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Forceps Delivery Volumes in Teaching and Nonteaching Hospitals: Are Volumes Sufficient for Physicians to Acquire and Maintain Competence?

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Abstract

Purpose—The decline in the use of forceps in operative deliveries over the last two decades raises questions about teaching hospitals' ability to provide trainees with adequate experience in the use of forceps. The authors examined: (1) the number of operative deliveries performed in teaching and nonteaching hospitals, and (2) whether teaching hospitals performed a sufficient number of forceps deliveries for physicians to acquire and maintain competence.

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Method—The authors used State Inpatient Data from nine states to identify all women hospitalized for childbirth in 2008. They divided hospitals into three categories: major teaching, minor teaching, and nonteaching. They calculated delivery volumes (total operative, cesarean, vacuum, forceps, two or more methods) for each hospital and compared data across hospital categories.

Results—The sample included 1,344,305 childbirths in 835 hospitals. The mean cesarean volumes for major teaching, minor teaching, and nonteaching hospitals were 969.8, 757.8, and 406.9. The mean vacuum volumes were 301.0, 304.2, and 190.4, and the mean forceps volumes were 25.2, 15.3, and 8.9. In 2008, 31 hospitals (3.7% of all hospitals) performed no vacuum extractions, and 320 (38.3%) performed no forceps deliveries. In 2008, 13 (23%) major teaching and 44 (44%) minor teaching hospitals performed five or fewer forceps deliveries.

Conclusions—Low forceps delivery volumes may preclude many trainees from acquiring adequate experience and proficiency. These findings highlighted broader challenges, faced by many specialties, in ensuring that trainees and practicing physicians acquire and maintain competence in infrequently performed, highly technical procedures.

Proficiency in all methods of operative childbirth delivery (cesarean section, vacuum extraction, and forceps assisted delivery) is considered a core skill in the field of obstetrics and gynecology (Ob/Gyn). As of 2013, the Residency Review Committee for Ob/Gyn requires that all residency programs provide an adequate number of opportunities for trainees to perform each operative procedure.[1] If this requirement is not met, the committee may place the residency program on probation.[2]

From a clinical standpoint, experts often provide several justifications for and against the use of forceps and vacuum deliveries under certain situations.[3,4] However, both methods are considered safe and appropriate in specific clinical scenarios when performed or supervised by an experienced clinician.[5] Generally, the method a physician selects is influenced heavily by his or her experience and confidence with each instrument.

Although forceps and vacuum deliveries are frequently used interchangeably, the mechanics are very different, as are the risks to both mother and baby. Forceps are in essence a “modified steel clamp” that can injure maternal soft tissue as well as fetal tissue if inappropriately applied.[6,7] In contrast, the vacuum is a soft plastic pulling device that attaches to the baby's skull. While a vacuum can injure the baby's skull or brain, overall it is considered much simpler to use than forceps.[6,8]

Over the last two decades, the rise in cesarean section rates has received much attention from both the obstetrical and public health communities, but far less consideration has been given to the progressive decline in the use of forceps and a corresponding increase in the use of vacuum deliveries.[9-11] Kozak and colleagues, for example, demonstrated a 13% decline in forceps use between 1990 and 2000, and other authors have demonstrated similar findings.[9] Given these changes, we do not know the volume of each method of operative delivery, nor do we know if teaching hospitals are performing a sufficient number of forceps deliveries to maintain practicing physicians' competence and to allow for the training of

residents and fellows. These concerns transcend Ob/Gyn and mirror national concerns in many medical specialties and subspecialties.[12-15]

With this study, our objective was to examine the volume of cesarean sections and operative vaginal delivery methods (i.e., vacuum and forceps) in a diverse group of U.S. hospitals. We hypothesized that the volume of forceps deliveries in many teaching hospitals would be low, threatening practicing physicians' ability to maintain competence and residents and fellows' ability to adequately learn these procedures.

Method

Data sources

We used a 100% sample of State Inpatient Data (SID) for the year 2008 from nine states (Arizona, California, Florida, Iowa, Maryland, New Jersey, North Carolina, Washington, and Wisconsin) to identify all patients who were hospitalized for childbirth (International Classification of Disease, 9th Clinical Modification [ICD-9-CM] codes of 650 or 640x-676.9x). We deliberately acquired SID data from these nine states because they represented all regions of the U.S., included a disproportionate percentage of the U.S. population, and covered a mix of urban and rural regions. We stratified maternal childbirth admissions into normal spontaneous vaginal deliveries (ICD-9 diagnosis codes of 640.x-676.9x, and the absence of a code for cesarean delivery), cesarean deliveries (ICD-9 procedure code of 74), vacuum extractions (ICD-9 procedure codes of 72.7, 72.72, and 72.79), and forceps deliveries (ICD-9 procedure codes of 72.0, 72.1, 72.2, 72.3, 72.4, 72.51, 72.53, and 72.6). We then excluded women who underwent a normal spontaneous vaginal delivery to focus our analysis on operative deliveries.

The Agency for Healthcare Research and Quality (AHRQ) developed the SID databases as part of the health care utilization project (HCUP) in partnership with individual states.[16] SID data have been used extensively in prior health services research, including prior obstetrical studies.[17-19] SID data include many elements from the Uniform/Universal Billing Form 92 (UB-92) hospital discharge abstract, including: patient demographics; admitting hospital; primary and secondary diagnoses and procedures, as captured by ICD-9-CM codes; the diagnosis related group (DRG); admission source (e.g., emergency department, transfer from another hospital); admission and discharge dates; patient's primary insurance (categorized as Medicare, private insurance, Medicaid, self-pay, other); type of insurance (fee-for-service or health maintenance organization [HMO]); and disposition at the time of hospital discharge (e.g., transfer to another acute care hospital, deceased).

We linked each hospital in the SID database to the American Hospital Association (AHA) 2008 Annual Survey. The AHA survey provides information on an array of hospital-level factors, including hospital teaching status. We categorized hospitals that were members of the Association of American Medical Colleges' Council of Teaching Hospitals and Health Systems (COTH) as “major teaching” hospitals[20], non-COTH hospitals that had one or more accredited residency training program as “minor teaching” hospitals, and all other hospitals as “nonteaching” hospitals.

Statistical analysis

We began by stratifying each hospital in our data set and its respective patients into one of three mutually exclusive categories--major teaching, minor teaching, or nonteaching. We calculated five separate measures of delivery volume for each hospital based on the 2008 data: (1) total operative childbirth volume (cesarean deliveries, vacuum extractions, and forceps deliveries); (2) cesarean deliveries volume; (3) vacuum extractions volume; (4) forceps deliveries volume; and (5) volume of patients who required two or more attempted delivery methods (defined as any combination of vacuum plus forceps or cesarean delivery).

We used bivariate methods (t test and Cochran-Mantel-Haenszel statistics) to compare the demographics, insurance coverage, and comorbidities of patients delivered by cesarean, vacuum, and forceps, as well as those patients who required two or more delivery methods, across our three hospital categories. We identified comorbid illnesses as high risk obstetrical conditions if they had been identified previously as such.[21] Next, we used similar methods to examine the mean volume of cesarean, vacuum, and forceps deliveries, as well as the volume of patients who required two or more delivery methods, across our three hospital categories. We conducted all analyses for cesarean deliveries, vacuum extractions, forceps deliveries, and two or more attempted procedures separately, and for all operative deliveries in aggregate. We performed all statistical analyses using SAS 9.2 (SAS Institute Inc., Cary, NC). The University of Iowa institutional review board approved our study.

Results

Our sample included 1,344,305 total childbirths. After excluding normal spontaneous vaginal deliveries (N = 720,305), our final cohort included 624,000 operative deliveries performed in 835 hospitals (424,224 cesarean deliveries; 174,036 vacuum extractions; 6,158 forceps deliveries; and 19,582 deliveries that required two or more methods). The 835 hospitals included 68 major teaching hospitals, 130 minor teaching hospitals, and 637 nonteaching hospitals. All 835 hospitals in our sample performed at least one cesarean delivery (100%), 804 performed at least one vacuum extraction (96.3%), 515 performed at least one forceps delivery (61.7%), and 671 hospitals delivered one or more patients requiring two or more delivery methods (80.4%). See Table 1 for complete data including patient demographics by delivery method.

Hospital operative volumes for major teaching, minor teaching, and nonteaching hospitals are displayed in Table 2. The mean annual cesarean volumes for major teaching, minor teaching, and nonteaching hospitals were 969.8, 757.8, and 406.9 respectively ($P < .0001$). The mean vacuum volumes were 301.0, 304.2, and 190.4 respectively ($P < .0001$), and the mean forceps volumes were 25.2, 15.3, and 8.9 ($P < .0001$) (see Table 2). From an alternative perspective, 31 hospitals (3.7% of all hospitals) did not perform a single vacuum extraction in 2008; this number included 8 major teaching hospitals (11.8% of major teaching hospitals), 4 minor teaching hospitals (3.1% of minor teaching hospitals), and 19 nonteaching hospitals (3.0% of nonteaching hospitals) ($P < .0001$). Looking at forceps deliveries, 320 hospitals (38.3% of all hospitals) did not perform a single forceps assisted delivery in 2008; this number included 11 major teaching hospitals (16.2% of major teaching hospitals), 30 minor teaching hospitals (23.1% of minor teaching hospitals), and

279 nonteaching hospitals (43.8% of nonteaching hospitals) ($P < .0001$). Finally, we found that essentially half of all major teaching hospitals performed less than 15 forceps deliveries each in 2008 (see Table 3).

Discussion

In our analysis of 624,000 operative deliveries in 835 U.S. hospitals in 2008, we observed a number of important findings. First, while the vast majority of hospitals performed at least one cesarean section and one vacuum delivery, nearly 40% of hospitals did not perform any forceps deliveries and 50% performed five or fewer. This finding raises significant questions about the ability of teaching hospitals to provide trainees with adequate experience in the use of forceps. Second, we found that 59% of nonteaching hospitals performed five or fewer forceps deliveries (see Table 3) and 8% performed 10 or fewer vacuum deliveries (data not reported), which highlights potential challenges for community-based practitioners seeking to maintain their skills after they complete their training.

Our findings also highlighted two related challenges that many medical specialties and subspecialties share--ensuring that trainees have adequate exposure to infrequently performed procedures during residency and fellowship and ensuring that practicing physicians continue to perform an adequate number of these procedures to maintain their expertise over time. The low volume of forceps deliveries in teaching hospitals, for example, raises significant questions about their ability to adequately train residents and fellows in this technique. To date, no professional or certifying body in Ob/Gyn has established an absolute minimum threshold for the number of procedures that residents and fellows must complete during training. Rather, the Residency Review Committee for Ob/Gyn suggests that, to maintain accredited status, residency programs should, in general, maintain procedure numbers that are similar to the mean number of procedures performed nationwide. While this approach is intuitively appealing, it becomes problematic for low volume procedures, such as forceps deliveries (the mean number of resident forceps deliveries nationally was 10.5 in 2008).[1] The Residency Review Committee for Ob/Gyn has "consistently used the 10th percentile [for procedural volume] from the annual data collection as the point below which it considers an individual resident's experience and/or a program's average resident experience to be inadequate."[2] And it considers resident or procedural experience in a category to be marginal if it falls between the 10th and 20th percentiles.[2] From a practical standpoint, this categorization means that a residency program's cesarean volume could be deemed inadequate or marginal at 50 or 100 deliveries per year. Yet, that same residency program's forceps volume could be deemed adequate at 5 or 10 deliveries per year.

In family medicine, where Ob/Gyn is taught (including operative deliveries), the American Board of Family Medicine mandates that, to be eligible for board certification in obstetrics, trainees "should have performed a minimum of 100 vaginal deliveries and a minimum of 50 cesarean sections within the last 5 years."[22] No such minimum requirement exists for operative vaginal deliveries (i.e. forceps or vacuum) despite the fact that these procedures require significantly more expertise to perform safely, when compared with normal spontaneous vaginal deliveries.

This difficulty determining procedural competence is not unique to Ob/Gyn in general and childbirth specifically. Rather, such ambiguity permeates most medical specialties, with many resorting to volume as a proxy for competence because volume (in contrast to proficiency) is possible--if not easy--to measure. For instance, according to the Residency Review Committee for general surgery, “The minimum case requirement prior to completion of general surgery residency remains at 750 major cases and 150 of these cases must be completed in the chief year.”[23] The Residency Review Committee for urology recently moved to numbers that “reflect the lowest acceptable clinical volume of critical procedures performed per resident for program accreditation. A program complies with requirements if each resident in the program achieves the minimum number of procedures for each listed procedure or category.”[24]

These inconsistencies among the various Residency Review Committees expose the lack of consensus and of evidence for how to measure acquisition of procedural proficiency. Setting minimum volume thresholds has the advantage of being relatively simple and the numbers easy to measure, but this measurement ignores the tremendous variation in skill acquisition rates at the level of the individual physician. Moreover, little empirical data exists to guide the number of rarely performed procedures, such as open aortic aneurysm repairs, hepatic wedge resections, and even forceps deliveries, that a physician must complete to attain proficiency.

No simple solutions exist to addressing our finding of low procedural volumes of forceps deliveries both in teaching and nonteaching hospitals. The current medical education model mimics the archetypal apprenticeship model of “learning by doing”[25] in which experienced physicians facilitate trainees' learning while promoting the trainees' autonomy. This approach works well for commonly performed procedures, but it fails to provide trainees with adequate or consistent experience in performing rare procedures. One alternate solution is to reconsider whether continued competence in forceps deliveries is possible or even necessary anymore.[26] Beginning in 2014, the Residency Review Committee will no longer require Ob/Gyn residents to case log forceps as an individual procedure. Rather, forceps and vacuum deliveries will be listed together under the label of operative vaginal delivery, possibly reflecting a recognition that the era of forceps delivery is coming to a close.

Still, even if proficiency in forceps deliveries is no longer deemed necessary, the question of setting proficiency standards for numerous other skills within Ob/Gyn and other procedural areas of medicine, from neurosurgery to ophthalmology, remains relevant. Some in academic medicine advocate alternate medical training models that seek to improve the apprenticeship model. Until recently, surgeons have maintained their existing skills and acquired new skills by attending workshops or surgical training courses, during which they practiced technically difficult procedures on animals, outside the formal Residency Review Committee or board certification process.[27-29] Today, however, simulation-based learning[30] has garnered more interest as a way for physicians to develop and maintain proficiency.[21] While simulation-based learning offers great promise and the findings from early studies are encouraging, data on whether competence gained through simulation results in satisfactory outcomes at the bedside remain limited.[31,32]

While physicians typically undergo training at a teaching hospital, the vast majority spend their careers at a community-based practice, where they must maintain and enhance their skills over time. While hospital procedural volume is not the same as individual physician procedural volume, our findings call into question the feasibility of physicians maintaining competence in vacuum or forceps deliveries over time once they have transitioned to a community-based practice.

Our study has a number of limitations. First, it relied on administrative data. Systematic miscoding of delivery modalities therefore could have biased our results, though we have no reason to believe that this is the case and prior studies have shown that the coding of obstetrical diagnoses and procedures is reliable.[33] Second, our analysis was limited to nine states, thus our results must be generalized to other states with care. Third, we lacked access to individual provider identifiers, thus were not able to calculate provider volume. Still, we do not think that individual provider volumes for these procedures would be much higher than hospital volumes and, in all likelihood, hospital volumes should be markedly higher than individual provider volumes.

In conclusion, in our analysis of 2008 data from over 800 hospitals, we found that the low volume of forceps deliveries at major teaching hospitals calls into question our ability to provide adequate training experience to residents and fellows. Our findings also highlight the challenges for physicians in community-based practices to maintain competence in infrequently performed, highly technical procedures. In response, we must develop new approaches to acquiring and maintaining competence and rigorously test these new models, particularly for technically demanding procedures.

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Table 1

Characteristics of Patients from Nine States Hospitalized for Childbirth in 2008, According to State Inpatient Data, By Operative Delivery Method

	Delivery method			
Characteristic	**Cesarean (N = 424,224)**	**Vacuum (N = 174,036)**	**Forceps (N = 6,158)**	**Two or more attempted procedures (N = 19,582)**
No. hospitals	835	804	515	671
Age, mean (standard deviation)	29.0 (6.3)	26.8 (6.3)	27.7 (6.3)	29.0 (6.4)
Race, no. (%)				
White	169,802 (40.0)	71,980 (41.4)	3,036 (49.3)	8,010 (41.0)
Hispanic	119,227 (28.1)	48,858 (28.1)	1,019 (16.6)	5,348 (27.3)
Black	50,216 (11.8)	12,241 (7.0)	471 (7.7)	2,112 (10.8)
Other	84,979 (20.0)	40,957 (23.5)	1,632 (26.5)	4,112 (21.0)
Payor, no. (%)				
Medicaid	176,062 (41.5)	70,104 (40.3)	2,136 (34.7)	7,725 (39.5)
Private	226,480 (53.4)	94,290 (54.2)	3,686 (59.9)	10,883 (55.6)
Medicare	1,875 (0.4)	434 (0.3)	32 (0.5)	95 (0.5)
Self-pay	11,051 (2.6)	5,557 (3.2)	125 (2.0)	472 (2.4)
No charge	817 (0.2)	287 (0.2)	8 (0.1)	32 (0.2)
Missing	7,939 (1.9)	3,364 (1.9)	171 (2.8)	375 (1.9)
Comorbidities, no. (%)				
Advanced maternal age	90,843 (21.4)	21,962 (12.6)	953 (15.5)	4,209 (21.5)
Hypertension disorders	62,600 (14.8)	11,421 (6.6)	621 (10.1)	2,530 (12.9)

	Delivery method			
Characteristic	**Cesarean (N = 424,224)**	**Vacuum (N = 174,036)**	**Forceps (N = 6,158)**	**Two or more attempted procedures (N = 19,582)**
Diabetes	41,393 (9.8)	8,365 (4.8)	331 (5.4)	2,191 (11.2)
Obesity	23,025 (5.4)	2,525 (1.5)	128 (2.1)	1,526 (7.8)
Multiple gestation	15,541 (3.7)	986 (0.6)	74 (1.2)	347 (1.8)
Maternal mortality, no. (%)	76 (0.02)	3 (0.0)	0 (0.0)	0 (0.0)
Length of stay in days, mean (standard deviation)	3.6 (3.0)	2.2 (1.5)	2.5 (1.6)	3.2 (2.1)

Table 2

Operative Delivery Volumes from Nine States in 2008, According to State Inpatient Data, By Operative Delivery Method and Hospital Category*

	Hospital category				
Operative delivery method	**Major teaching**	**Minor teaching**	**Nonteaching**	**Total**	***P* value**
No. all operative births	87,686	144,040	392,274	624,000	
No. hospitals performing	68	130	637	835	
Hospital operative birth volume, mean (IQR)	1,289.5 (559-1,528)	1,108.0 (484-1443)	615.8 (145-868)	755.4 (183-1053)	< .0001
No. cesarean deliveries	65,948	99,080	259,196	424,224	
Hospitals performing, no. (%)	68 (100.0)	130 (100.0)	637 (100.0)	835 (100.0)	
Hospital cesarean volume, mean (IQR)	969.8 (461-1,133)	757.8 (340-1,033)	406.9 (95-569)	513.6 (123-718)	< .0001
% of all operative births, no. (%)	65,948 (75.2)	99,080 (68.8)	259,196 (66.1)	424,224 (68.0)	< .0001
No. vacuum extractions	18,061	38,333	117,642	174,036	
Hospitals performing, no. (%)	60 (88.2)	126 (96.9)	618 (97.0)	804 (96.3)	
Hospital vacuum volume, mean (IQR)	301.0 (103-386)	304.2 (131-392)	190.4 (41-252)	218.4 (53-295)	< .0001
% of all operative births, no. (%)	18,061 (20.6)	38,333 (26.6)	117,642 (30.0)	174,036 (27.9)	< .0001
No. forceps deliveries	1,439	1,534	3,185	6,158	
Hospitals performing, no. (%)	57 (83.8)	100 (76.9)	358 (51.7)	515 (61.7)	
Hospital forceps volume, mean (IQR)	25.2 (6-35)	15.3 (3-16)	8.9 (2-11)	12.0 (2-14)	< .0001
% of all operative births, no. (%)	1,439 (1.6)	1,534 (1.1)	3,185 (0.8)	6,158 (1.0)	< .0001
No. two or more attempted procedures	2,238	5,093	12,251	19,582	
Hospitals performing, no. (%)	59 (86.8)	117 (90.0)	495 (77.7)	671 (80.4)	
Hospital ≥ two procedures volume, mean (IQR)	37.9 (14-47)	43.5 (12-51)	24.7 (4-32)	29.4 (6-39)	< .0001
% of all operative births, no. (%)	2,238 (2.5)	5,093 (3.5)	12,251 (3.1)	19,582 (3.1)	< .0001

*We categorized hospitals that were members of the Association of American Medical Colleges' Council of Teaching Hospitals and Health Systems (COTH) as major teaching hospitals, non-COTH hospitals that had one or more accredited residency training program as minor teaching hospitals, and all other hospitals as nonteaching hospitals. IQR indicates interquartile range.

Table 3

Forceps Delivery Volumes from Nine States in 2008, According to State Inpatient Data, By Hospital Category*

	No. forceps deliveries				
Hospital category	**≤ 5**	**6-15**	**16-25**	**≥ 26**	***P* value**
Major teaching, no. (%)	13/57 (22.8)	15/57 (26.3)	9/57 (15.8)	20/57 (35.1)	< .0001
Minor teaching, no. (%)	44/100 (44.0)	30/100 (30.0)	8/100 (8.0)	18/100 (18.0)	< .0001
Nonteaching, no. (%)	210/358 (58.7)	87/358 (24.3)	29/358 (8.1)	32/358 (8.9)	< .0001

*We categorized hospitals that were members of the Association of American Medical Colleges' Council of Teaching Hospitals and Health Systems (COTH) as major teaching hospitals, non-COTH hospitals that had one or more accredited residency training program as minor teaching hospitals, and all other hospitals as nonteaching hospitals.