52]. In prelabour rupture of membranes, women with latency >12 hours who have received antibiotics have a lower rate of chorioamnionitis (2.9% vs 6.1%), compared with women with latency <12 hours[53]. Therefore, antibiotics should be considered when the latency is >12 hours.

Intrapartum fever is associated with an increased risk for perinatal mortality because the fetus is often exposed to a combination of hyperthermia and inflammation and, in some cases, to infection[54]. Prevention of prolonged labour can reduce the rates of intrapartum fever[54]. Among nulliparas at >36 weeks' gestation, a high-dose oxytocin regimen is associated with a lower rate of intrapartum fever, compared with a low-dose oxytocin regimen (10.4% vs 15.6%)[55]. Although intrapartum fever generally has a non-infectious origin, intra-amniotic infection or chorioamnionitis cannot be excluded with available clinical or biochemical markers[54]. Therefore, antibiotic treatment should be considered even with an isolated intrapartum fever of >38°C[54].

Shoulder dystocia

Risk assessment for the prediction of shoulder dystocia is insufficiently predictive[56]. Induction of labour at term can reduce the incidence of shoulder dystocia in women with gestational diabetes, whereas elective Caesarean section should be considered for suspected macrosomia[56].

Timely management of shoulder dystocia requires prompt recognition by attending midwives or doctors[56]. The conventional recommendation is to start with external manoeuvres including the McRoberts' manoeuvre and suprapubic pressure, followed by internal manoeuvres including rotation and posterior arm delivery[57]. However, posterior arm delivery has a consistently higher success rate than rotational methods and external manoeuvres[57]. Therefore, the conventional recommendation should be followed in view of the current evidence. If external manoeuvres do not lead to the delivery of the shoulders, internal manoeuvres should be performed early, avoiding prolonged excessive traction on the fetal neck, which carries a risk of brachial plexus injury. Besides, all trainees should undergo proper training (such as the Advanced Life Support in Obstetrics programme) and simulation exercises to learn the proper techniques of delivery manoeuvres. Both the safety and the success of various manoeuvres are related, as is how properly these manoeuvres are performed[57].

Operative vaginal birth

Expediting delivery in the second stage of labour via operative vaginal birth (forceps or ventouse) is associated with increased risk of neonatal and maternal morbidity and mortality. Poor outcomes of operative vaginal birth are associated with inaccurate determination of fetal head position, among other factors[58]. The ascertainment of fetal head position and station is a prerequisite before considering operative vaginal birth. The use of ultrasound before operative vaginal birth is associated with fewer infants delivered in an unexpected position and reduced neonatal morbidity[58]. The Royal College of Obstetricians and Gynaecologists guidelines recommend using ultrasound to assess fetal head position before the use of ventouse or forceps, when uncertainty exists after a clinical examination[59]. Therefore, use of transabdominal ultrasound for fetal position is highly recommended.

Fetal head position in the axial and sagittal planes can be assessed through transabdominal ultrasound to identify the fetal occiput and spine, the two orbits, and the midline cerebral echo (for occipital transverse) for occipital anterior, occipital posterior, and occipital transverse positions, respectively[60]. An ultrasound machine equipped with a wide-sector and low-frequency transducer should be made readily available in each maternity unit[60].

Obstetrician and neonatologist attendance

A specialist in obstetrics and gynaecology should arrive to attend to an obstetric patient in an emergency (life threatening to the mother and/or the fetus) within 30 minutes of such an alert. Hospital guidelines on the presence of a neonatologist at delivery can improve communication. Attending obstetrician/midwives should assess the degree of neonatal risk anticipated and communicate their concerns early and effectively to the neonatologist to make management decisions.

New developments

There are limitations to the currently available tools for fetoplacental monitoring. Development of more accurate and nuanced methods is needed such as wearable fetal movement monitors, mRNA markers measurement for prediction of stillbirth, and magnetic resonance imaging for assessment of placental and fetal oxygenation[61].

Machine learning and artificial intelligence on conventional fetoplacental monitoring have been applied to improve diagnostic or predictive accuracy[61]. Examples of potential applications are ultrasonography for estimation of fetal body weights and gestational age, first trimester placental volume, and vascularity for predicting SGA, FGR, and preeclampsia, whereas intrapartum cardiotocography and fetal electrocardiography are for assessment of fetal wellbeing.

Conclusion

The perinatal death rate in Hong Kong remains low, but the stillbirth rate has fluctuated over the past 12 years. Efforts should be made to prevent avoidable perinatal death, focusing on SGA/FGR, preterm birth, congenital malformations and genetic disorders, perinatal asphyxia, preeclampsia, diabetes, and infection. Non-invasive prenatal testing for common trisomies, first-trimester screening for preeclampsia, and mid-trimester morphology scanning should be offered to pregnant women. Screening for a short cervix and vasa previa should be included in the mid-trimester morphology scan. To increase the detection rate of SGA/FGR, a routine third-trimester scan can be offered to low-risk population. Timely reporting and prompt assessment of RFM are important. Elective induction of labour at 39 weeks can be offered to low-risk nulliparous women after careful counselling and shared decision-making. During intrapartum, it is important to provide effective fetal monitoring and remain vigilant about the presence of chorioamnionitis and risk factors for sepsis. Ultrasound can be used selectively to assess fetal head position before the use of ventouse or forceps, when uncertainty exists after a clinical examination. All trainees should undergo proper training in emergency obstetric care to improve their clinical competency.

Contributor

The author designed the study, acquired the data, analysed the data, drafted the manuscript, and critically revised the manuscript for important intellectual content. The author had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

As an executive editor of the journal, KYL was not involved in the peer review process.

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Data availability

All data generated or analysed during the present study are available from the corresponding author upon reasonable request.

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Self-management of pessary in patients with pelvic organ prolapse

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Objectives: This study aimed to evaluate the acceptance of self-management of a pessary and its associated factors in patients with pelvic organ prolapse (POP).
Methods: Patients with POP attending one of the three gynaecological outpatient clinics who planned to use or were using pessaries were invited to participate. Participants were asked to complete a six-item questionnaire: whether they had used a pessary before; whether they were aware of self-management of the pessary; whether they would opt for self-management of the pessary; what the reasons were for learning self-management; and what the reasons were for not using or stopping using the pessary, if applicable. Factors associated with their choices were evaluated.
Results: In total, 301 participants were included in the analysis. The mean age of the participants was 71.1 years, and the median parity was two. Most had stage I to II POP and were current users of pessaries. Overall, 53.5% of participants agreed to learn to self-manage the pessary; they were more likely to be younger, sexually active, and aware of self-managing a pessary.
Conclusion: Self-management of a pessary is an acceptable option for POP. Most participants agreed to learn self-management, and therefore patient education and encouragement should be aimed at.

Keywords: Pelvic organ prolapse; Pessaries; Self-management

Introduction

Pelvic organ prolapse (POP) is a common gynaecological condition worldwide, with prevalence ranging from 9% to 41%[1-3]. It affects daily living and quality of life. The lifetime risk for women requiring surgical treatment for a POP is 11% to 19%[4-6]. Yet, surgical treatment is associated with anaesthetic and surgical risks, and there is a long waiting time for an operation in the public sector. Thus, the use of a pessary is invaluable while awaiting definitive surgical treatment.

Conservative measures such as pelvic floor exercises and pessaries are recommended as first-line management for a POP. A pessary can relieve the symptoms of prolapse and is effective in treating prolapse in the advanced stages[7]. It has been recommended by the National Institute for Health and Care Excellence and the American College of Obstetricians and Gynecologists[8,9]. However, pessaries may increase vaginal discharge, vaginal discomfort, bleeding, and ulceration[7,10]. It requires long-term follow-up (every 3-6 months) to change or cleanse pessaries. This increases the burden to the public healthcare system in terms of costs and waiting time.

Self-management of a pessary by patients is cost-effective and can reduce complication rates[10,11]. Patients are encouraged to learn to remove and insert the pessary for their daily living and schedule. Of all pessary users, 18% to 53% were offered self-management[12,13]. Self-management is associated with the continued use of a pessary for POP, despite inconsistent evidence[14].

In Hong Kong, self-management of a pessary by patients is uncommon. This study aimed to evaluate the acceptance of self-management of a pessary and its associated factors in patients with POP.

Methods

Patients with POP attending the gynaecological outpatient clinics of Alice Ho Miu Ling Nethersole Hospital, Kwong Wah Hospital, or Prince of Wales Hospital between November 2023 and April 2024 who planned to use or were using pessaries were invited to participate. Patients were

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excluded if they could not understand the questionnaire, had limited physical dexterity, were pregnant, or aged <18 years.

Participants were provided with an information sheet introducing the pessary and its self-management. Participants were asked to complete a six-item questionnaire: whether they had used a pessary before; whether they were aware of self-management of the pessary; whether they would opt for self-management of the pessary; what the reasons were for learning self-management; and what the reasons were for not using or stopping using the pessary, if applicable.

Baseline characteristics and symptoms of POP were collected by clinicians. Data collected included age, education level, past obstetric history, history of any obstetric anal sphincter injuries, menopausal status, sexual activities, body mass index, duration of symptoms, and prior use of a pessary. The stage of the POP was based on the POP quantification system.

The sample size was calculated using the formula: $n=N\times X/(X+N-1)$, where $X=Z_{\alpha/2}{}^2-p(1-p)/MOE^2$ ($Z_{\alpha/2}$ denotes the critical value of the normal distribution at $\alpha/2$; MOE denotes the margin of error; p denotes the sample proportion; and N denotes the population size). Finite population correction was applied to the sample size formula. The sample size was estimated to be >270, assuming a 5% margin of error, 90% confidence interval, and a population of around 100 000.

Statistical analysis was performed using SPSS (Windows version 24.0; IBM Corp, Armonk [NY], United States). Associations between variables and acceptance of self-management were assessed using Fisher's exact test or Chi-squared test for qualitative variables and Student's *t* test for quantitative variables. A p value of <0.05 was considered statistically significant.

Results

Of 461 patients invited, 333 (72.2%) agreed to participate. Of these, 32 were excluded owing to incomplete questionnaire (n=22), duplicated recruitment (n=2), use of donut or Gellhorn pessaries (n=6), or the absence of POP at the time of recruitment (n=2). The remaining 301 participants were included in the analysis (Table 1).

The mean age of the participants was 71.1±8.9 years, and the median parity was two. Most had stage I to II POP and were current users of pessaries. Overall, 53.5% of

Table 1. Acceptance of self-management of a pessary among participants

Variable	Self-management of a pessary*		p Value
	Agree (n=161)	Disagree (n=140)	
Age, y	69.0±9.2	73.5±8.1	<0.001
Body mass index, kg/m^2	24.5±3.0	24.4±3.2	0.334
Parity			0.485
0	1 (0.6)	0	
1	23 (14.3)	16 (11.4)	
≥2	137 (85.0)	124 (88.6)	
History of instrumental delivery			0.62
No	147 (91.3)	130 (92.9)	
Yes	14 (8.7)	10 (7.1)	
History of any obstetric anal sphincter injuries			0.317
Yes	2 (1.2)	4 (2.9)	
No	159 (98.8)	136 (97.1)	
Menopausal status			0.876
Menopaused	148 (91.9)	128 (91.4)	
Premenopausal	13 (8.1)	12 (8.6)	
Current status of sexual activity			0.012
Active	30 (18.6)	12 (8.6)	
Inactive	131 (81.4)	128 (91.4)	
Education level			
Unknown	32 (19.9)	39 (27.9)	0.07
Nil	11 (6.8)	14 (10.0)	
Primary	58 (36.0)	55 (39.3)	
Secondary	57 (35.4)	29 (20.7)	
Tertiary	3 (1.9)	3 (2.1)	
Stage of prolapse			
I	38 (23.6)	39 (27.9)	0.115
II	90 (55.9)	79 (56.4)	
III	28 (17.4)	13 (9.3)	
IV	5 (3.1)	9 (6.4)	
Duration of symptoms of prolapse, y			0.44
<1	6 (3.7)	2 (1.4)	
1-2	34 (21.1)	23 (16.4)	
3-5	50 (31.1)	43 (30.7)	
6-10	36 (22.4)	32 (22.9)	
>10	35 (21.7)	40 (28.6)	
Have you used pessary before?			0.16
Never	16 (9.9)	7 (5.0)	
Current use	140 (87.0)	131 (93.6)	
Ever user	5 (3.1)	2 (1.4)	
Duration of pessary use, y			0.196
0-1	57 (35.4)	33 (23.6)	
>1-2	23 (14.3)	23 (16.4)	
3-5	35 (21.7)	30 (21.4)	
6-10	27 (16.8)	33 (23.6)	
>10	19 (11.8)	21 (15.0)	
Do you know about self-management of a pessary?			0.03
Yes	69 (42.9)	43 (30.7)	
No	92 (57.1)	97 (69.3)	

* Data are presented as mean ± standard deviation or No. (%) of participants

participants agreed to learn to self-manage the pessary; they were more likely to be younger, sexually active, and aware of self-managing a pessary. Table 2 shows the reasons for agreeing or disagreeing to practise self-management of a ring pessary.

Discussion

Of the participants, 53.5% agreed to self-manage a pessary after receiving adequate explanation and education, and only 37.2% had heard of self-management before this survey. Participants with higher acceptance of self-managing the pessary were those who had knowledge about self-management or were younger or sexually active. Thus, promoting self-management, as early as possible, to all patients requiring pessaries is crucial to increase its acceptance.

Participants who were sexually active had higher acceptance of self-managing a pessary. This is likely due to the benefit of being able to remove the pessary before coitus. Acceptance of self-managing a pessary was not associated with education level, parity, history of instrumental delivery, history of obstetric anal sphincter injuries, severity and duration of POP, or duration of pessary use. This suggests that self-management of a pessary can be promoted at any time during the patient's journey. Self-management can reduce both short-term and long-term pessary-related complications and is cost-effective[11].

Participants who agreed to self-manage a pessary were largely those who wanted autonomy over use and care, and/or decreases in the number of follow-ups and complications such as per vagina bleeding and discharge, whereas participants who declined self-management were mainly as a result of lack of confidence, fear of failure to learn and/or fear of hurting the vagina, pessary malposition, or bleeding; they perceived self-management as troublesome and preferred clinic-based management. Patient education and encouragement may promote self-management of a pessary.

Our findings provide perspectives on the promotion of self-managing a pessary for POP. Early education on self-management should be provided at the initial presentation. Patients, especially young, sexually active patients, should be counselled on the advantages of self-management in reducing the number of follow-ups and complications. Patients should be empowered to learn self-management for the benefit of patient autonomy. The misconception of self-management being troublesome should be clarified. Adequate support should be provided so that patients can be confident when handling minor complications.

There were limitations to the present study. Only views on acceptance were explored, but the success rate of self-replacement was not assessed. Patients' ability to learn self-management has been shown to be high in Caucasian

Table 2. Reasons for agreeing/disagreeing self-management of a pessary

Reason	No. (%) of participants*
Agree to practise self-management	n=161
Able to self-manage	139 (86.3)
Can reduce the number of clinic follow-ups	91 (56.5)
Can reduce the occurrence of vaginal bleeding/discharge	63 (39.1)
Can rest vaginal mucosa	57 (35.4)
Can remove before coitus	13 (8.1)
Others: less painful (n=3), less risk of infection (n=6), can avoid a clinical procedure (n=6), undergoing chemotherapy (n=1)	16 (9.9)
Disagree to practise self-management	n=140
Lack confidence	97 (69.3)
Fear of learning failure	60 (42.9)
Prefer clinic-based management	55 (39.3)
Fear of hurting vagina, pessary malposition, or bleeding	51 (36.4)
Sounds troublesome	50 (35.7)
Fear of touching vagina	28 (20.0)
Only planned for short-term use	23 (16.4)
Other: pessary is expensive (n=1)	1 (0.7)

* Multiple reasons are allowed

populations[15]. There could be selection bias because the views of patients who refused to participate were not included. The views of patients who opted for conservative or surgical management may not be included, because they had been preoccupied with alternative options before acquiring knowledge about self-managing a pessary.

Conclusion

Self-management of a pessary is an acceptable option for POP. Most participants agreed to learn self-management, and therefore patient education and encouragement should be aimed at.

Contributors

All authors designed the study, acquired the data, analysed the data, drafted the manuscript, and critically revised the manuscript for important intellectual content. All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

As an editor of the journal, SCSC was not involved in the peer review process. Other authors have no conflicts of interest to disclose.

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Data availability

All data generated or analysed during the present study are available from the corresponding author on reasonable request.

Ethics approval

This study was approved by the Kowloon Central/ Kowloon East Cluster Research Ethics Committee (reference: KC/KE-23-0126/ER-1) and the Joint Chinese University of Hong Kong – New Territories East Clinical Research Ethics Committee (reference: 2023.603). The patients were treated in accordance with the tenets of the Declaration of Helsinki. The patients provided written informed consent for all treatments and procedures and for publication.

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Women's knowledge, perception, and intention concerning human papillomavirus vaccination: a survey in a public hospital in Hong Kong

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Objectives: This study aimed to explore the knowledge, perception, and intention concerning human papillomavirus (HPV) vaccination among women attending our hospital, and to identify factors influencing the decision to receive HPV vaccination.
Methods: This was a cross-sectional observational study. Women aged 16 to 45 years who attended gynaecology outpatient clinics at Queen Elizabeth Hospital between May and July 2024 were invited to participate. Participants were asked to complete a questionnaire about knowledge, perception, and intention concerning HPV vaccination.
Results: In total, 286 women (mean age, 35.9 years) were included in the analysis. Regarding knowledge on HPV infection, transmission, and vaccination, >80% of participants correctly answered at least 10 out of 12 questions. Regarding perceptions of HPV vaccine, participants, on average, agreed that "the HPV vaccine is safe" and that "the current HPV vaccine is capable of preventing the occurrence of cervical cancer". Regarding intention to receive HPV vaccination, 82 (28.7%) participants received vaccination, 24 (8.4%) were in the process of completing vaccination, and 180 (62.9%) did not receive vaccination. Of the latter, 105 (58.3%) had no intention to receive it mainly owing to worries about the vaccine's adverse effects and safety issues (54.3%) and insufficient knowledge about the vaccine (43.8%). Additionally, 86 (81.9%) would consider receiving vaccination if their gynaecologists recommended it. Of 39 participants with children, 30 (76.9%) would recommend their children to receive HPV vaccination. In multivariate analysis, independent factors associated with higher vaccination rate were higher education levels (odds ratio [OR]=2.007, p=0.025), higher household income (OR=1.451, p=0.021), better knowledge on HPV-related questions (OR=1.541, p<0.001), and the perception that the vaccines are safe (OR=2.168, p<0.001).
Conclusion: Despite adequate knowledge and favourable perception towards HPV vaccination, our participants have suboptimal vaccination uptake. Gynaecologists should be more proactive to educate women on vaccination.

Keywords: Human papillomavirus vaccine; Uterine cervical neoplasms

Introduction

In Hong Kong, cervical cancer is the seventh most common cancer among women[1], mostly caused by persistent human papillomavirus (HPV) infection. HPV vaccination can prevent cervical cancer by protecting against oncogenic-type HPV infections[2]. The efficacy and safety of the HPV vaccine have been well demonstrated[3,4]. Although the vaccine is most beneficial when administered at a younger age and before the start of sexual activity[5], it can still offer protective immunity across older age groups[6]. Women who have been infected with HPV but have cleared the infection can still achieve protection against the HPV types included in the vaccines[7].

Physicians play a significant role in one's vaccination decision[8,9]. This study aimed to explore the knowledge, perception, and intention concerning HPV vaccination among women attending our hospital, and to identify factors influencing the decision to receive HPV vaccination.

Methods

This was a cross-sectional observational study. Women aged 16 to 45 years who attended gynaecology outpatient clinics at Queen Elizabeth Hospital between May and July 2024 were invited to participate. Those who were mentally incapacitated or illiterate or had a history of abnormal cervical smears were excluded.

Participants were asked to complete a questionnaire about knowledge, perception, and intention concerning HPV vaccination. The knowledge section comprised

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12 statements; answers were either true or false. The perception section comprised two statements; responses were measured in a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The intention section comprised five questions; percentages of participants received, in the process of completing, or did not receive vaccination were recorded, as were reasons for not receiving vaccination. Other data collected included age, marital status, income, education level, number of sexual partners, and ethnicity.

Based on the total number of women aged 16 to 45 years attending our clinics in 3 months, which amounts to about 1000, a minimum sample size of 278 is needed to achieve a 95% confidence interval at a 5% margin of error. Comparisons of categorical or continuous variables were made using the Chi-squared test or Student's *t* test, respectively. Variables with a p value of <0.1 in the univariate analysis were entered in the multivariate analysis to identify independent factors influencing HPV vaccination. A p value of <0.05 was considered statistically significant. Statistical analyses were performed using SPSS (Windows version 26.0; IBM Corp, Armonk [NY], United States).

Results

In total, 286 women were included in the analysis (Table 1). There were no missing data because completeness of questionnaire responses was checked by staff before submission. The mean age of participants was 35.9±7.5 years; 56.3% were aged 36 to 45 years; 42.2% had at least one child; 72.4% reported being sexually active; and 43.5% of the latter never had cervical smear screening.

Regarding knowledge on HPV infection, transmission, and vaccination, >80% of participants correctly answered at least 10 out of 12 questions (Table 2).

Regarding perceptions of HPV vaccine, the mean score was 3.86 (95% confidence interval, 3.77-3.95) for the statement "the HPV vaccine is safe" and 3.76 (95% confidence interval, 3.68-3.84) for the statement "the current HPV vaccine is capable of preventing the occurrence of cervical cancer" (Table 2).

Regarding intention to receive HPV vaccination, 82 (28.7%) participants received vaccination, 24 (8.4%) were in the process of completing vaccination, and 180 (62.9%) did not receive vaccination (Table 2). Of the latter, 105 (58.3%) had no intention to receive it. Specifically, younger age groups (16-25 and 26-35 years) had higher intention to receive vaccination than the older age group (36-45 years) [44.8% vs 47.9% vs 29.2%, p=0.035]. Among the 105 participants with no intention to receive vaccination, 57 (54.3%) worried about the vaccine's adverse effects and safety issues; 46 (43.8%) reported having insufficient knowledge about the HPV vaccine; 30 (28.6%) considered the vaccine too expensive; and 86 (81.9%) would consider receiving vaccination if their gynaecologists recommended

Table 1. Characteristics of participants

Characteristics	No. (%) of participants (n=286)
Age group, y	
16-25	29 (10.1)
26-35	96 (33.6)
36-45	161 (56.3)
Education level	
Primary	5 (1.7)
Secondary	111 (38.8)
Tertiary	170 (59.4)
Household income, HK$	
<10 000	25 (8.7)
10 001-29 999	98 (34.3)
30 000-49 999	82 (28.7)
50 000	81 (28.3)
Ethnicity	
Chinese	263 (92.0)
Non-Chinese	23 (8.0)
Smoking	
Yes	9 (3.1)
No	277 (96.9)
Cervical smear screening	
Yes	117 (40.9)
No	90 (31.5)
Not applicable	79 (27.6)
No. of sexual partners	
0	79 (27.6)
1	116 (40.6)
2-4	70 (24.5)
5-10	20 (7.0)
>10	1 (0.3)
Children	
Yes	121 (42.3)
No	165 (57.7)

Table 2. Knowledge, perception, and intention concerning human papillomavirus (HPV) vaccination

Statement	No. (%) of participants with correct response (n=286)
Knowledge	
Women no longer need to undergo cervical cancer screening after receiving HPV vaccine (false)	268 (93.7)
Only women who have had more than one sexual partner need to receive HPV vaccine (false)	271 (94.8)
Cervical cancer may be caused by HPV infection (true)	252 (88.1)
Genital warts may be caused by HPV infection (true)	238 (83.2)
HPV vaccine can only be received after sexual contact (false)	264 (92.3)
Using condoms can eliminate the risk of HPV infection (false)	258 (90.2)
People must find a gynaecologist to receive the vaccine (false)	207 (72.4)
HPV vaccine is only suitable for women (false)	245 (85.7)
HPV vaccine requires two to three injections (true)	258 (90.2)
There is only one type of HPV vaccine available on the market (false)	245 (85.7)
People who are already infected with HPV can completely clear the virus by receiving the HPV vaccine (false)	263 (92.0)
The government currently provides two free doses of 9-valent HPV vaccine to all eligible girls from primary 5 to primary 6 through the Hong Kong Childhood Immunisation Programme (true)	212 (74.1)
Perception (measured using a five-point Likert scale from 1 [strongly disagree] to 5 [strongly agree])	**Mean±standard deviation (95% confidence interval)**
The HPV vaccine is safe	3.86±0.74 (3.77-3.95)
The current HPV vaccine is capable of preventing the occurrence of cervical cancer	3.76±0.67 (3.68-3.84)
Intention	**No. (%) of participants**
Have you received HPV vaccination?	82 (28.7)
If you have not yet received vaccination, will you consider receiving vaccination?	24 (8.4)
If the answer is no, what are the reasons for not taking the vaccination? (multiple answers allowed)	n=105
I am worried of adverse effects / safety profile	57 (54.3)
I am not sure about the effectiveness of HPV vaccines in prevention of cervical cancer	32 (30.5)
I do not have enough information about HPV vaccine	46 (43.8)
I think it is too expensive	30 (28.6)
I am not sure where to receive HPV vaccine	12 (11.4)
My partner/family members do not allow me to take it	1 (1.0)
Will you consider taking the vaccination if it is recommended by your gynaecologist?	86 (81.9)
Will you recommend the vaccines to your children? (if applicable)	39 (37.1)

it. Of 39 participants with children, 30 (76.9%) would recommend their children to receive HPV vaccination.

In multivariate analysis, independent factors associated with higher vaccination rate were higher education levels (odds ratio [OR]=2.007, p=0.025), higher household income (OR=1.451, p=0.021), better knowledge on HPV-related questions (OR=1.541, p<0.001), and the perception that the vaccines are safe (OR=2.168, p<0.001) [Table 3].

Discussion

Despite satisfactory knowledge on HPV vaccination and favourable perception towards receiving it, only 106 (37.1%) of our participants received or were in the process of completing HPV vaccination. Among the 180 unvaccinated

Table 3. Independent factors associated with human papillomavirus (HPV) vaccination

Variable	Univariate analysis		Multivariate analysis	
	Odds ratio (95% confidence interval)	p Value	Odds ratio (95% confidence interval)	p Value
Age group	0.613 (0.429-0.876)	0.007	0.780 (0.522-1.166)	0.226
Education level	2.680 (1.618-4.439)	<0.001	2.007 (1.090-3.693)	0.025
Household income	1.823 (1.390-2.391)	<0.001	1.451 (1.058-1.989)	0.021
Smoking status	0.845 (0.207-3.450)	0.814	-	-
Cervical smear screening	0.799 (0.491-1.299)	0.366	-	-
Chinese ethnicity	0.146 (0.033-0.634)	0.010	2.239 (0.441-11.365)	0.331
No. of lifetime sexual partners	1.089 (0.964-1.231)	0.172	-	-
Having children	1.120 (0.688-1.823)	0.647	-	-
Knowledge score	1.719 (1.397-2.117)	<0.001	1.541 (1.226-1.937)	<0.001
Perception				
The HPV vaccine is safe	1.858 (1.296-2.663)	<0.001	2.168 (1.436-3.274)	<0.001
The current HPV vaccine is capable of preventing the occurrence of cervical cancer	1.324 (0.916-1.914)	0.135	-	-

participants, 105 (58.3%) had no intention to receive vaccination mainly owing to worries about the vaccine's adverse effects and safety issues (54.3%) and insufficient knowledge about the vaccine (43.8%). Participants with positive perception towards the vaccine's adverse effects and safety were more likely to have been vaccinated.

Our participants showed satisfactory knowledge about HPV vaccination. In a 2008 study in Hong Kong, adolescents had limited knowledge of cervical cancer, and most never heard of HPV[10]. Similarly, in a 2008 study in Canada, women had a moderate understanding of HPV-related issues[11]. Better knowledge and awareness of HPV and cervical cancer is associated with higher vaccination uptake[11,12]. Common barriers to HPV vaccination include parents' lack of understanding, concerns about vaccine safety or efficacy, and vaccine costs[13]. The safety profile of HPV vaccine has been validated through extensive clinical trials, even among those with gynaecological disease or a history of sexual exposure[14]. Nonetheless, apprehension regarding severe adverse effects remains a concern[15-17]. Our participants had similar barriers to vaccination, except for vaccine costs. This suggests that factors beyond affordability play a significant role in vaccine hesitancy, although costs are a key factor influencing vaccine acceptance[18,19]. Vaccine hesitancy may stem from many aspects including, but not limited to, religious beliefs, societal norms, and psychological constructs[20]. To gain an insight into these concerns, focus group interviews could yield a more thorough understanding of the cultural and psychological factors[21,22]. Findings may help healthcare practitioners to understand specific misconceptions for targeted counselling.

More than 25% of participants wrongly believed that only gynaecologists could give HPV vaccination. This lack of knowledge about vaccine access and availability may deter vaccination uptake[11,23]. Therefore, public health campaigns and education should emphasise the availability of HPV vaccination in the primary care settings.

Physicians have a significant role in influencing one's vaccine acceptance and uptake[8,9]. Gynaecologists should consider providing education on HPV vaccines to all women during consultation. Although this may be difficult, it may be appropriate for women with an abnormal cervical smear. Additionally, gynaecologists should promote cervical screening, which is essential in cervical cancer prevention and early detection. Of sexually active participants, 43.5% did not have regular cervical screening. Therefore, education about cervical screening should be provided. The HPV vaccine is safe and effective, even for women with abnormal cervical screening and other gynaecological conditions[24]. Practitioners must be knowledgeable and positive towards the HPV vaccine. Healthcare providers are often inconsistent in recommending HPV vaccination[25]. In Hong Kong, many healthcare workers including doctors and nurses did not view the HPV vaccine favourably[26].

There are limitations to the present study. It was conducted in a single public hospital using convenience sampling, which may introduce selection bias and limit the generalisability of the findings to private hospital settings that have different sociodemographic backgrounds or to the entire Hong Kong population, although the public healthcare system caters for 90% of the population. Women with abnormal cervical screening results were excluded. Cervical cancer prevention should not be limited to HPV vaccination. The rate of cervical cancer screening of our participants was lower than that recommended by the World Health Organization for cervical cancer elimination. Education on cervical cancer prevention is more appropriately provided at the community level rather than in gynaecology clinics during consultations. HPV vaccination is not contraindicated for women with gynaecological illnesses or abnormal cervical cancer screening.

Conclusion

Despite adequate knowledge and favourable perception towards HPV vaccination, our participants have suboptimal vaccination uptake. Gynaecologists should be more proactive to educate women on vaccination.

Contributors

PWAY designed the study and analysed the data. PWAY and WYH acquired the data. PWAY and WYH drafted the manuscript. All authors critically revised the manuscript for important intellectual content. All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

All authors have disclosed no conflicts of interest.

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Data availability

All data generated or analysed during the present study are available from the corresponding author upon reasonable request.

Ethics approval

This study was approved by the Central Institutional Review Board, Hospital Authority (reference: PAED-2024-026). The patients were treated in accordance with the tenets of the Declaration of Helsinki. The patients provided written informed consent for all treatments and procedures and for publication.

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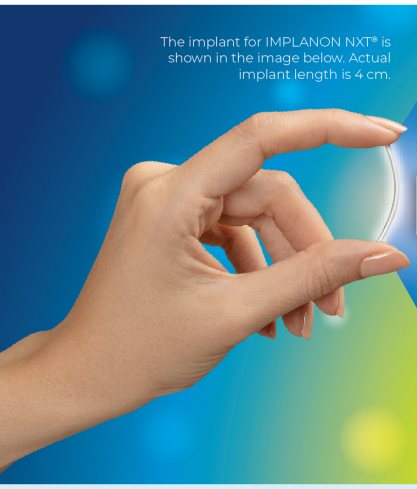

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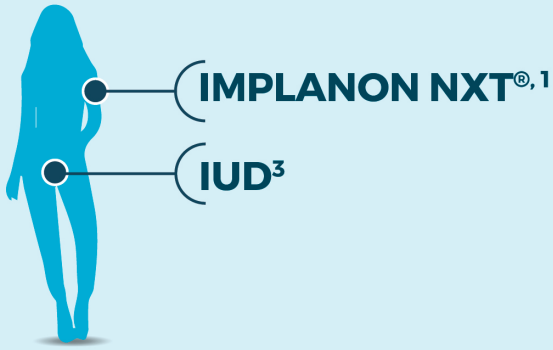

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Lasts for 3 years without any daily, weekly, or monthly dosing[2]

Over **99%** effective[1,*]

>99.9% effective[2]

Reversible[2]
Rapid return to normal menstrual cycle upon removal

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* Placed subdermally just under the skin in the inner non-dominant upper arm.

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