Published in final edited form as:

Am J Perinatol. 2012 March ; 29(3): 217–224. doi:10.1055/s-0031-1285096.

Using Improvement Science to Increase Accuracy and Reliability of Gestational Age Documentation

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Abstract

Our aim was to improve the reliability of recording gestational age (GA) in the mother's obstetric record, as this record is used for clinical management, research databases, and eventual transmission to the Ohio Department of Health birth certificates. We performed a prospective cohort study, including all hospital births. We began quality improvement interventions in October 2009. Improvement test cycles were targeted to four working groups, including nursing staff, community obstetric providers, and the process itself. Test cycle results were evaluated to determine which successful interventions could spread further. Rates of process outcome measurements were compared by statistical process control and univariate analysis pre- and postintervention. During the preintervention period, the median daily GA reliability was 25%. To date, over 30 small sample size tests of change have been completed. Of 8795 births studied, significant improvement in GA accuracy/completeness was detected (median postintervention =78%, $p < 0.01$). Increased communication of and completion of the prenatal record, in addition to GA recording in high-risk groups, such as premature infants, were also achieved (all $p < 0.01$). GA reliability can be increased using standardized improvement science methods. Better communication of GA will enable better clinical decisions and foster population-based perinatal research.

Keywords

Gestational age; electronic medical record; birth certificate; vital statistics; quality improvement

Gestational age, as recorded on birth certificates, is used in research and in planning intervention programs for at-risk pregnancies. In addition, gestational age guides obstetric and pediatric decisions about the appropriate timing of delivery and preparation for anticipated neonatal resuscitation and subsequent care. Therefore, obstetric and neonatal providers collaborate to record the most accurate gestational age so as to provide appropriate care for the pregnant mother and her infant, and avoid the consequences of inappropriate preterm delivery, which is known to have consequence of neonatal morbidity and cost.^{1,2} In addition, the best estimate of gestational age must also be recorded on the birth certificate or other vital statistics registries to be used in valid epidemiological, population-based research

and in the development of effective intervention programs. If vital statistics are incomplete or inaccurate, estimates of risk status, clinical care, or outcomes will not adequately reflect the population being studied. It is worrisome, then, that gestational age documentation is often not achieved due to poor communication between various health care providers, thereby affecting clinical care and downstream vital statistics or research registries.

In 2008 to 2009, two events occurred that led us to evaluate the communication of gestational age from community obstetric providers, to hospital obstetric providers and neonatal providers, and to the birth certificate. First, in 2006, the Ohio General Assembly passed House Bill 197, requiring hospitals to publicly report, beginning in 2009, selected performance measures, many of which rely on gestational age. Examples of these measures include appropriate antenatal administration of steroids to premature infants and elective delivery prior to 39 weeks' gestation. At our hospital, these data are obtained from birth certificates and are abstracted from the electronic medical record used for patient care. Second, sentinel events occurred in our hospital. On two separate occasions, a pregnant woman was admitted to the labor and delivery unit without prenatal records transmitted appropriately from her obstetric provider. To estimate gestational age, the women themselves were asked to recall their estimated due dates (EDDs). Because this self-reported information overestimated gestational age, the infants were born prematurely and required admission to the neonatal intensive care unit for respiratory support.

Therefore, our main goal of this study was to ensure that all available information used to calculate estimated due date and gestational age is available at the time of mother's admission for delivery such that hospital providers could provide clinical care and birth certificate registrars could accurately document gestational age on the birth certificate. Interviews with the hospital's birth certificate registrar indicated that gestational age is documented on the birth certificate using the information present in the electronic medical record. If the electronic medical record is incomplete, the registrar must review the entire medical record to determine the provider's best estimate of gestational and to decide what to enter into the birth certificate.

To that end, we designed and conducted a quality improvement (QI) project to perfect the recording of accurate gestational age data in the electronic medical record used for patient care, where data were abstracted to eventually appear on the birth certificate. We focused specifically on improving the communication of correct gestational age information to relevant hospital personnel, the first step in ensuring that correct information appears on the birth certificate and that would help improve clinical care and the ability to make patient care decisions. This project represents an effective collaboration between maternal-fetal medicine specialists, obstetric nurses, neonatologists, data analysts, and the Ohio Perinatal Quality Collaborative³ to achieve better patient outcomes and birth certificate data quality.

METHODS

Setting

Good Samaritan Hospital (GSH) is located in Cincinnati, Ohio, and is the largest maternity hospital in the State of Ohio, with ~7000 deliveries per year. Over 100 obstetric providers, including a large maternal-fetal medicine practice, 32 obstetric residents, a large midwifery service, and more than 10 community-based physician groups, admit obstetric patients. GSH has a level III neonatal intensive care unit, staffed by 10 neonatologists, working in conjunction with 19 pediatricians, who care for the infants not requiring intensive care.

The data elements used to calculate gestational age are the first day of the last menstrual period (LMP), the date of the earliest pregnancy ultrasound, and the gestational age

estimated at the time of the first pregnancy ultrasound. Using these data elements, the obstetrician can calculate two gestational ages and two EDDs—one based on LMP and the other on the ultrasound. These data elements, and the obstetrician's EDD, as recorded on the prenatal record, are ideally transmitted to the hospital prior to the mother's admission for delivery. These data are then reviewed and transcribed into the electronic medical record by the hospital doctors and nurses. This electronic record was considered complete if all data elements, a final EDD, and the method of calculating the EDD were filled out. For the purposes of this improvement project, if the following data were documented, the electronic record was also considered complete: (1) the mother had an ultrasound in the first trimester, or (2) it was documented that the mother was unsure of her LMP, but had the earliest ultrasound documented.

Aims and Working Groups

After the two iatrogenic premature deliveries occurred, a QI team consisting of a maternal–fetal medicine specialist, a neonatologist, and two obstetric nurses began to examine methods for improving transfer of information of the mother's prenatal records, which is expected to contain her LMP and ultrasound results, to hospital providers. Figure 1 is a flowchart that demonstrates the algorithm by which information is documented in the electronic medical record and conveyed to hospital-based providers for clinical care and to research databases. As an increase in accurate documentation on the electronic medical record would not only improve clinical care but also improve the quality of other data repositories used to study high-risk populations, the Ohio Perinatal Quality Collaborative (www.OPQC.net) and the Ohio Department of Health were interested in our efforts. Our most important aim was to improve the completion of gestational age recorded in the electronic medical record to 90%, prior to the infant's birth, in the population of women with prenatal care who delivered a live-born infant at least 20 weeks' gestational age. Adequate prenatal care was defined as more than eight antenatal visits. We based our 90% goal on our hospital's global aim to become a highly reliable organization, meaning that we wanted to standardize processes and increase mindfulness of gestational age recording. Institutional Review Board approval was obtained.

Prior to initiating improvement interventions, the current process for the communication of maternal pregnancy data to the hospital and subsequent providers was reviewed. This review led to an understanding that interventions would need to be individualized toward four working groups, each playing an important role in ensuring that the electronic medical record was complete: community obstetric providers (COB), labor and delivery (LD)/nursing process, antepartum ward (AP), and Process.

The COBs initiate prenatal care with the pregnant woman, and compile a chart of all her office visits, including completion of each practice's unique prenatal record, which contains information regarding the woman's LMP and first ultrasound. At designated intervals during the pregnancy, the COBs review the women in the practice who are due to deliver, and fax an up-to-date prenatal record for these women to the hospital. Once received at the hospital, the prenatal records are scanned and attached to the mother's electronic medical record by a data analyst. When a woman presents to the hospital with a pregnancy complaint or possible labor, she is sent to the LD unit. LD represents the initial intake into the hospital. The AP houses women with high-risk pregnancies who are often hospitalized prior to delivery. High-risk women with an antepartum stay and their resulting infants are of particular interest for obstetric and neonatal research studies and targeted interventions, and represent an important cohort of mothers and babies for whom valid, complete data are essential. Both the LD and AP nurses use the prenatal record, if available, to enter the correct information onto the electronic medical record for calculation of gestational age. The electronic medical record is then available for all health care providers and the birth certificate registrar to

review. Finally, the last working group was termed “Process,” to represent the overall methods by which COBs correctly complete the prenatal record and communicate the mother’s prenatal information to the hospital and subsequent providers.

Interventions

The project commenced in September 2009, with 1 month of acquiring baseline data. Every delivery that occurred at the study institution was reviewed and included in the study if the mother had adequate prenatal care. The list of women who delivered was obtained daily, and their electronic medical records were reviewed retrospectively for completion. Our main outcome measure was the percentage of daily deliveries that had a complete electronic medical record based on the criteria noted above.

In October 2009, after 1 month of baseline data collection, improvement test cycles (Plan, Do, Study, Act) began. These cycles are, in effect, the scientific method for action-oriented learning and allow the improvement team to evaluate if proposed changes led to desired improvement, would work in the environment of change, and would improve outcome measures. The QI team as previously described met regularly to work on specific components of the test cycles and report results. Table 1 summarizes the interventions tested during each phase.

In phase I, during Fall 2009, our QI team began training nurses in LD and AP regarding completion of the electronic medical record. We used this period to understand the process gaps when the electronic medical record was not reliably completed. The nursing supervisors developed test cycles specific for their wards. If the communication process worked correctly—the prenatal record had been received, completed with the essential data elements, and attached to the patient’s electronic medical record—the nurse caring for the delivering mother transcribed what the referring provider had documented for the calculation of gestational age. Nurses documented in an open comments box in the electronic medical record when prenatal records were not available, or when they were incomplete. Review of these comments showed that the most common reason that the electronic medical record was incomplete was that antenatal ultrasound data had not been sent from the community provider. In addition, parts of the prenatal record (either the LMP or first ultrasound’s date or results) were often missing, and only the final EDD as calculated by the obstetrician, without the data elements used, was documented. Algorithms were developed for both LD and AP that included processes for hospital staff (nurses and unit secretaries) to flag charts with incomplete electronic medical record information and to contact community providers to obtain complete information. In addition, as the project became more publicized, the obstetric residents were taught to document all data elements for dating the pregnancy in their History and Physical form.

During phase I, our QI group also realized that different communication processes existed on the weekends versus weekdays. Although our initial test cycles demonstrated improvement on weekdays, often community provider records were not available to provide information on deliveries occurring on weekends, when most births were spontaneous or unscheduled. We specifically targeted weekend nurses, who, by reputation, were high achievers and considered peer leaders, to start the momentum for improvement. We instructed these nurses on completion of the electronic medical record and encouraged them to spread the teaching to their colleagues.

With much of the initial nursing process mapped, including identification of communication gaps, phase II focused on the working group of Process, the overall process by which the prenatal record was transmitted by the COB to the hospital. We developed a new standardized History and Physical form, required to be completed by all COBs upon

admission of their patients for delivery, which contained all the information necessary for completion of the electronic medical record. We also empowered nursing staff to alert obstetric providers when the electronic medical record calculated a different gestational age than that upon which the providers were basing their clinical decision for delivery, as was documented in their prenatal record. For example, after correct completion of the electronic medical record, one nurse notified an obstetrician that a pregnant patient had a lower gestational age than had been previously thought, stopping a planned induction. In effect, she prevented the iatrogenic delivery of a premature infant. As other providers saw such examples of patient safety benefits that arose from accurate completion of the electronic medical record, the efforts of the QI team gained further momentum.

In phase III, during Spring 2010, the LD nursing supervisor on our QI team began real-time auditing of the nursing staff for incomplete electronic medical records. On weekdays, she opened the chart of each patient and informed each nurse directly if the electronic medical record on one of her patients was lacking any information. This helped us to know that the electronic medical record was being completed prior to delivery and also gave the nurses real-time feedback if the electronic medical record had not been completed correctly. The nurses themselves began to ask obstetric providers to confirm dating criteria when the prenatal record was not available, and this also caused an increased awareness in community providers to complete the prenatal record correctly and communicate the information to the hospital in a timely fashion. In addition, the QI team developed a “pregnancy card” for the community practices, which could be given to each pregnant woman upon initiation of prenatal care, to be carried with her throughout the pregnancy. The card contained vital information pertaining to the pregnancy and included her LMP and ultrasound information for calculation of gestational age.

From April 14 to May 3, 2010, the electronic medical record failed and was not online for clinical care. Once the electronic medical record was back online, our project team began phase IV of our test cycles, which included continued real-time auditing of the nursing staff for completion of the electronic medical record. In addition, we continued to build on our test cycles with individual community practices, as the new History and Physical form was implemented, and practices were audited and given feedback for all obstetric admissions to assess completion of the medical record, including electronic medical record.

Since Summer 2010, we have held learning sessions on QI for the obstetric residents to continue the widespread education regarding pregnancy dating and its importance, and also began tracking additional outcome measures, including completion of the electronic medical record for certain high-risk groups, including mothers whose infants were premature, had congenital anomalies, had a pediatrician present at the delivery for neonatal resuscitation, or were admitted to the neonatal intensive care unit. We believed that these mothers and infants represented patients who would be of greatest interest for future research and should be particularly targeted for communication of accurate gestational age for clinical care and vital statistics.

Statistics and Manuscript Reporting

We plotted the percentage of maternal records that had completed obstetric dating information by week on a run chart. This method allowed us to identify in real time what changes to the process resulted in an improvement and then to track over time if these changes showed reliable and sustained improvement. We used statistical process control to evaluate whether significant improvement had occurred as a result of our QI efforts. After eight consecutive points are demonstrated above a baseline mean, the theory of statistical process control indicates that normal random variation cannot account for sustained

increased values and that a significant change, due to our improvement efforts, had been achieved.⁴

In addition, we compared the baseline data to a period after our interventions had begun, to determine if improvements were seen in particular high-risk groups. Rates of record completion in the pre- and postintervention period in these high-risk groups were compared with χ^2 tests.

We adhered to the STROBE guidelines for reporting on cohort studies and the SQUIRE guidelines for reporting on QI interventions.

RESULTS

Since the initiation of our project, 8795 deliveries with adequate prenatal care occurred at GSH. Less than 1% of deliveries were excluded due to inadequate prenatal care. Baseline data indicated that the electronic medical record was reliably completed in ~25% of daily records, as seen on the annotated run chart (Fig. 2). With the initiation of our test cycles in phase I, we saw statistically significant improvement in our primary outcome, percentage of daily deliveries with a completed electronic medical record (Fig. 2). With evidence of a significant change by statistical process control as previously described, we were able to redraw a new median line, up to 57%. Similarly, in phase III, the initiation of real-time auditing by an LD nursing supervisor had the greatest impact on improvement of our primary outcome and allowed for another increase in the median line, up to 75%. Since Summer 2010, the implementation of the new standardized History and Physical form allowed for even further improvement, up to almost 80%.

We performed a comparison between two periods of the project, to see how much improvement had been achieved in key outcome measures (Table 2). We compared our baseline month of September 2009 to our more recent data in October/November 2010. We saw significant increases in the electronic medical record completion overall and in high-risk groups, including mothers pregnant with premature infants, infants admitted to neonatal intensive care, and infants who required delivery room resuscitation. No significant increase was seen in mothers whose infants had congenital anomalies, likely because numbers were small. In addition, we saw significant improvement in the community providers sending prenatal information to the hospital prior to the delivery and in completion of the prenatal record prior to it being sent in the first place.

DISCUSSION

As Gould⁵ argues, “The key to the effectiveness of vital statistics data for QI is for a consortium of clinicians, maternal and child health professionals, vital records personnel, and data analysts to work together to provide timely, accurate data that has been fairly risk-adjusted, and the technical assistance to interpret and act on the data.” In effect, the individuals that are most invested in the use of the data to improve outcomes of clinical care and research need to get involved to improve the data itself.

Our results show that a large delivery hospital can increase the quality and completeness of critical information (most importantly, gestational age) transferred from the mother’s antenatal record to the hospital record. Run charts enabled us to follow the trend of improvement over time as we initiated, modified, and intensified our improvement test cycles. In addition, despite the failure of the electronic medical record for a 3-week block of time, we demonstrated that this improvement was sustained (Fig. 2).

Several key elements contributed to the success of this project. Our initial test cycles clearly depended on front-line and high-achieving nursing staff to spread the desired change. In addition, daily data collection and real-time auditing allowed for immediate feedback to staff when the electronic medical record was incomplete. As such, the practice of electronic medical record completion became truly integrated into the mental models of the staff. Second, because nurses were truly the gatekeepers of this information in the record, they were empowered to alert physicians when clinical management was being dictated by an incorrectly calculated gestational age, preventing premature delivery.

Although we are extremely encouraged by these initial results and the improvements in outcome measurements for all working groups (Table 2), our work is not yet complete. We have not yet reached our goal of 90% completion of the electronic medical record; however, the most recent run chart continues to show improvement, and much work still needs to be done with community providers, all of whom have different processes in their office settings for correctly transmitting the mother's antenatal records to our hospital. We continue to work toward the implementation of the pregnancy card, a document to be carried by the pregnant woman throughout her entire pregnancy. We also continue to perform real-time auditing to perfect the nursing staff's method for electronic medical record completion. Finally, we will need to confirm that the birth certificates adequately reflect what is in the electronic medical record.

As we continue to improve electronic medical record completion, this improvement makes the job of the birth certificate registrar easier, as she is no longer required to put her own judgment into the recording of the most accurate gestational age onto the birth certificate; she acknowledges that she can merely turn to the electronic medical record and copy what is written there. This has decreased the amount of time that she spends on this task, freeing her to do other aspects of her job. The accuracy and quality of the vital statistics are thereby improved, ensuring that when birth records are used to study at-risk newborns, the data best direct our research and interventions to the infants that need us most.

Acknowledgments

The authors wish to thank the obstetric nurses at GSH for their enthusiasm and willingness to participate in this QI intervention. We also thank Mounira Habli, M.D., for her review of this work and Jonathan Labare for help with the run chart templates.

References

1. Ashton DM. Elective delivery at less than 39 weeks. *Curr Opin Obstet Gynecol*. 2010; 22:506–510. [PubMed: 20978440]
2. Bird TM, Bronstein JM, Hall RW, Lowery CL, Nugent R, Mays GP. Late preterm infants: birth outcomes and health care utilization in the first year. *Pediatrics*. 2010; 126:e311–e319. [PubMed: 20603259]
3. The Ohio Perinatal Quality Collaborative Writing Committee. A statewide initiative to reduce inappropriate scheduled births at 36⁰/₇–38⁶/₇ weeks' gestation. *Am J Obstet Gynecol*. 2010; 202:243. e1–8. [PubMed: 20207241]
4. Thor J, Lundberg J, Ask J, et al. Application of statistical process control in healthcare improvement: systematic review. *Qual Saf Health Care*. 2007; 16:387–399. [PubMed: 17913782]
5. Gould JB. Vital records for quality improvement. *Pediatrics*. 1999; 103(1, Suppl E):278–290. [PubMed: 9917471]

Figure 1.
Algorithm for communication of gestational age for clinical care and vital statistics.

Figure 2.

Run chart of gestational age recording in the electronic medical record. Dashed lines represent control limits.

Table 1

Summary of Working Group Improvement Efforts by Phase of Implementation

Phase	Dates	Nursing Process/Labor and Delivery	Antepartum Ward	Process	Community Obstetric Providers
1	Fall 2009	<ul style="list-style-type: none">Trained nurses in completion of electronic medical record at yearly nursing continuing-based educationHigh-performing nurses instructed how to complete electronic medical record and spread to colleaguesSupervised night-shift nursesIdentified need for separate process and training on weekendsEmpowered nursing staff to document why electronic medical record cannot be filled out to identify process issues	<ul style="list-style-type: none">Established algorithm for ward clerk to run daily census and check for completion of electronic medical recordObstetric residents instructed that dating criteria must be in History and PhysicalHistory forms requested from community obstetric provider if electronic medical record incomplete		<ul style="list-style-type: none">Presented information on sentinel events and completion of electronic medical record at Obstetrics and Gynecology staff meetingIdentified community practices that are "low performers"Identified that electronic medical record most often not completed because ultrasound information is not communicated
2	Winter 2009	<ul style="list-style-type: none">Empowered nurses to alert doctors if electronic medical record incomplete or doctors planning interventions based on incorrect dating		<ul style="list-style-type: none">Developed new History and Physical form that contains all data for completion of electronic medical record	<ul style="list-style-type: none">Individual test cycles begin for one practice: work with office nurse practitioner to fax ultrasound results
3	Spring 2010	<ul style="list-style-type: none">Initiated real-time auditing of electronic medical records and direct communication with nursing provider for incompletesElectronic medical record upgraded; reviewed completion of electronic medical record at nurse training sessions	<ul style="list-style-type: none">Identified charts with incomplete data for completion of electronic medical record with stickers	<ul style="list-style-type: none">Developed pregnancy card for pregnant women to take to all appointments and have dating information entered	
(Obstetric electronic medical record down April 14–May 3, 2010)					
4	Summer 2010	<ul style="list-style-type: none">Expanded real-time auditing of electronic medical record by nursing staff	<ul style="list-style-type: none">Initiated real-time auditing of electronic medical record by nursing staff	<ul style="list-style-type: none">Additional data collecting and reporting on correct completion of prenatal record	<ul style="list-style-type: none">Implemented new History and Physical formAudit of two community practices with incomplete forms sent to hospital

Table 2

Comparison of Baseline and Current Pregnancy Tab Completion

	Baseline Data: September 1–15, 2009	Current Data: October 29–November 18, 2010	<i>p</i> Value
Overall completion	69/292 (24.6%)	294/361 (81.4%)	<0.01
Completion for mothers with premature infants	6/31 (19.3%)	29/41 (70.7%)	<0.01
Completion for mother whose infants who required a pediatrician present at delivery for resuscitation	9/47 (19.1%)	42/57 (73.6%)	<0.01
Completion for mothers whose infants admitted to neonatal intensive care	3/21 (14.2%)	30/40 (75.0%)	<0.01
Completion for mothers who had received antenatal consultation for infants with congenital anomalies	0/3 (0)	5/7 (71.4%)	0.14
Prenatal record received by hospital and attached to electronic medical record	161/292 (54.9%)	311/361 (86.1%)	<0.01
Of prenatal records received, those completed with all data needed to complete Pregnancy Tab	95/161 (59.0%)	258/311 (83.0%)	<0.01