Induction of labor: reviewing the past to improve the future

Claire Marie McCarthy, MB, BCh, BAO; Sarah Meaney, PhD; Michelle McCarthy, MB, BCh, BAO; Nicole Conners, MB, BCh, BAO; Noirin Russell, MD

BACKGROUND: Women undergoing induction of labor should be empowered with accurate information.
OBJECTIVE: This study aimed to examine the characteristics of and indications for induction of labor and delivery outcomes to help inform practice and counseling.
STUDY DESIGN: We conducted a retrospective cohort study of all singleton pregnancies undergoing induction of labor over a 3-month period in a tertiary-level hospital in the Republic of Ireland. Data were obtained from paper and electronic registries. Descriptive and inferential statistics were performed on data collected.
RESULTS: There were 1084 women delivered, with an induction rate of 46.0% (n=499). Primiparous women were more likely to be induced compared with multiparous women (51.4%; n=254/494 vs 41.5%; n=245/590; $P<.001$), and were more likely to be induced for postmaturity (30.7%; n=78/254 vs 23.6%; 58/245; $P\leq.001$). More than half (50.3%; 251/399) were induced before 40 weeks' gestation, irrespective of parity. Multiparous women and those induced for maternal medical indications had a shorter overall time to delivery interval (21.7 hours [standard deviation, 13.0] vs 13.8 hours [standard deviation, 11.2]; $P<.001$ and 18.3 hours [standard deviation, 12.7] vs 14.7 hours [standard deviation, 12.4]; $P<.01$).
CONCLUSION: Information on induction of labor can aid in the guidance and education of women undergoing the process, educate clinicians for appropriate counseling, and facilitate shared decision-making.

Keywords: induction of labor, obstetrics, patient information, perinatal care, pregnancy

Introduction

Induction of labor (IOL) is defined as the process of artificially stimulating the uterus to start labor, with World Health Organization data showing an average IOL rate of 10%.[1] However, rates of IOL can vary markedly with respect to variables such as gross domestic product, urban and rural population, and healthcare provider presence.[2] IOL in the Republic of Ireland is a common procedure, with 31.5% of women undergoing IOL in 2017, increasing from 24% in 2008.[3]

IOL can be recommended in circumstances where the risk of waiting for the spontaneous onset of labor is judged to be greater than the risks associated with IOL.[1] There is a wide variety of indications for IOL with the aim of preventing adverse outcomes in the interest of both the mother and infant. Levels of evidence can vary greatly for various indications,[4] and thus it is essential that decisions around IOL occur within a shared decision framework through which a woman and her clinician can examine the risks and benefits of her individual clinical situation.[5,6]

The rationale for IOL in certain circumstances is to prevent intrauterine fetal death, which can be associated with factors such as postmaturity, small-for-gestational-age (SGA) fetuses, and advanced maternal age.[7–10] Although IOL may help prevent intrauterine fetal death and other adverse outcomes, it does confer significant personal and economic cost to women and the healthcare system.[11] It requires increased staffing[12] and increased maternal and fetal monitoring,[13] and can contribute to a negative labor experience.[14,15] In addition, although IOL may be carried out for clinically confirmed indications (such as advanced maternal age or hypertension), there is some unexplained variation in IOL rates, potentially because of varied clinical risk perception of obstetricians and midwives for some indications.[16] This study found that there was less accountability for decision-making in hospitals with high IOL rates, whereas the converse was true in hospitals with low IOL rates.

IOL has intrinsically been linked to rates of cesarean delivery (CD), which is a much-discussed parameter in maternity care.[17] CD rates in our institution were 32.8% in 2018,[18] increasing to 39.0% in 2021.[19] It has been shown that a CD rate >10% does not confer a reduction in maternal or fetal mortality and involves a risk of morbidity and complications that may be permanent.[20] Traditionally, observational studies have associated IOL with CD; however, emerging evidence disputes this.[21] A recent study comparing IOL with expectant management in low-risk primiparous women at 39 weeks' gestation showed a lower CD rate in the IOL

From the Cork University Maternity Hospital, Cork, Ireland (Dr C McCarthy, Dr M McCarthy, and Prof Russell); National Perinatal Epidemiology Centre, University College Cork, Cork University Maternity Hospital, Cork, Ireland (Dr Meaney); University College Cork, Cork, Ireland (Dr Conners)

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Corresponding author: Claire Marie McCarthy, MB, BCh, BAO. claire_mccarthy@hotmail.com

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Why was this study conducted?
This study aimed to examine induction of labor practices to improve patient counseling.

Key findings
Nearly 50% of our population had an induction of labor, and those with a shorter length of labor were multiparous or induced for maternal medical indications.

What does this add to what is known?
Shared decision-making can be facilitated by empowering women with information on induction of labor outcomes.

group.[22] Similarly, an elective induction policy was not shown to be associated with an increased risk of CD or operative vaginal delivery.[23]

Pregnant women are increasingly empowered and actively engaged in decision-making in pregnancy,[24] and thus enthusiastically seek information on elements of their care, such as IOL.[25] Given the large increase in IOL rates and the varied indications and rationales, it is important to examine this information to aid with service planning and assess compliance with recommendations. Concurrently, examining these data will provide women with information to allow more focused counseling (including projected timelines and outcomes), and thus may increase satisfaction with the process. Therefore, this study aimed to investigate the characteristics of and indications for IOL, and evaluate the time intervals and delivery outcomes of IOL.

Materials and Methods

Study design

A retrospective cohort study was conducted between March and May 2018 in a large colocated tertiary university teaching hospital with ca 7400 deliveries per annum located in the Republic of Ireland. Eligible participants included women with singleton pregnancies who underwent IOL. Women undergoing IOL for multiple pregnancies were excluded.

Data collection

Medical information was gathered using paper and electronic health records. Data on ultrasound scan findings, if sought, were based on internal computerized reports generated by a suitably qualified ultrasonographer who performed the investigation. Data on maternal demographics such as age, ethnicity, body mass index (BMI), and parity were collected.

Indication for IOL and the mode of delivery were recorded. Indications were categorized as:

1. fetal and placental, including SGA fetuses, reduced fetal movements, large-for-gestational-age neonates, oligohydramnios, polyhydramnios, and fetal anomaly
2. maternal medical, including maternal diabetes mellitus, medical history, hypertension, preeclampsia, obstetrical cholestasis, and epilepsy
3. maternal characteristic, including maternal age, in vitro fertilization, and history (eg, previous abruption or intrauterine device use)
4. current obstetrical, including prolonged rupture of membranes at term (>37 weeks' gestation), abdominal pains and/or bleeding, preterm prelabor rupture of membranes (<37 weeks), and group B strep−positive test
5. postmaturity (defined as 41+3 weeks' gestation, as per the unit policy)
6. social/other

Information was collected on induction processes including the location, methods used to induce labor, and the timing of these interventions.

Fetal outcomes including Apgar scores at 1 and 5 minutes, cord and initial infant blood gases, admission to the neonatal unit, and therapeutic hypothermia were also recorded. Gestation Related Optimal Weight (GROW) software and coefficients derived from 6 maternity units across the island of Ireland from 2008 to 2009 were used to calculate fetal growth in utero for all infants to identify those born <10th or >90th centile in this cohort.[26]

Statistical analyses

Descriptive statistics were calculated to describe our sample characteristics. Inferential statistics, including chi-square and *t* tests, were performed to assess the differences between indication for IOL and maternal and fetal outcomes. All data were analyzed using IBM SPSS Statistics (IBM Corp, Armonk, NY).

Ethical approval

Ethical approval was granted by the Clinical Research Ethics Committee of the Cork Teaching Hospitals (Ref: ECM 4V 05/06/2018). This study did not receive any financial support.

Results

Demographics

Over the 3-month period, there were 494 and 590 singleton deliveries to primiparous and multiparous women, respectively. Of these, 499 women had an IOL, and primiparous women were more likely to be induced compared with multiparous women (51.4%; n=254/494 vs 41.5%; n=245/590; $P<.001$). As outlined in Table 1, of the women who were induced, half were primiparous (48.2%; n=241). Most women who had an IOL were White Irish (72.7%; n=357). Maternal age ranged from 16 to 46 years, with two-thirds of this cohort aged between 30 and 39 years (63.6%; n=312). The BMIs of two-thirds of women were either in the overweight range (33.1%; n=159) or the obese range (31.7%; n=152). Only 2.9% (n=14) of women had a previous CD.

Indications for induction

As outlined in Table 2, almost half of all inductions were booked by nonconsultant hospital doctors (ie, doctors in

TABLE 1
Maternal and pregnancy characteristics of women who were induced

Characteristics	Total=499
Age group (y)[a]	
<24	49 (10.0)
25–29	93 (18.9)
30–34	189 (38.5)
35–39	123 (25.1)
>40	37 (7.5)
BMI category (kg/m^2)[b]	
Underweight (<18.5)	7 (1.5)
Healthy (18.5–24.9)	162 (33.8)
Overweight (25.0–29.9)	159 (33.1)
Obese (>30.0)	152 (31.7)
Parity[a]	
Primiparous	241 (49.1)
Multiparous	250 (50.9)
Ethnicity[a]	
White Irish	357 (72.7)
Irish Traveller	18 (3.7)
Other White background	68 (13.8)
Asian/Asian Irish	11 (2.2)
Black/Black Irish	6 (1.2)
Other/mixed	9 (1.8)
Undocumented	22 (4.5)
Insurance[a]	
Private	108 (22.0)
Public	383 (78.0)
Previous cesarean delivery	14 (2.9)

Values are shown as number (percentage) unless otherwise stated.

BMI, body mass index.

[a] Missing data for 8 women; [b] Missing data for 19 women.

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training before specialist registration) (46.8%; n=228) and 42.0% were booked by a consultant obstetrician (n=206). There were 22 identified indications for IOL, which were classified into 6 overarching categories. The most common indication for IOL was postmaturity (27.7%; n=136). Primiparous women were more likely to be induced for postmaturity compared with multiparous women (32.4%; n=78 vs 23.2; n=58; $P \leq .001$). Multiparous women were 13 times more likely to be induced for social reasons compared with primiparous women (10.8%; n=27 vs 0.8%; n=2). Irrespective of parity, half of women were induced between 37+0 and 39+6 weeks' gestation (51.5%; n=251).

Small-for-gestational-age fetuses

Having an SGA fetus was the indication for induction in SGA fetuses were the indication for IOL in 9.2% (n=45) of the women; 62.6% of infants from these cases were classified as SGA following delivery (n=28). Correct identification of SGA fetuses was more likely in women who had a growth scan undertaken by a midwife sonographer than in women induced for SGA fetuses on the basis of palpation alone (65.8%; 25/38 vs 28.6%; 2/7). Of the 446 women induced because of an indication other than an SGA fetus, 38 had an infant classified as SGA following delivery (8.3%).

Timing/induction process

The induction process commenced with the administration of prostaglandin E2 gel (PGE2) in over two-thirds of women (68.2%; n=334/490), with one-quarter of women beginning with an artificial rupture of membranes (ARM) (26.5%; n=130 of 490). Multiparous women were almost 4 times more likely to begin their induction with ARM compared with primiparous women (40.6%; 101/249 vs 12.0%; 29/241; $P<.001$). As outlined in Table 3, a variety of methods were used in the IOL process, with over one-quarter of women having all 3 methods used (27.8%; n=36/140). Almost one-quarter of primiparous women had ≥4 mg of PGE2 (22.3%; n=193) vs only 1 multiparous woman.

The mean time to delivery from the first intervention was 17.8 hours (standard deviation [SD], 12.7). As expected, parity was a significant factor in this time difference, with primiparous women having a longer labor than multiparous women (21.7 hours [SD, 13.0] vs 13.8 hours [SD, 11.2]; $P<.001$). Women who were induced because of placental indications labored for longer compared with women induced because of maternal indications (18.3 hours [SD, 12.7] vs 14.7 hours [SD, 12.4]; $P=.01$).

Delivery outcomes

Over half of the women had a spontaneous vaginal delivery (SVD) following induction (57.3%; n=281/490). Multiparous women were more than twice as likely to have an SVD compared with primiparous women (81.1%; n=202 vs 57.3%; n=281; $P<.001$).The highest rate of CD was among women induced for

TABLE 2
Indication for induction by parity

Factor under consideration	Total N=491	Primiparous N=241	Multiparous N=250	*P* value
Decision by				.19
Nonconsultant hospital doctor	228 (46.4)	122 (50.6)	106 (42.4)	
Midwife	57 (11.6)	26 (10.8)	31 (12.4)	
Consultant (including discussion with consultant)	206 (42.0)	93 (38.6)	113 (45.2)	
Indication				<.001
Fetal and placental	139 (28.3)	63 (26.1)	76 (30.4)	
Maternal medical	122 (24.8)	66 (27.4)	56 (22.4)	
Maternal characteristic	40 (8.1)	20 (8.3)	20 (8.0)	
Current obstetrical	25 (5.1)	12 (5.0)	13 (5.2)	
Postmaturity	136 (27.7)	78 (32.4)	58 (23.2)	
Social/other	29 (5.9)	2 (0.8)	27 (10.8)	
Location for induction				<.001
Induction room	172 (35.0)	59 (24.5)	113 (45.2)	
Ward	319 (65.0)	182 (75.5)	137 (54.8)	
Gestational age at induction (wk)				.55
<37	15 (3.1)	9 (3.6)	6 (2.5)	
$37-39^{+6}$	251 (51.1)	134 (53.6)	117 (48.5)	
$40-41^{+3}$	200 (40.7)	95 (38.0)	105 (43.6)	
$>41^{+3}$	25 (5.1)	12 (4.8)	13 (5.4)	

Values are shown as number (percentage) unless otherwise stated.

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maternal medical indications (22.1%; n=27/122). As illustrated in Table 4, the CD rate among these women was almost 7 times higher in primiparous than in multiparous women (36.4%; n=24/66 vs 5.4%; n=3/56). Of the 29 women who were induced because of social/other reasons, most had an SVD (79.3%; n=23/29).

TABLE 3
Combined methods of induction of labor for primiparous and multiparous women

Methods of IOL	Total N=490[a]	Primiparous N=241	Multiparous[a] N=249
Prostin only	75 (15.3)	46 (19.1)	29 (11.6)
Oxytocin only	26 (5.3)	19 (7.9)	7 (2.8)
ARM only	45 (9.2)	8 (3.3)	37 (14.9)
Prostin and ARM	84 (17.1)	26 (10.8)	58 (23.3)
Prostin, ARM, and oxytocin	136 (27.8)	91 (37.8)	45 (18.1)
ARM and oxytocin	85 (17.3)	21 (8.7)	64 (25.7)
Prostin and oxytocin	39 (8.0)	30 (12.4)	9 (3.6)

Values are shown as number (percentage) unless otherwise stated.

ARM, artificial rupture of membranes; *IOL*, induction of labor.

[a] Data not available for one.

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Discussion

Principal findings

In our study, we described the demographics of women undergoing IOL, and examined in depth the indications for induction and the time intervals associated with IOL.

Results

We described that postmaturity was the most common indication for IOL in primiparous women (32%), whereas in multiparous women, fetal and placental indications were most prevalent (30%). This could be explained by multiparous women being older and having a more complex obstetric history. Mode of delivery did not differ significantly by induction indication for multiparous

TABLE 4
Analysis of mode of delivery vs parity in induction categories

Mode of delivery	Fetal and placental		Maternal medical		Maternal characteristic		Current obstetrical		Postmaturity		Social/other	
	P N=63	M N=76	P N=66	M N=56	P N=15	M N=20	P N=12	M N=12	P N=77	M N=58	P N=2	M N=27
SVD	34.9 (22)	78.9 (60)	33.3 (22)	85.7 (48)	35.0 (7)	85.0 (17)	16.7 (2)	91.8 (11)	33.3 (26)	74.1 (43)	0 (0)	85.2 (23)
Instrumental	36.5 (23)	13.2 (10)	30.3 (20)	8.9 (5)	40.0 (8)	10.0 (2)	58.3 (7)	8.3 (1)	39.7 (31)	13.8 (8)	0 (0)	7.4 (2)
CD	28.6 (18)	7.9 (6)	36.4 (24)	5.4 (3)	5 (25.0)	5.0 (1)	25.0 (3)	0 (0)	26.9 (21)	12.1 (7)	2 (100)	7.4 (2)

Values are shown as number (percentage) unless otherwise stated.

CD, cesarean delivery; *M*, multiparous; *P*, primiparous; *SVD*, spontaneous vaginal delivery.

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women. Primiparous women induced for social indications had a higher CD rate; however, the numbers were too small to make inferences.

It is accepted that the estimation of fetal weight at more advanced gestation is inaccurate.[27] It is interesting and important to note that one-third of women induced for SGA fetuses delivered a normal-sized infant, showing that the screening tests of ultrasound and abdominal palpation are oversensitive. When examining the accuracy of induction categories, we could observe that one-third of women who were induced for SGA fetuses did not fit this criterion. In addition, nearly 1 in 12 infants born could be classified as unidentified SGA, and were not detected during the antenatal period. Gardosi et al[28] have previously demonstrated that unrecognized SGA infants have higher rates of pregnancy complications and advocate the use of customized centile charts.

Clinical implications

We discussed the interval from commencement of induction to delivery, which is a crucial piece of information to share with women undergoing IOL because it enables them to prepare appropriately for labor and delivery. As expected, we found that higher parity equates to shorter labor intervals. We observed slightly longer times for IOL in all women receiving vaginal prostaglandins compared with other studies.[29,30] However, information on time of admission to delivery needs to be individualized to each unit, and is largely dependent on the method of induction used and whether outpatient induction is used in the respective units. Importantly, we also demonstrated a longer time interval from induction to delivery in women induced because of placental indications. Further institutional guidance can be established to inform women of these findings and encourage extrapolation of this research to other institutions.

In primiparous women, the highest rate of CD was found among those with socially indicated inductions, followed by those with maternal medical and postmaturity indications. Multiparous women had a low rate of CD overall, with postmaturity being the most common indication for unsuccessful induction. However, it is known that determining an appropriate CD rate can be unhelpful in isolation, as is the case with IOL rates, but can provide a better understanding of healthcare performance to improve care.[31]

Research implications

This study also uncovered several areas that could benefit from further study. Because of the observational study design, we were unable to enact change, but future studies could focus on assessing women's satisfaction levels when provided with individualized information. Providing information to hospital governance structures may also streamline IOL services, leading to a more cost-effective intervention from a health economics point of view.

Initiatives to increase compliance with aspects such as the definition of postmaturity and senior obstetrical review would improve the quality of care offered to women and potentially reduce the rate of unnecessary interventions. Improving the governance of inductions would both enhance compliance with induction indications and allow ongoing quality improvement and audit initiatives. Ultimately, this multidisciplinary approach could provide both improved care and consistency within a large unit.

Strengths and limitations

Our study provided concise yet detailed information on several interesting parameters on the topic of IOL. We examined both indications for and outcomes of IOL, and in addition focused on the time intervals for IOL. We also investigated time intervals in the IOL process; knowledge of these are important for empowering women as they experience pregnancy, labor, and delivery. Providing women and their support structures with personalized information, such as likely IOL outcome and anticipated length of IOL could potentially minimize some of the negative perceptions surrounding IOL.

Our study has several limitations that should be acknowledged and limited in future studies. Its noninterventional nature minimized the ability to enact change in our labor ward. In addition, there were limitations in data recording. Information gathered was dependent on its accurate recording. Regarding IOL indication, the current proforma protocol only allows recording of 1 indication, and thus other factors may not be taken into account when examining

delivery outcomes. This was similar to the protocols of other studies, where decision for IOL was based on a single indication rather than cumulative factors.[4] This limits our understanding of the complexities of the decision-making around IOL and may affect management if staff are unaware of concomitant factors.[32] Finally, the overall IOL rate in 2018 was 37.0%,[18] and has increased to 40.4% in 2021.[19] The increase in the IOL rate further reflects the need to have accurate information to counsel women on their outcomes following IOL.

Conclusions

This study demonstrated the characteristics of women undergoing IOL in a large maternity unit in the Republic of Ireland, and their indications and outcomes. This information can be used to adequately counsel women undergoing IOL. Women planned for IOL should be fully informed not only of the process of IOL but the possible outcomes with respect to mode of delivery and fetal outcomes. ■

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