PERINATAL JOURNAL

Original Article

Perinatal Journal 2025;33(1):18-24

Reducing the rate of permanent obstetric brachial plexus palsy: Impact of a simulation training program in shoulder dystocia after five years of training

Christian Garrido López[1], Emma Batllori Badía[1], Cecilia Villalaín[2], María Inmaculada Mejía Jiménez[1], Patricia Barbero[1], Laura Forcén Acebal[1]

[1]Hospital Universitario 12 de Octubre, Department of Obstetrics and Gynaecology, Madrid, Spain

[2]Hospital Universitario 12 de Octubre, Department of Obstetrics and Gynaecology, Primary Care Interventions to Prevent Maternal and Child Chronic Diseases of Perinatal and Developmental Origin (RICORS network), RD21/0012/0024, Madrid, Spain.

Abstract

Objective: The aim is to analyse whether simulation-based training in shoulder dystocia improves perinatal outcomes, including permanent brachial plexus palsy.

Methods: This is a retrospective observational study conducted in a tertiary centre in Madrid, Spain. Cases occurring between 2015 and 2023 were analysed. The sample was divided into three periods based on their relation to a simulation training program initiated in 2018 (pre-training, initial training, and systematic training). The results are presented by periods. Comparisons were made between the second period (reference) and the adjacent periods.

Results: A significant increase in the rate of dystocia was observed (1.21%, 1.98%, 2.67%, p<0.01). Once training began, the use of secondary manoeuvres per case of dystocia increased significantly (28, 73, 93, p=0.03), without increasing the total number of cases solved using these manoeuvres. The rate of permanent obstetric brachial palsy was significantly reduced (5.26%, 0.55%, 1.32%, p<0.01), and this improvement was maintained over time, with 0 cases in 2023. No increase in the caesarean section rate was registered. There were no changes in the rates of transient palsy, fractures, hypoxic-ischemic disease, or perinatal outcomes based on Apgar scores and arterial pH.

Conclusion: Simulation-based training improves the overall management of shoulder dystocia and reduces complications, including permanent brachial palsy, without being associated with worse perinatal outcomes in terms of fractures, Apgar scores, arterial pH, or encephalopathy.

Keywords: Shoulder dystocia, simulation training, permanent obstetric brachial plexus palsy, perinatal outcomes, resolution manoeuvres

Introduction

Shoulder dystocia is a major obstetric complication, unpredictable and unforeseeable, which requires additional manoeuvres beyond the usual axial traction for its resolution.[1-2] Its incidence is low, between 0.6-3% depending on the definition used, although it seems to be increasing due to rising risk factors such as obesity or diabetes and greater recognition ability by trained personnel.[3-6]

Simulation-based training has been proposed as a useful tool to improve the resolution of medical emergencies, aiming to reduce complications and risks for patients. In obstetrics, its value is especially recognized in shoulder dystocia, where the goal is to reduce the rate of permanent obstetric brachial plexus palsy, with an estimated incidence of 0.4-5.1 per 1000 live births [3]. However, the low rate of these complications, the lack of standardized programs, and the heterogeneity of published studies leads to the absence of formal recommendation from scientific societies regarding this matter.

Our hypothesis is that specific instruction with simu-

Information: This study has been funded by the Instituto de Salud Carlos III (ISCIII) through the project RD21/0012/0024 and Next Generation EU funds, which finance the actions of the Recovery and Resilience Mechanism (MRR). Patient consent was waived due to the fact that this is a retrospective observational study, and its results would not affect the patients included in any case. The data presented in this study are available on request from the corresponding author due to the privacy of patient data. The authors declare no conflicts of interest.

Correspondence: Christian Garrido López, Hospital Universitario 12 de Octubre, Department of Obstetrics and Gynaecology, Madrid, Spain, **e-mail:** chrttn@gmail.com, **Received:** November 12, 2024 **Accepted:** February 14, 2025

How to cite this article: López CG, Badía EB, Villalaín C, Jiménez MIM, Barbero P, Acabel LF. Reducing the rate of permanent obstetric brachial plexus palsy: Impact of a simulation training program in shoulder dystocia after five years of training. Perinatal Journal 2025;33(1):18-24 DOI: 10.59215/prn.24.0323004

ORCID ID: CG López 0009-0000-6232-405X; EB Badía 0000-0002-6047-7615; C Villalaín 0000-0002-9456-4100; MIM Jiménez 0000-0003-2487-3466; P Barbero 0000-0002-6261-8450; LF Acabel 0000-0002-7345-2767

CETUS Publishing

lation improves perinatal outcomes in shoulder dystocia, including permanent obstetric brachial plexus palsy, in addition to enhancing staff satisfaction, communication skills, and practical abilities to resolve this complication.

Methods

A retrospective observational study with prospectively collected data was conducted, including all vaginal deliveries complicated with shoulder dystocia at a tertiary centre in Madrid, Spain, between January 2015 and December 2023. Caesarean section deliveries were excluded.

The primary objective was to analyse the rate of permanent obstetric brachial plexus palsy in cases with shoulder dystocia through three different periods of time (2015-2017, 2018-2020, 2021-2023). Permanent palsy was considered as an injury lasting more than 12 months. Shoulder dystocia was defined as excessive difficulty in delivering the fetal shoulders, necessitating additional manoeuvres beyond the usual gentle and sustained axial traction to achieve shoulder delivery, regardless of time or number of pushes. Secondary objectives included comparing other complications associated with shoulder dystocia, such as transient obstetric brachial plexus palsy (defined as injury lasting less than 12 months), bone fractures, anal sphincter tears, necessary treatments (expectant management, rehabilitation, or surgery) and adverse perinatal outcomes in terms of arterial pH and Apgar score (considered adverse if Apgar ≤ 7 at the 5th minute and arterial pH ≤ 7.10). Fetal and maternal characteristics, time and manoeuvres needed for resolution, need for sedation, admission into the Intensive Care Unit and staff satisfaction were also compared.

Since 2018, a multidisciplinary theoretical-practical simulation-based course on shoulder dystocia resolution has been conducted at our centre, led by specialized instructor personnel. The course, which is not mandatory, lasts 4 hours and has been organized monthly during non-summer months since its inception. The training program includes first, a theoretical part focused on action protocols and resolution manoeuvres; secondly, a practical part with 3 workshops: resolution manoeuvre training with low-fidelity Prompt Flex birth simulators, force measurement during axial traction with the Prompt Flex Birth SimAdv simulator with an incorporated force sensor, and an emergency communication workshop; a third part with clinical simulation scenarios using hybrid simulators and real actors; and lastly a final debriefing. After the course, participants complete an anonymous survey evaluating 15 items related to course content, usefulness, instructor performance, and overall participant satisfaction.

Following the model proposed in the 2016 study by Croft et al [7], our sample was divided into three groups defined by their temporal relationship with the instruction: pre-training (2015-2017), initial training (2018-2020), and systematic training (2021-2023). Analysis was conducted, first, comparing the second period (taken as reference) with the previous and subsequent periods, with the aim of determining if differences exist once the training commenced and if these persist over time. Secondarily, differences between the three groups altogether were tested. Results are presented by period. Fetomaternal characteristics, resolution manoeuvres, shoulder dystocia features and fetomaternal complications are presented with descriptive statistics (mean and standard deviation for continuous variables, or absolute frequencies and percentages for categorical variables, as appropriate). A normality analysis of the different variables was performed. For the first analysis (pairwise comparisons between the second period and the first and third periods respectively) Poisson regression, logistic regression or linear regression test were performed as appropriate. For overall comparisons one-way ANOVA or Krustall Wallis for quantitative variables and chi-square or Fisher's test for qualitative variables were used, as appropriate. A p-value < 0.05 was considered statistically significant. Analyses were performed using SPSS-21 statistical software.

The study was approved by the 'Hospital Universitario 12 de Octubre' Investigation Commission in July 2024. The authors declare that they have no financial interests or other conflicts of interest that could have influenced the results presented.

Results

During the years included in our study, a total of 27,166 vaginal deliveries were attended, with no differences in their distribution across the time periods included. A total of 522 cases with shoulder dystocia were recorded (global incidence 1.92%), distributed as 114 (1.21%), 181 (1.98%), and 227 (2.67%) in each period, with the increase in the rate of shoulder dystocia being statistically significant both in the overall analysis and in the pairwise comparisons between periods ($p<0.01$). The caesarean section rate was 23.1%, 21.5%, and 23.5% in each period, with the difference being significant (again in both analyses), due to a lower caesarean section rate in the second period.

Most fetal and maternal characteristics remained stable, with a significantly higher rate of instrumental delivery and precipitous delivery in the second period, while a lower rate of macrosomia was identified in the third pe-

riod. Fetal weight and the rate of episiotomy significantly decreased over time (Table 1).

There were no significant differences in the number of cases solved with primary and secondary manoeuvres by period. Primary manoeuvres were the most used and resolved >69% of cases, with a significant increase in the use of the Rubin I manoeuvre from the second to the third period (p=0.02). Although the number of cases globally resolved with second level manoeuvres did not increase, the total amount of secondary manoeuvres performed did, due to a higher number of secondary manoeuvres used per dystocia case, with the difference being significant between the first two periods (p=0.05), remaining stable between the second and third periods. A trend change was also observed in the use of secondary manoeuvres, with a significant increase in the use of the posterior shoulder between the first two periods (p=0.01) and a reduction in the use of the Rubin II manoeuvre (p=0.03). A significant increase in time required for resolution was recorded in the third period, accompanied by a significant decrease in admissions to the intensive care unit. The main aspects related to the resolution of cases complicated with shoulder dystocia are summarized in Table 2.

Table 1. Main fetomaternal characteristics of complicated deliveries with shoulder dystocia according to training period.

	First period	Second period	Third period	p- value 1ˢ vs 2nd vs 3rd
Maternal age (years)	30.82 (6.85)	31.20 (5.83)	31.56 (6.54)	0.60
BMI (kg/m2)	26.21 (5.15)	26.44 (5.61)	26.17 (5.44)	0.95
Weight gain (kg)	12.79 (5.80)	13.28 (5.80)	12.34 (5.58)	0.31
Maternal diabetes	16 (14.55)	17 (9.44)	31 (13.72)	0.32
Parity				0.34
Nulliparous	47 (41.23)	63 (34.81)	94 (41.41)	
Multiparous	67 (58.77)	118 (65.19)	133 (58.59)	
Onset of labor				0.25
Labour induced	53 (46.49)	73 (40.33)	110 (48.46)	
Spontaneous onset of labour	61 (53.51)	108 (59.67)	117 (51.54)	
Mode of delivery				0.03
Eutocic delivery	93 (81.58)	145 (80.11)	202 (88.99) *	
Instrumental delivery	21 (18.42)	36 (19.89)	25 (11.01) *	
Prolonged second stage of labour	4 (3.50)	17 (9.39)	17 (7.48)	0.32
Precipitous birth	34 (29.82) *	70 (39.89)	51 (24.52) *	<0.01
Gestational age (days)	279.61 (8.49)	279.18 (8.82)	278.03 (8.63)	0.11
Birthweight (g)	3915.43 (416.87) *	3758.56 (448.73)	3667.20 (452.73) *	<0.01
Macrosomia (>4000g)	48 (42.1)	61 (33.70)	53 (23.34) *	<0.01
Sex				0.96
Male	60 (52.63)	98 (54.14)	120 (52.86)	
Female	54 (47.37)	83 (45.86)	107 (47.14)	
Episiotomy	55 (48.25) *	58 (32.04)	45 (19.82) *	<0.01

[1] Data presented as mean (standard deviation) or n (%). Statistically significant differences compared to the second period are marked with * and written in bold letter. P-values correspond to the overall analysis.

The incidence of complications arising from should dystocia is summarized in Table 3. There were 6 permanent obstetric brachial plexus palsy in the first period, while only 1 and 3 cases were diagnosed in the second and third period (5.26%, 0.55%, and 1.32% respectively), with the difference being statistically significant (p=0.03)

between the first and second period, but remaining stable between the second and third period, despite de diagnosis of no cases in 2023. Fetal and maternal characteristics and intrapartum characteristics of these cases, along with their evolution and specific treatment, are described in supplementary table 1. The incidence of transient brachial plexus palsy per period was 7.02% (8 cases), 5.52% (10 cases), and 7.05% (16 cases), without statistically significant differences.

Table 2. Shoulder dystocia resolution manoeuvres and other resolution characteristics according to training period.

	First period	Second period	Third period	p- value 1ˢ vs 2ⁿᵈ vs 3ʳᵈ
Total cases	114 (1.21) *	181 (1.98)	227 (2.67) *	<0.01
Cases solved with primary manoeuvres	84 (73.68)	126 (69.61)	163 (71.81)	0.39
Cases solved with secondary manoeuvres	25 (21.92)	55 (30.39)	64 (28.19)	0.39
McRoberts position performed	108 (94.73)	178 (98.34)	223 (98.24)	1.00
Rubin I performed	71 (62.28)	127 (70.17)	181 (79.74) *	<0.01
Total of secondary manoeuvres performed	28 (25.00) *	73 (36.68)	93 (36.33)	0.03
Posterior arm extraction performed	10 (8.77) *	38 (20.99)	50 (22.03)	0.01
Rubin II performed	19 (16.67)	24 (13.26)	16 (7.05) *	0.01
Woods performed	3 (2.63)	8 (4.41)	18 (7.93)	0.54
Gaskin performed	0 (0.00)	3 (1.68)	9 (3.96)	0.29
Sedation	2 (1.83)	4 (2.21)	3 (1.32)	1.00
Time (s)	1.07 (0.79)	1.14 (0.85)	1.35 (1.01) *	0.02
Admission into the Intensive Care Unit	12 (10.62)	17 (9.39)	9 (3.96) *	0.03

[1] Data presented as mean (standard deviation) or n (%). Statistically significant differences compared to the second period are marked with * and written in bold letter. P-values correspond to the overall analysis.

Table 3. Complications associated to shoulder dystocia cases

	First period	Second period	Third period	p- value 1ˢ vs 2ⁿᵈ vs 3ʳᵈ
Permanent obstetric brachial plexus palsy	6 (5.26) *	1 (0.55)	3 (1.32)	0.01
Transient obstetric brachial plexus palsy	8 (7.02)	10 (5.52)	16 (7.05)	0.80
Anal sphincter tears	4 (3.54)	17 (9.39)	7 (3.08) *	0.06
Apgar score ≤ 7 at 5º min/arterial pH ≤ 7.10	13 (11.40)	22 (12.15)	24 (10.57)	0.68
Clavicle fracture	7 (6.19)	9 (4.97)	6 (2.64)	0.25
Humerus fracture	2 (1.77)	3 (1.66)	4 (1.76)	1.00
Hypoxic-ischemic encephalopathy	0 (0.00)	4 (2.21)	1 (0.44)	0.16

[1] Data presented as mean (standard deviation) or n (%). Statistically significant differences compared to the second period are marked with * and written in bold letter. P-values correspond to the overall analysis.

There were 4 (3.54%), 17 (9.39%), and 7 (3.08%) cases with anal sphincter tears in each period, with the difference being significant between the second and third period (p=0.01) due to an increased rate in the second period. Deliveries complicated with anal sphincter tears were significantly longer (p=0.02) and had a lower rate of episiotomy (p=0.04) in the second period. Additionally, in the second period, we found a significantly higher rate of instrumentation (41.18% vs. 17.68%) and neonatal weight (4027g vs. 3730g) in cases with sphincter tear compared to those without. However no differences were found in neonatal weight, delivery instrumentation, or the need for secondary manoeuvres within all cases with third-degree or higher tear.

Regarding perinatal outcomes in terms of arterial pH and Apgar score, 13 (11.40%), 22 (12.15%), and 24 (10.57%) in each period had poor outcomes, without sig-

nificant differences. However, perinatal outcome was directly related to dystocia only in 38.46% (5/13), 22.72% (5/22), and 37.50% (9/24) of cases. This association was stablished either due to its duration or complexity (need for multiple manoeuvres and/or sedation) or due to associated morbidity (obstetric brachial plexus palsy or other nerve injuries, bone fractures, hypoxic-ischemic disease, pneumothorax, or internal hematomas). Additionally, other concomitant factors such as poorly controlled diabetes with hypoglycaemia, meconium or bloody fluid, non-reassuring trace (suspicion of prenatal hypoxia), intrapartum fever, or prolonged or precipitous delivery were identified, which could have interfered with the outcome in 61.53% (8/13), 54.54% (12/22), and 58.33% (14/24) of cases, with up to 12 cases (20.34%) where the perinatal outcome was directly associated with one of these entities.

The percentage of staff involved throughout the study exceeded 80%. Staff satisfaction was over 90%. Participants reported an improvement in their recognition, performance, and communication skills, as well as an enhancement in their practical skills regarding the execution of second-level manoeuvres. Data collection also improved.

Table S1. Risk factors, characteristics and treatment of cases with permanent plexus palsy.

	Year	Risk Factors	Days of pregnancy	Weight (g)	Apgar at 5′	Arterial pH
Case 1	2015	Primigravidae; Induction of labour; Male; Instrumental delivery	288	4660	10	7.17
Case 2	2015	Primigravidae; Induction of labour; Male; Instrumental delivery	285	3975	3	7.16
Case 3	2016	Primigravidae; Induction of labour; Precipitous birth	280	4510	8	
Case 4	2016	Primigravidae; Induction of labour	289	4320	10	
Case 5	2016	Obesity; Precipitous birth	273	3800	10	7.36
Case 6	2017	Obesity; Maternal diabetes; Induction of labour; Male	270	4050	7	7.13
Case 7	2018	Obesity; Precipitous birth	278	4530	9	7.29
Case 8	2021	Obesity; Induction of labour; Male; Instrumental delivery; Prolonged second stage of labour	259	4220	8	7.23
Case 9	2022	Obesity; Induction of labour; Male; Precipitous birth	282	4074	9	7.15
Case 10	2022	Primigravidae; Induction of labour; Obesity	289	3670	10	7.27

Table S1. Risk factors, characteristics and treatment of cases with permanent plexus palsy (continuation)

	Year	Manoeuvre	Time (min)	Personel	Bone fracture	ICU admission	Rehab	Surgery
Case 1	2015	Rubin I	-	-	No	Yes	Yes	Yes
Case 2	2015	Posterior shoulder	-	-	No	Yes	Yes	No
Case 3	2016	Primary	1	Resident	No	No	Yes	No
Case 4	2016	Primary	2	Midwife	No	No	Yes	No
Case 5	2016	Primary	1	Midwife	No	No	Yes	No
Case 6	2017	Posterior shoulder	2	Obstetrician	Yes	Yes	Yes	No
Case 7	2018	Posterior shoulder	2,5	Obstetrician	No	No	Yes	Yes
Case 8	2021	Posterior shoulder	2	Obstetrician	No	No	Yes	No
Case 9	2022	Primary	1,5	Midwife	No	No	Yes	No
Case 10	2022	Posterior shoulder	1,5	Resident	No	No	Yes	No

Discussion

In our study, 522 cases complicated by shoulder dystocia were included. Its distribution and evolution over time of complications and manoeuvres were analysed considering the implementation of staff training in 2018. The incidence increased significantly, with a significant reduction in the rate of permanent obstetric brachial plexus palsy, reaching zero in 2023, without worsening other perinatal outcomes or increasing number of cases solver with second level manoeuvres.

In our sample, the maternal and fetal characteristics of the included cases remained stable, which is consistent with the existing literature.[4,6,7] Only a progressive reduction in birth weight was observed. Our overall incidence of shoulder dystocia was 1.92%, aligning with the 0.6-3% incidence reported in the literature.[3-7] This increase

in incidence after the initiation of training (from 1.21% to 2.67%) is also described in the literature [7-17], as training improves the ability to recognize and report the complication and enhances data collection [14,16], reducing the rate of missing data.

The proportion of cases resolved with primary manoeuvres in our study is slightly higher than reported in the literature (70% vs. 60%) (18) but remained stable over the years. The number of cases resolved with secondary manoeuvres also remained stable; however, our study found a significant increase in the use of these manoeuvres, a finding that has been documented in the literature.[7-9,13,16] In our sample, the most used manoeuvre was the posterior shoulder, although the literature is more varied as no manoeuvre has been described as superior to another.[7,9,13,16]

The effect of simulation on brachial plexus palsy is less consistent, although the heterogeneity of published studies makes it difficult to obtain conclusive data. Some studies report a non-significant reduction in the rate of brachial plexus palsy [6,8-11,15], while others report significant differences.[7,12,16,17,19] However, only two studies demonstrate a significant reduction in permanent obstetric brachial plexus palsy.[7,16] On the other hand, studies like those by Kim et al.[13] or Seligman et al.[14] show a non-significant increase, although these studies have limitations that warrant cautious interpretation of their results. Our study is one of the few that differentiates between permanent and transient brachial plexus palsy, and like Croft et al.[7] and Kaijomaa et al.[16], we found a significant reduction in permanent obstetric brachial plexus palsy, with this reduction being sustained over time, ultimately reaching zero cases in the last year (2023). The need for surgery was also reduced, although not significantly, however, given the importance of the event, it can be considered clinically relevant.

The literature reports a reduction in anal sphincter tears after starting training without significant differences. [8-10,13] In our study, there was an increase in anal sphincter tears in the second period, in which, there was a higher proportion of instrumental deliveries compared to the last period. Additionally, a higher rate of instrumentation and neonatal weight was found in cases with sphincter tear in comparison with those without it in the second period, while the rate of episiotomy was significantly lower. These findings do not extrapolate to the other periods, leading us to believe that the higher rate of tears in this period may be due to more instrumentation on fetuses with higher weight without systematic use of episiotomy. We consider it necessary to continue monitoring anal sphincter tears in these cases prospectively, carefully evaluating the indication for instrumental delivery and episiotomy.

As reported in the literature, we found no significant differences in transient brachial plexus palsy, hypoxic-ischemic encephalopathy, bone fractures, or Apgar and arterial pH outcomes.[7-11,13,15-17] Although there appears to be a growing trend in this last item, we must consider that the rate of missing data for arterial pH in the first period is high, which may have affected our analysis in this regard. Additionally, up to 20% of the poor perinatal outcomes were related to other concomitant factors.

We therefore conclude that simulation reduces the rate of permanent brachial plexus palsy without worsening perinatal outcomes or increasing the rate of hypoxic-ischemic disease. It is necessary to carefully evaluate the indication for instrumental delivery and episiotomy in cases of risk of shoulder dystocia.

Regarding strengths and limitations, in our study, a progressive reduction in neonatal birth weight was observed, which may imply a lower risk of dystocia and, therefore, lower morbidity. Additionally, for several years included in the study, a protocol was followed in our centre proposing active management of suspected fetal macrosomia with induction at 39 weeks in an attempt to reduce birth weight and associated comorbidities such as shoulder dystocia. This could have influenced the reduction in neonatal weight we observed and could partly explain the reduction in morbidities. However, this protocol was discontinued in 2022 following a study conducted at our centre, which included 32 cases affected by this protocol. The study demonstrated no significant differences in the number of vaginal deliveries, caesarean sections or complications, including shoulder dystocia and third-degree perineal tears, with the only notable change being an increase in the induction rate. Additionally, after its discontinuation, neonatal weight continued to decrease in 2023, while the incidence of dystocia continued to increase. Furthermore, our caesarean section rate only decreased in the second period, probably related to the pandemic, but remained stable in the first and third period despite the active management of suspected fetal macrosomia, so we cannot assume that the decrease in neonatal weight is due to a higher rate of caesarean sections for fetuses at high risk of shoulder dystocia. All this leads us to believe that the reduction in neonatal weight is a casual finding, although it could be affected by other uncontrolled factors, so we must interpret our results with caution.

Our study is retrospective and susceptible to inherent biases. However, the data collection was prospective, reducing error and information loss rates. We have a long follow-up period and a large sample size. Being a sing-

le-centre study with unique action protocols reduces heterogeneity. Additionally, the course has always been taught by the same staff, and participation rates were high and stable, implying a high percentage of trained staff. Like in the study by Crofts et al.[7], three groups were differentiated, allowing us to confirm the permanence of our findings over time. Our study differentiates between transient and permanent brachial plexus palsy and thoroughly analyses the manoeuvres used for resolution and perinatal outcomes, being one of the few studies published to date that includes these data.

Conclusion

Our results consolidate those obtained by Crofts et al.[7] and support that simulation-based training in shoulder dystocia can reduce the rate of permanent obstetric brachial plexus palsy without worsening other perinatal outcomes and without increasing cases of hypoxic-ischemic encephalopathy. Training improves staff's ability to recognize and report the emergency, their practical and communication skills, and their confidence, resulting in greater satisfaction and increased use of secondary manoeuvres without affecting the number of cases resolved with primary manoeuvres. Therefore, simulation training should be considered as a valuable tool in obstetrics which may enhance perinatal outcomes.

References

1. Chauhan SP, Gherman RB. Shoulder dystocia: challenging basic assumptions. Obstet Gynecol Clin North Am 2022;49:491–500. [PubMed][CrossRef]
2. Davis DD, Roshan A, Varacallo M. Shoulder dystocia. StatPearls [Internet]. 2023 Dec 20. Treasure Island (FL): StatPearls Publishing; 2024.
3. Mollberg M, Ladfors LV, Strömbeck C, Elden H, Ladfors L. Increased incidence of shoulder dystocia but a declining incidence of obstetric brachial plexus palsy in vaginally delivered infants. Acta Obstet Gynecol Scand 2023;102:76–81. [PubMed][CrossRef]
4. Youssefzadeh AC, Tavakoli A, Panchal VR, Mandelbaum RS, Ouzounian JG, Matsuo K. Incidence trends of shoulder dystocia and associated risk factors: a nationwide analysis in the United States. Int J Gynaecol Obstet 2023;162:578–589. [PubMed][CrossRef]
5. Sheen JJ, Goffman D, Deering S. Simulation in obstetric emergencies. Obstet Gynecol Clin North Am 2022;49:637–646. [PubMed][CrossRef]
6. Wagner SM, Bell CS, Gupta M, Mendez-Figueroa H, Ouellette L, Blackwell SC, et al. Interventions to decrease complications after shoulder dystocia: a systematic review and Bayesian meta-analysis. Am J Obstet Gynecol 2021;225:484.e1–484.e33. [PubMed][CrossRef]
7. Crofts JF, Lenguerrand E, Bentham GL, Tawfik S, Claireaux HA, Odd D, et al. Prevention of brachial plexus injury-12 years of shoulder dystocia training: an interrupted time-series study. BJOG 2016;123:111–118. [PubMed][CrossRef]
8. Van de Ven J, van Deursen FJ, van Runnard Heimel PJ, Mol BW, Oei SG. Effectiveness of team training in managing shoulder dystocia: a retrospective study. J Matern Fetal Neonatal Med 2016;29:3167–3171. [PubMed][CrossRef]
9. Dahlberg J, Nelson M, Dahlgren MA, Blomberg M. Ten years of simulation-based shoulder dystocia training- impact on obstetric outcome, clinical management, staff confidence, and the pedagogical practice - a time series study. BMC Pregnancy Childbirth 2018;18:361. [PubMed][CrossRef]
10. Kumar A, Sturrock S, Wallace EM, Nestel D, Lucey D, Stoyles S, et al. Evaluation of learning from Practical Obstetric Multi-Professional Training and its impact on patient outcomes in Australia using Kirkpatrick's framework: a mixed methods study. BMJ Open 2018;8. [PubMed][CrossRef]
11. Weiner CP, Collins L, Bentley S, Dong Y, Satterwhite CL. Multi-professional training for obstetric emergencies in a U.S. hospital over a 7-year interval: an observational study. J Perinatol 2016;36:19–24. [PubMed][CrossRef]
12. Gurewitsch Allen ED, Will SEB, Allen RH, Satin AJ. Improving shoulder dystocia management and outcomes with a targeted quality assurance program. Am J Perinatol 2017;34:1088–1096. [PubMed][CrossRef]
13. Kim T, Vogel RI, Das K. Simulation in shoulder dystocia: does it change outcomes? BMJ Simul Technol Enhanc Learn 2018;5:91–95. [PubMed][CrossRef]
14. Seligman NS, Walden B, Arnold C, Burhans K, Thornburg LL, Pressman EK. Safety in shoulder dystocia: implementation of an injury prevention program improves completeness of documentation. Am J Obstet Gynecol 2019;220–197. [CrossRef]
15. Salvador López R, Cruz Melguizo S, Sanz Lorenzana A, Diez de Los Rios Quintanero B, Malalana Martinez A, de la Cruz Conty ML, et al; en representación del Grupo Multiprofesional de Simulación Obstétrica PDH. Incidence of obstetric brachial plexus palsy after a training program in shoulder dystocia. An Pediatr (Engl Ed) 2022;97:415–421. [PubMed][CrossRef]
16. Kaijomaa M, Gissler M, Äyräs O, Sten A, Grahn P. Impact of simulation training on the management of shoulder dystocia and incidence of permanent brachial plexus birth injury: An observational study. BJOG 2023;130:70–77. [PubMed][CrossRef]
17. Brogaard L, Glerup Lauridsen K, Løfgren B, Krogh K, Paltved C, Boie S, et al. The effects of obstetric emergency team training on patient outcome: A systematic review and meta-analysis. Acta Obstet Gynecol Scand 2022;101:25–36. [PubMed][CrossRef]
18. McFarland MB, Langer O, Piper JM, Berkus MD. Perinatal outcome and the type and number of maneuvers in shoulder dystocia. Int J Gynaecol Obstet 1996;55:219–224. [PubMed][CrossRef]
19. Inglis SR, Feier N, Chetiyaar JB, Naylor MH, Sumersille M, Cervellione KL, et al. Effects of shoulder dystocia training on the incidence of brachial plexus injury. Am J Obstet Gynecol 2011;204:322.e1–6. [PubMed][CrossRef]