Leveraging American College of Obstetricians and Gynecologists Guidelines for Point-of-Care Decision Support in Obstetrics

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Abstract

Background The American College of Obstetricians and Gynecologists (ACOG) provides numerous narrative documents containing formal recommendations and additional narrative guidance within the text. These guidelines are not intended to provide a complete "care pathway" for patient management, but these elements of guidance can be useful for clinical decision support (CDS) in obstetrical and gynecologic care and could be exposed within electronic health records (EHRs). Unfortunately, narrative guidelines do not easily translate into computable CDS guidance.

Objective This study aimed to describe a method of translating ACOG clinical guidance into clear, implementable items associated with specific obstetrical problems for integration into the EHR.

Methods To translate ACOG clinical guidance in Obstetrics into implementable CDS, we followed a set of steps including selection of documents, establishing a problem list, extraction and classification of recommendations, and assigning tasks to those recommendations.

Results Our search through ACOG clinical guidelines produced over 500 unique documents. After exclusions, and counting only sources relevant to obstetrics, we used 245 documents: 38 practice bulletins, 113 committee opinions, 16 endorsed publications, 1 practice advisory, 2 task force and work group reports, 2 patient education, 2 obstetric care consensus, 60 frequently asked questions (FAQ), 1 women's health care guidelines, 1 Prolog series, and 9 others (non-ACOG). Recommendations were classified as actionable ($n = 576$), informational ($n = 493$), for in-house summary ($n = 124$), education/counseling ($n = 170$), policy/advocacy ($n = 33$), perioperative care ($n = 4$), delivery recommendations ($n = 50$), peripartum care ($n = 13$), and non-ACOG ($n = 25$).

Keywords
► clinical decision support
► obstetrics
► medical informatics
► electronic health records

Conclusion   We described a methodology of translating ACOG narrative into a semi-structured format that can be more easily applied as CDS in the EHR. We believe this work can contribute to developing a library of information within ACOG that can be continually updated and disseminated to EHR systems for the most optimal decision support. We will continue documenting our process in developing executable code for decision support.

Background and Significance

The American College of Obstetricians and Gynecologists (ACOG) provides numerous types of narrative documents that offer guidance for clinical care, including practice bulletins, committee opinions, practice advisories, endorsed guidelines, and task force publications. These documents contain formal recommendations, as well as additional narrative guidance within the text. While ACOG guidelines are not intended to provide a complete "care pathway" for patient management, these elements of guidance can be useful for clinical decision support in obstetrical and gynecologic care and could be exposed within electronic health records (EHRs). Unfortunately, narrative guidelines do not easily translate into computable clinical decision support guidance.

With the wide adoption of EHRs, many providers rely on EHRs to provide documentation, data retrieval, and in some cases clinical decision support for care. Various EHR systems, either at the vendor level or by customization on a local level, have included clinical decision support rules into their build. The selection and interpretation of these rules can be driven by local preference or anecdote, as well as factors extrinsic to direct care such as reimbursement, billing and coding, government regulations, and other payer requirements. Successful clinical decision support should provide clinical knowledge using the five rights framework: clinical decision support should provide the right information, to the right people, in the right intervention formats, through the right channels, and at the right points in workflow.[1] For clinical decision support to work properly, there needs to be a "trigger" within the EHR to present the relevant clinical decision support, and a resultant "action" for the provider to consider. Successful clinical decision support can increase safety and improve workflow.[2] However, if clinical decision support is poorly implemented, it can lead to alert fatigue, decrease efficiency, and potentially cause patient harm.[3]

The optimal process for translating narrative guidelines or recommendations into the EHR remains unclear. In the past, attempts to integrate guidelines and pathways into EHR have been described through indirect models that are partially integrated into the EHR, or checklists from paper forms that have been converted to electronic forms.[4] In 2004, Shiffman proposed a multistep process for translating clinical guidelines into a form implementable by a clinical decision support system.[5] This system used the Guideline Elements Model to represent the guideline knowledge, which gave a detailed structure and process to this effort, but as reported a decade later, has not been widely adopted because the resultant files were not executable.[6] Boxwala et al presented a framework for transforming clinical narrative using a multilayered stepwise approach that converts narrative into semi-structured and then structured recommendations prior to implementation as executable code.[7] Both Shiffman and Boxwala's underlying steps provided a framework for this translational process.

Objectives

We sought to translate ACOG clinical guidance into clear, implementable clinical decision support associated with specific obstetrical problems. This article outlines how these guidelines were reduced to specific actionable items for EHR integration.

Methods

To translate ACOG clinical guidance into implementable clinical decision support, we followed the set of steps outlined below. The process included selection of the documents, establishing a problem list, extraction and classification of recommendations, and assigning tasks.

First, we had to determine how we would store the information we abstracted from ACOG literature. We chose to use AirTable, a multiuser workspace which functions as both a spreadsheet and database. As this ACOG effort is a work in progress, the AirTable is constantly evolving, so we chose a date to freeze the AirTable for the purpose of this study. We froze the AirTable on March 17, 2020. ACOG has a well-established process for updating their narrative documents. To keep our database up to date, we have adopted a process to add, delete, and edit recommendations as new guidance is released.

Selection of Documents

ACOG has an extensive library of documents that contain guidance for obstetric and gynecologic care. All obstetrical ACOG documents were reviewed including practice bulletins, practice advisories, obstetric care consensus, prolog series, patient education, frequently asked questions (FAQs), ACOG endorsed publications, committee opinions, women's health care guidelines, and task force and work group reports. Consumer material publications were excluded, as were publications which held a joint copyright with another organization.

We then reviewed documents for specific recommendations. Documents that did not include specific

recommendations were excluded at this point, but some of these were revisited in the "building out care plans" step below. All included documents were entered into AirTable. The initial review of documents was performed by a board-certified obstetrician/gynecologist physician-informatician, a professor of informatics, a clinical informatics fellow, an obstetrics and gynecology resident, and a medical student.

Establishing a Problem List

For a recommendation to be useful, it must be attached to a specific problem (or "reason"). The specific problems serve as "triggers" within the EHR that allow a recommendation to be exposed to the provider at the point of care. ACOG does not maintain a list of possible problems that might be encountered during a routine pregnancy. Therefore, to attach recommendations to specific topics, we needed to develop a problem list. International Classification of Diseases (ICD) codes from a large database of deliveries were collated to develop a problem list. Due to redundancy in the ICD coding system, many ICD codes were combined into one problem.

The problems were derived directly from ACOG guidelines and recommendations. To better assign recommendations to specific situations, some problems had to be broken down into multiple "states." One example includes the problem varicella, which was broken down into varicella immune, varicella equivocal, and varicella nonimmune. Additional problems were added to this list to accommodate the subjects of specific recommendations.

Extraction, Classification, and Assigning Tasks to Recommendations

We extracted called-out recommendations from the selected documents. All recommendations were placed into AirTable, and each recommendation was then classified into one of the following categories: action, informational, delivery recommendation, education/counseling, ACOG policy/advocacy, perioperative care, in-patient summary, or a performance measure (►Table 1). Figures and tables from the source documents were also included alongside recommendations.

For action recommendations, when appropriate, a specific clinical order was added to the recommendation. For each

Table 1 Types of recommendations

Recommendation type	Count[a]	Description	Example
Action	576	A recommendation with a specific task associated with the recommendation.	Hyperemesis treatment recommendation Action: "order prochlorperazine 25 mg BID per rectum"
Information	493	Recommendations that contain information directed at the provider.	Hyperthyroidism in pregnancy: "because antithyroid medication crosses the placenta and could theoretically have adverse fetal or neonatal effects, treatment of pregnant women with subclinical hyperthyroidism is not warranted."[16]
Delivery recommendation	50	A recommendation for the timing of delivery	Deliver uncomplicated dichorionic-diamniotic twins at $38^{0/7}$–$38^{6/7}$ weeks[17]
Education/Counseling	170	Information that can be used for patient education or counseling.	Patient FAQ: back pain during pregnancy[18]
Inpatient/In-House	124	Provided information about the specific problem that would be relevant during inpatient management.	"Magnesium sulfate reduces the severity and risk of cerebral palsy in surviving infants if administered when birth is anticipated before 32 weeks of gestation, regardless of fetal number."[19]
Perioperative care	4	Provided recommendations for surgery including preoperative, intraoperative, and postoperative care	"The use of vasopressin in the paracervical block may decrease blood loss from D&E."[20]
Peripartum care	13	Recommendations that apply to the period of time around delivery.	"All women whose vaginal-rectal culture screens at $36^{0/7}$–$37^{6/7}$ weeks gestation are positive for Group B Streptococcus should receive appropriate intrapartum antibiotic prophylaxis unless a prelabor cesarean birth is performed in the setting of intact membranes."[21]
ACOG policy/advocacy	33	Recommendations for the system level	"Develop a working relationship with local dentists. Refer patients for oral health care with a written note or call, as would be the practice with referrals to any medical specialist."[22]
Non-ACOG	25	Recommendations that originate from sources outside of ACOG.	"All women should be screened serologically for syphilis early in pregnancy."[23]

Abbreviations: ACOG, American College of Obstetricians and Gynecologists; D&E, dilation and evacuation; FAQ, frequently asked question.
[a]228 unassigned, multiple assigned to numerous categories.

Table 2 Types of orders

Type of order	Count[a]	Order example	Review task example
Order medication	59	If high risk for preeclampsia, order aspirin 81 mg PO q Day	Are you taking the low-dose aspirin? (Yes)/(No)
Order laboratory test	66	Order 50 g GTT	If 50 g GTT is greater than the cutoff, order 3 hour 100 g GTT.
Order imaging	33	Order ultrasound for growth	If estimated fetal weight is less than 10%, add intrauterine growth restriction to the problem list.
Order consultation	53	Consult maternal fetal medicine	Review consult note
Questions for patient	21	Have you had a flu shot? (Yes/No)	If no, order/administer influenza vaccine. If the patient refuses, document why: "allergic/afraid of needles/fear of side effects/had a bad reaction before/don't think its effective/fear of autism/already had one/other.
Patient education	20	A healthy pregnancy for women with diabetes FAQ[24]	Not applicable
Requests for provider input	12	Does this patient have obstructive sleep apnea? (snoring, excessive daytime sleepiness, witnessed apneas, or unexplained hypoxia)[25]	If yes, refer to a sleep medicine specialist.
Orders for fetal surveillance	7	Order antepartum fetal surveillance at/beyond $41^{0/7}$ weeks. Order nonstress test. Order biophysical profile.	If oligohydramnios present, consider induction.
Admit to hospital orders	2	Schedule the patient for an ECV if she does not have contraindications. ECV is contraindicated if vaginal delivery is not clinically appropriate.[26]	Why did patient refuse ECV? (had a contraindication/not offered/had a previous CS/was okay with a cesarean delivery/thought it sounded too dangerous)
Add problem to problem list	3	Consider adding impaired glucose tolerance to the problem list for additional guidance	Do you want to add gestational diabetes care plan for this patient? If yes, add it.

Abbreviations: CS, cesarean section; FAQ, frequently asked question; GTT, glucose tolerance test; ECV, external cephalic version.
[a]298 unassigned.

specific order, a review task was also created which would provide a reminder that the action had been ordered, but the results need to be followed up. The review task also contained actions that would drive additional clinical decision support (►Table 2). A gestational age at which the action should be exposed was also assigned. If a gestational age was not explicitly noted in the rule, a best clinical estimate was provided by the authors. These recommendations and associated elements were placed in a separate table in AirTable.

Business Process Model and Notation

A single recommendation in isolation is not as useful as a series of recommendations joined together into a care pathway. ACOG has undertaken a collaborative initiative with the Dorsata EHR to supply care pathways, based on ACOG literature, for use in the Dorsata ACOG Prenatal Record.[8] After each problem is identified through the process we have described, it is being constructed into an executable pathway using Business Process Model and Notation (BPMN). We chose to use BPMN because it is easily understood by clinicians (for review), but specific enough to provide details for coders. For the purposes of this paper, we have included one example of a disease process, Rh negative mother in the

postpartum period, for which we have created pathways using data contained in the AirTable (►Table 3). The pathway, based on the data from multiple sources in our AirTable, is represented in this BPMN model in ►Fig. 1. ACOG has developed over 100 additional care pathways in this format, this will be the subject of an additional publication.

Results

Documents/Sources

The search strategy produced 536 unique documents. After exclusions and counting only sources relevant to obstetrics that had at least one recommendation, we used 245 documents: 38 practice bulletins, 113 committee opinions, 16 endorsed publications, 1 ACOG practice advisory, 2 task force and work group reports, 2 ACOG patient education, 2 obstetric care consensus, 60 ACOG FAQ, 1 ACOG women's health care guidelines, 1 ACOG prolog series, and 9 others (non-ACOG; ►Table 4).

Reasons/Development of a Problem List

We created 216 distinct problems for obstetrics, which were assigned recommendations from the associated literature.

Table 3 Condensed AirTable Example for an Rh negative woman in the postpartum period

Recommendation	Type of recommendation	Reasons	Count of reasons	Source
Following birth, if the infant is confirmed to be Rh D positive, all Rh D-negative women who are not known to be sensitized should receive anti-D immune globulin within 72 h of delivery.	In-house summary	Rh negative and pregnancy	1	Practice bulletin 181: prevention of Rh D alloimmunization[9]
The Rh factor: how it can affect your pregnancy FAQ	Education/ Counseling	Rh negative and pregnancy	1	The Rh factor: how it can affect your pregnancy FAQ.[10]
Anti-D immune globulin is indicated only in Rh-negative women who are not previously sensitized to D.	Information	Rh negative and pregnancy	1	Practice Bulletin 192: management of alloimmunization in pregnancy.[11]

Abbreviations: CS, cesarean section; FAQ, frequently asked question.

Recommendations

We extracted a total of 1,620 recommendations from the source documents (average: 5.9 recommendations per document; range: 0–98). For this study, we only report recommendations that were currently active and not retired. Recommendations were classified as actionable ($n = 576$), informational ($n = 493$), for in-house summary ($n = 124$), education/counseling ($n = 170$), policy/advocacy ($n = 33$), perioperative care ($n = 4$), delivery recommendations ($n = 50$), peripartum care ($n = 13$) or non-ACOG ($n = 25$; ►Table 1). If they were actionable, additional steps were made to establish an order that could be seen in an EMR. The action recommendations included 66 laboratory orders, 59 medication orders, 53 consultations or referrals, 33 imaging tests, 21 questions for the patient, 20 patient educational topics, 12 requests for provider input, 7 orders for fetal surveillance, 2 admit to hospital orders, and 3 add-problem-to-problem-list orders (►Table 2).

Association of Recommendations with Problems (Reasons)

Each recommendation was linked to one or more problems ("reasons"). There were 13 recommendations that were only associated with a single reason, 14 were associated with two reasons, 15 with three, 9 with four, 8 with five, 13 with six, and 106 recommendations were associated with seven or
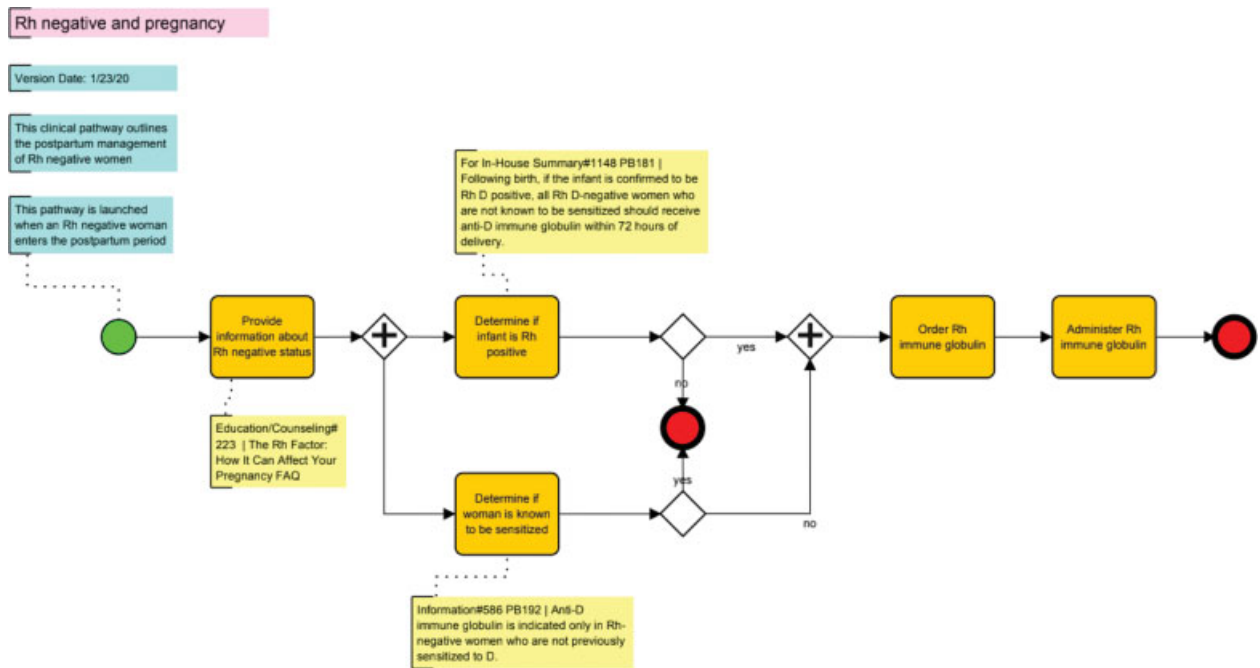

Fig. 1 This pathway demonstrates the management of a woman with Rh negative blood who is postpartum. The pathway launches when a pregnancy ends and the woman enters the postpartum period (green circle). The first action the provider must make is providing education about Rh negative disease in pregnancy (gold rectangle). Then, the provider must simultaneously check the neonate's blood for Rh and determine whether the woman is already sensitized (diamond with plus sign, followed by two gold rectangles). If the neonate is Rh negative or the woman is sensitized, the pathway ends (red circle). If the neonate is Rh positive and the woman is not sensitized, Rh immunoglobulin is ordered and administered, and then the pathway ends (red circle).

Table 4 Number of documents by type

Type	Number
ACOG Committee Opinion	113
ACOG Practice Bulletin	38
ACOG Task Force and Work Group Report	2
ACOG Practice Advisories	1
ACOG Patient Education	2
ACOG Obstetric Care Consensus	2
ACOG FAQ	60
ACOG Women's Healthcare Guideline	1
ACOG Prolog series	1
ACOG Endorsed Publication	16
Other, not ACOG	9

Abbreviations: ACOG, American College of Obstetricians and Gynecologists; FAQ, frequently asked question.

Table 5 Distribution of clinical problems with related recommendations

Problem count	Number
Zero	38
One	13
Two	14
Three	15
Four	9
Five	8
Six	13
Seven or more	106

more reasons (►**Table 5**). There were 38 reasons that had no associated recommendations.

Timing of Recommendations in Regard to Obstetrical Practice
Recommendations were also categorized by the time period that they would be pertinent during the obstetrical care of a patient (►**Table 6**). There were 56 recommendations for preconception counseling, 38 for the first obstetrical visit, 726 for general antenatal care, 270 for delivery, and 57 for postpartum care. We also identified 54 relevant to screening questions, 65 relevant to genetics, and 43 relevant to immunizations.

Business Process Model and Notation
We have provided an example of how the information gathered has been constructed in an executable pathway using BPMN. We used postpartum Rho(D) immune globulin administration as an example of how we have created a BPMN pathway. There are four recommendations for the management of women with Rh negative blood during the

Table 6 Timing of recommendations in regard to obstetrics practice

Type[a]	Number
Preconception	56
New OB/first OB	38
General antenatal	726
L&D/Delivery	270
Postpartum	57
Screening questions	54
Genetics	65
Immunization	43

Abbreviations: L&D, labor and delivery; OB, obstetric.
[a]330 unassigned.

postpartum period (►**Table 3**, ►**Fig. 1**). There are two education and counseling recommendations, one recommendation for the in-house summary, and one informational recommendation.[9–11]

Discussion

Utilizing the framework described by Boxwala et al, our paper describes the process of translating ACOG narrative into a semi-structured format.[7] This is the first step in transforming clinical narrative into executable code. By linking guidelines to problems and providing additional data about the recommendations (e.g., type of action and timing), we believe this will make guidelines easy to integrate into an EHR system.

Most medical care in the United States is delivered with the aid of an EHR system. ACOG gives providers narrative guidelines to practice evidence-based medicine; however, in their current format, they are not easily integrated into the EHR for clinical decision support. Ideally, our work described in this paper would be part of a library of models for each reason (problem), in which ACOG would be the central hub of information that would distribute updated pathways for each EHR automatically.

Ongoing work by Vander Schaaf et al has shown that practice guidelines have the potential to improve population health but are underutilized. They have found multiple barriers to implementation including clinician hesitancy to change routine, difficulty navigating copious recommendations, and resistance by patients and families. Another barrier is the number of guidelines that can be considered in evidence-based care.[12] Many of these barriers would be overcome by the database we have created. Once incorporated into the EHR, it would reduce the need to navigate numerous guidelines, and could make it easier to adopt evidence-based recommendations because they are simplified and presented at the point of care. In a study by Marchisio et al, investigators examined compliance with a care pathway for labor and delivery practices and episiotomy rate. The rate of episiotomy was twice as high in the group that did not use their developed care pathway, but the rate of perineal

lacerations was the same in both groups. Patient satisfaction was significantly improved in the care pathway group where they performed fewer episiotomies.[13] We anticipate that with the integration of our database of recommendations, patient care would be standardized and likely improve patient satisfaction. This would be another area for future research as our database of recommendations is utilized in the EHR.

In 2013, Bockmann and Heiden described a model-driven approach for breast carcinoma that was similar to our methods described here.[14] Their care pathway could be utilized in multiple hospital information systems (HIS); however, this pathway was for one clinical scenario. The ability to apply evidence-based guidelines to multiple HIS with ease is imperative for the future of improving the delivery of medical care to patients. The development of our database, utilizing a single-source of evidence-based guidelines, should allow for the future integration of this knowledge across all EHRs.

It is clear that several systems have recognized that standardizing medical care can improve outcomes, but the delivery of evidence-based knowledge and protocols is not always easy to execute within a digital platform, especially with the vast number of guidelines available to providers.[3,15] Our next steps will be to convert all our data, which is currently in a semi-structured format, into an executable format for integration into the electronic health record across multiple platforms. We believe this will help improve compliance with evidence-based guidelines, improve physician satisfaction, and may improve patient care and outcomes. Additionally, as guidelines are integrated into the EHR, we will be able to study the quality of care and this could help inform new guideline development.

Work is underway to expand the database to include gynecologic guidelines, and we will continue to update the current obstetrical guidelines. The database we have created has been applied to a current EHR system as clinical decision support in obstetrics, and there is ongoing work to evaluate the benefits of its use. This project provides a single source of truth database of ACOG recommendations, organized, and referenced, and continually updated. This library can be used as the basis for development of care pathways.

Strengths of our process include a systematic approach, using a well-established knowledge source, and having a mechanism in place for regular updating of the data. The AirTable database is updated daily as new recommendations are added by ACOG. A limitation that this process exposes are the many gaps in evidence-based medicine. The available recommendations are frequently insufficient to form a complete care pathway. How to bridge this gap is an ongoing discussion within ACOG, and a great subject for further investigation. Additionally, it is equally important that an infrastructure for automatic updates and standard care pathways is developed to ensure there is only one version of each care pathway across all EHRs.

Conclusion

Translation of narrative documents into a format that is easily consumable by a digital platform must be done in a careful,

formalized process. We have described such a process and executed the resulting database within a commercial product. Ongoing work to make the care pathways available in a similar "single source of truth" library is the next step in bringing valuable ACOG guidance to the digital point of care.

Clinical Relevance Statement

We have described a methodology of translating ACOG narrative into a semi-structured format that can be more easily applied as clinical decision support in the EHR. We believe this work can contribute to developing a library of information within ACOG that can be continually updated and disseminated to the EHR systems. By integrating evidence-based guidelines into the EHR through decision support, we believe this can help providers deliver safer and more efficient care to patients.

Multiple Choice Questions

1. Which of the following is an example of clinical decision support?
   a. Providing access to a medical database through your institutions website
   b. Providing note templates for documentation
   c. Providing a reminder to perform a certain test at a patient's current visit
   d. A billing wizard providing guidance on billing codes

   Correct Answer: The correct answer is option c. Clinical decision support should provide the right information, to the right people, in the right intervention formats, through the right channels, and at the right points in workflow. It is an example of clinical decision support through providing a pertinent reminder for a test that should be ordered at the point of care.

2. Which of the following is true about semi-structured knowledge for clinical decision support?
   a. Narrative text format
   b. Organized text format
   c. Can be interpreted by a computer
   d. In a coded format

   Correct Answer: The correct answer is option b. Semi-structured knowledge is formatted as organized text where structure is added to a narrative guideline. This format is an intermediate between the narrative guidance/text and the coded and computable structured format that can eventually be utilized as clinical decision support.

Note
This publication was written under the direction of The American College of Obstetricians and Gynecologists

Health Information Technology (Health IT) staff. All referenced content and materials were provided to the authors for purposes of further analysis in this publication. The methodology described in this publication is considered proprietary and is not intended for commercial consumption, promotion, or product development.

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