BMC Medical Education

RESEARCH

Open Access

Establishing core competencies for neonatology fellowship training in Syria: a modified Delphi study approach

Imad Zoukar[1,2*], Sham Zoukar[3*], Mervat Muad[4] and Mayssoon Dashash[5,2]

Abstract

Introduction Competency-based medical education is gaining momentum globally, emphasizing demonstrable skills and knowledge. However, the Syrian neonatology fellowship program remains largely grounded in a traditional, time-based model and faces significant challenges due to the ongoing conflict in Syria. This study aims to identify and prioritize core competencies for Syrian neonatology fellowship curricula to establish a foundation for a standardized national curriculum.

Methods A mixed-methods approach was utilized, incorporating a literature review, focus group discussions, and a modified Delphi technique involving three survey rounds. This process engaged a panel of 135 Syrian healthcare professionals with expertise in neonatal care. Participants evaluated a preliminary list of 120 competencies derived from a literature review and focus group discussions using a 5-point Likert scale. A consensus threshold of 75% agreement was applied to determine the final competency list.

Results Expert consensus identified 135 competencies, categorized as 38 (28.1%) knowledge, 80 (59.3%) skills, and 17 (12.6%) attitudes. A weighted ranking system determined that 89 (65.9%) of these competencies are essential for successful neonatology fellowship training in Syria. Prioritized competencies emphasized foundational clinical skills, infection control, and teamwork, reflecting the resource limitations and collaborative needs of the Syrian healthcare system.

Conclusion This study establishes a comprehensive set of core competencies for neonatology fellowship training in Syria. These findings provide a framework for developing contemporary, evidence-based curriculum aligned with international standards while adapting to local resource constraints. They represent a crucial step in standardizing neonatology fellowship training and advancing neonatal care in Syria.

Keywords Neonatology, Fellowship training, Competency-based medical education, Modified Delphi technique, Syria, Core competencies, Curriculum development, Healthcare system

*Correspondence:
Imad Zoukar
zoukar2002@gmail.com
Sham Zoukar
dr.sham2018@gmail.com
[1]Department of Pediatrics, Faculty of Medicine, Damascus University, Damascus, Syrian Arab Republic
[2]Medical Education Program, Syrian Virtual University, Damascus, Syrian Arab Republic
[3]Department of Radiology, Faculty of Medicine, Damascus University, Damascus, Syrian Arab Republic
[4]Department of Obstetrics & Gynecology, Faculty of Medicine, Damascus University, Damascus, Syrian Arab Republic
[5]Pediatric Dentistry Department, Faculty of Dentistry, Damascus University, Damascus, Syrian Arab Republic

Introduction

Competency-based medical education (CBME) is a learner-centered, outcome-oriented approach that aims to develop healthcare professionals with the proficiency to practice medicine at a defined standard, while also possessing the flexibility to address the specific healthcare issues faced by their local population [1].

CBME is built upon four key elements: clearly defined competencies essential for effective patient care, continuous and comprehensive assessments to track progress, personalized learning pathways catering to individual needs, and robust feedback mechanisms for ongoing improvement. By focusing on these pillars, CBME ensures physicians develop the necessary skills and knowledge to deliver high-quality healthcare [2, 3].

Building a CBME curriculum is a multi-step process that begins with identifying essential competencies for patient care and professional development [4], informed by a thorough needs assessment. However, as evidenced by its variable implementation in national healthcare training initiatives across countries such as the United States, Canada, Australia, Turkey, and the Netherlands [5, 6], successful CBME necessitates careful adaptation to the local context, particularly in resource-constrained settings.

Established in 2013, the Syrian neonatology fellowship program aims to cultivate specialized expertise in neonatal care. Training occurs at various centers nationwide, including major hospitals in Damascus, Latakia, Aleppo, and Hama, with an average of 10 fellows graduating annually (Dr. Nader Eid, the program director, personal communication). Despite this established infrastructure, the program, as described by the program director and further corroborated by our focus group discussions, primarily employs a traditional, time-based approach. Characterized by opportunistic learning, an unstructured curriculum, a heavy reliance on senior physician supervision, minimal feedback and assessment, and a shortage of essential equipment [7], this approach often emphasizes theoretical knowledge over practical skills and can result in inconsistencies in training quality [7–9].

Further compounding these challenges, Syria's healthcare system has been severely weakened by prolonged conflict and economic instability. More than 60% of hospitals have been damaged or destroyed, while neonatal intensive care units (NICUs) face critical shortages of essential equipment, such as ventilators, monitoring devices, and incubators, which impede effective neonatal and critical care services [10–12]. Consequently, neonatal mortality rates significantly exceed regional and global averages due to the destruction of healthcare infrastructure and inadequate maternal and child health services [13, 14].

Beyond resource constraints, the Syrian conflict has caused a brain drain, creating gaps in expertise and mentorship, and overburdening remaining staff [10, 11, 13]. Limited access to simulation training and advanced technology further undermines healthcare services and professional development [12, 14], impacting neonatology fellows by restricting exposure to complex procedures and hindering skill development [15, 16]. The faculty shortage also limits mentorship and research opportunities, potentially impeding fellows' independent practice readiness [17].

Given the global shift towards CBME and the unique challenges of the Syrian healthcare system, a tailored and resource-conscious approach to neonatology fellowship training is essential. Effective CBME implementation requires careful consideration of local contexts, cultural sensitivities, and resource constraints, particularly where direct parallels to high-income settings are limited [18]. This adaptation should prioritize foundational clinical skills relevant to resource-limited settings, such as managing preterm births without advanced technology and diagnosing sepsis and other neonatal conditions with minimal diagnostics, over resource-intensive procedures more commonly emphasized in high-income countries [15, 16]. Identifying and prioritizing core competencies for neonatology practice in Syria is a critical first step in this process.

Addressing a gap in research on these challenges within Syria, this study offers a crucial foundation for targeted improvements in neonatology training and care. Aligning with the widespread use of the Delphi technique in developing core competencies for CBME across medical specialties [19, 20], and building upon previous Syrian research in undergraduate neonatology training [21], this study aims to identify and prioritize core competencies for Syrian neonatology fellowship curricula through expert consensus. While not prescriptive in terms of specific curriculum content, this research seeks to establish a framework for a context-adapted and resource-conscious CBME program, enabling the effective training of clinically competent neonatologists despite existing limitations, and laying the foundation for a standardized national curriculum.

Methods

Study design

To achieve the study's objectives and address the complexities of defining core competencies for neonatology fellowship training in a resource-limited setting, we employed a mixed-methods approach that integrated a literature review, focus group discussions, and the modified Delphi technique. The literature review established a foundational understanding of existing competencies and identified areas requiring adaptation. Focus group

discussions provided qualitative insights into the specific challenges of neonatology training in Syria, such as equipment shortages and context-specific ethical dilemmas. These discussions also facilitated a deeper exploration of the local training environment, capturing expert perspectives on key priorities. The qualitative findings directly informed the Delphi survey, leading to modifications such as the removal of a competency on cardiac ultrasound and the inclusion of a competency on sepsis management—both reflecting the constraints of the Syrian healthcare system. The Delphi technique then enabled a structured consensus-building process, ensuring that the prioritized competencies were both evidence-based and contextually relevant. By integrating qualitative insights with the rigor of quantitative methods, this mixed-methods approach produced a comprehensive competency framework tailored to the Syrian context and endorsed by local experts.

Literature search

Initially, existing literature was reviewed to guide the Delphi process in our research. The research team then conducted a non-systematic literature search on CBME, neonatology competencies, and fellowship training to create a provisional competencies list for neonatology fellowship.

The research question, "What are the essential competencies required for neonatology fellowship training in Syria?" was formulated using the Participant, Concept, and Context (PCC) framework [22]. This framework identifies the key elements of the research: the Participant, which is Neonatology Fellows, representing the target population of the study; the Concept, which is Essential Competencies, encompassing knowledge, skills, and attitudes, as the core focus of the research; and the Context, which is Syrian Universities, defining the specific setting and geographical scope of the investigation. This structured approach ensures a clear understanding of the research objective and target audience.

The search, restricted to English-language, peer-reviewed articles, was conducted in Scopus and PubMed using keywords like "neonatology," "fellowship," and "competency." Exclusion criteria filtered out non-original research, while inclusion criteria prioritized clarity and methodology of studies.

All peer-reviewed journal articles and related references, which include studies that explored the competencies of neonatology curricula and used quantitative, qualitative, or mixed methods, were also searched. International competencies from recognized organizations such as the American Board of Pediatrics [23], Royal College of Physicians and Surgeons of Canada [24], and European Board of Neonatology [25] were also included in our search.

The search, refined through Boolean operators, resulted in 61 relevant articles, with 48 from PubMed and 13 from Scopus (Table SM-1 in Supplementary Materials-2). This strategic approach enhanced the precision and comprehensiveness of the search.

Researchers IZ, SZ, MM, and MD meticulously screened the articles for relevance, and quality was assessed based on the clarity of the study aim, the appropriateness of the methodology applied, the data analysis, and the clarity of findings [26]. In addition, the reference list of each article was also scanned to identify any article that might fit the identified inclusion criteria.

Focus group

In conjunction with the literature review to guide the Delphi process, we solicited insights from a focus group, a widely utilized qualitative research technique extensively employed in health science [27, 28].

A focus group was conducted with four neonatology consultants, each with over 10 years of academic and clinical expertise, and two medical education specialists. Informed consent was obtained from all six participants prior to the 3-hour virtual focus group, which was conducted via the WhatsApp platform.

The principal investigator (IZ) facilitated focus group discussions to delineate essential competencies for the Syrian neonatology fellowship program. The discussions, guided by a semi-structured interview guide, elicited expert perspectives on key competencies, challenges, and priorities, including resource-intensive procedures (e.g., hip ultrasound, pericardiocentesis) and the feasibility of high-fidelity simulation training and Neonatologist-Performed Echocardiography (NPE). The discussions were audio-recorded and transcribed verbatim. Two researchers (SZ and MM) independently analyzed the transcripts using thematic analysis to identify recurring themes and patterns related to essential competencies. These findings informed the refinement of a preliminary competency list derived from the literature review. This refinement involved adding competencies, modifying wording for clarity and relevance to the Syrian context, and prioritizing competencies based on perceived importance and feasibility, resulting in a list of 120 competency statements categorized by domain (knowledge, skills, and attitudes) and structured according to Bloom's taxonomy.

Modified Delphi

A modified Delphi technique was employed to achieve consensus on core competencies for Syrian neonatology fellowship training, offering advantages such as minimizing bias, ensuring anonymity, and gathering expert opinions from geographically dispersed participants [29, 30]. This method has been successfully used to establish

consensus on competency identification in specialized fields, including medical education [21, 31].

The study's modified Delphi process involved three rounds of surveys, beginning with a curated competency list based on literature and focus group discussions [32]. Feedback from participants in subsequent rounds refined the competencies, ensuring that the final list reflected the collective judgment of the expert panel.

Informing the Delphi process

Survey development

The survey instruments for this study were created sequentially using Google Forms [33]. The research team designed the first survey based on the preliminary list of competencies formulated during the focus group meeting. The survey was structured into six sections, beginning with an introductory letter outlining the study's goals and providing instructions, including a statement on implied consent. The second section collected demographic details of the participants. The following three sections presented a preliminary list of 120 competencies, organized into knowledge, skills, and attitudes categories, which were further subdivided to encourage completion. A box for free comments accompanied each statement, enabling participants to explain their responses and suggest any changes. The final section allowed for open-ended responses, enabling participants to propose new competencies or offer feedback.

The survey utilized Likert-scale questions and open commentary to efficiently collect structured data and qualitative insights. Participants rated the importance of each competency for graduating fellows on a 5-point scale (1 = no need to know, 5 = must know). The survey design facilitated quantitative and qualitative data collection, enabling structured data analysis while capturing detailed feedback. A copy of the surveys (Round 1 and Round 2) in English is available in Supplementary Materials-1.

The survey items are intentionally unnumbered to prevent potential bias stemming from their presentation in a particular sequence [34].

Before the first round, a pilot test of the online survey was conducted by a small group of non-expert stakeholders to ensure readability, correct functioning, and face validity. This process aimed to obtain feedback regarding the survey's content and design, allowing for revisions before the survey's launch [35].

All survey rounds relied on secure, confidential online mediums for communication and data gathering—namely email, WhatsApp, and Google Forms. Email and WhatsApp facilitated participant invitations and communication, while Google Forms was used for survey administration. Maintaining contributors' anonymity helped mitigate response bias that could arise from groupthink or interpersonal dynamics affecting candid perspectives [36].

Criteria for expert inclusion

To ensure the content validity of the final competency list and its relevance to the intended user population [37], the Delphi panel was carefully selected to represent a diverse array of stakeholders from various geographic regions within Syria.

Given neonatology's interdisciplinary nature—especially in resource-limited settings like Syria—we included a broad panel. For the purposes of this study, expertise in neonatal care was broadly defined to encompass physicians with knowledge and experience in neonatal care, extending beyond clinical practice to include those with academic experience. This included physicians certified in neonatology, pediatricians with extensive NICU experience, and pediatric subspecialists with a focus on neonatology, as well as other relevant healthcare professionals involved in neonatal care. Panel members were recruited from specialized professional groups such as the Syrian Society of Pediatrics and the Syrian Society of Neonatology, along with directors of neonatology programs associated with the Ministry of Higher Education, the Ministry of Health, and the Ministry of Defense.

The Delphi panel participants were categorized into four domains of specialized expertise:

- Group 1: Certified practicing neonatologists, advanced neonatology fellows, and pediatricians with at least 5 years of recent, hands-on experience in NICUs. Eligibility for this group is determined by their affiliation with the Syrian Society of Neonatology, which accepts both certified neonatologists and certified pediatricians who have accumulated at least 5 years of NICU experience.
- Group 2: Pediatricians and pediatric subspecialists (pediatric cardiology, pediatric neurology, pediatric nephrology) with a dedicated neonatology focus for at least 5 years.
- Group 3: Experts from complementary specialties, including obstetrics and gynecology, pediatric surgery, dermatology, family medicine, radiology, general practice, and neonatology nursing. Each participant had a minimum of 5 years of experience managing neonatal patients, providing diverse perspectives.
- Group 4: Program directors and academic faculty overseeing neonatology fellowship training centers in Syria, including Children's University Hospital (Damascus), neonatology department at Al-Zahrawi Hospital (Damascus), pediatric department at Damascus Hospital (Damascus), the Children's Hospital in Latakia, Pediatric department

at Al-Bassel Complex in Hama, the Pediatrics Department at Aleppo University Hospital, and Pediatric department at Tishreen Hospital in Latakia.

By incorporating feedback from a wide range of experts, we aimed to create a comprehensive set of competencies that address the practical realities of neonatal care within the Syrian context.

Recruitment process

The initial two rounds of the Delphi process engaged participants (groups1-4) from a broad spectrum of medical affiliations, including medical schools, pediatric departments, private clinics, hospitals, and medical centers, spanning various regions in Syria such as Damascus, Aleppo, Hama, Tartous, Homs, Deir Alzour, Daraa, and Al-Kalamoon. The participant selection aimed for diverse perspectives and expertise, strengthening the consensus-building process and enriching the study with a comprehensive pool of expertise. This approach highlighted a commitment to developing competencies reflecting national standards and expectations.

In contrast, the final phase of the Delphi study was distinctively reserved for the directors of the neonatology fellowship program (group 4), who had also contributed to the initial two phases. The inclusion of directors in the final round served as a crucial step in validating the competencies identified in the initial two rounds. Incorporating input from key stakeholders with leadership roles in the field ensured the credibility and relevance of the study's findings.

One hundred and sixty-eight Syrian experts in neonatal care were invited to participate in the study via email and WhatsApp, and. Before participation, experts received a Participant Information Sheet and were requested to submit a summary of their experience in the field. All experts who consented to participate returned a completed informed consent form before commencing the consensus development process.

Sample size for the Delphi panel

The Delphi group size is more influenced by group dynamics in achieving consensus than statistical power [38]. While there is no fixed standard for the sample size of a panel, it is commonly acknowledged that having a more significant number of members can enhance the reliability of group judgments [39].

In our study, a deliberate purposive sampling strategy was employed to select expert clinicians from various regions in Syria, ensuring the formation of a national panel with diverse expertise [36, 40]. Additionally, a "snowball sampling" approach was adopted to expand the participant pool, encouraging existing panel members to extend invitations to other relevant individuals [37].

Delphi process

This study used a modified Delphi method in three rounds to determine essential competencies for the neonatology fellowship program in Syria. The researchers gathered input from a panel of experts, who evaluated a comprehensive list of competencies based on existing literature and focus group discussions. Through a controlled feedback process across three surveys, the panel reached a consensus on the key competencies needed for successful neonatology training in Syria. This process, which adhered to the CREDES guidelines for conducting and reporting Delphi studies [41], resulted in a tailored framework of competencies that aligns with the specific needs and challenges of Syrian neonatal education [21].

This study employed a structured Delphi method with a priori criteria to ensure reliability and validity. The process included limiting the surveys to three rounds to ensure engagement and effective consensus-building [42]. This fixed number of rounds indicates good quality in the Delphi study design, reflecting a well-organized approach [43]. Enforced deadlines were also used to optimize the study, balancing participant flexibility with accountability to ensure a smooth and efficient progression through its phases.

Experts were given a 3-week timeframe to respond to each survey iteration, with reminders issued at one-week intervals. Non-responsive members were excluded after 3 weeks to mitigate potential delays and maintain the study's momentum, ensuring adherence to the planned three-round process. The three rounds of the Delphi study were conducted over 6 months (July 2022 - December 2022).

The use of electronic communication facilitated contributions from geographically dispersed Syrian experts. This approach allowed for the autonomous sharing of insights, fostering a collective vision for neonatology training priorities that are well-suited to the local context.

The Delphi iterative approach relies on analyzing feedback, refining tools, and repeating cycles to shape consensus progressively.

The study used several key procedures to ensure a systematic synthesis of expert feedback:

- Summary statistics were provided to highlight consensus levels and qualitative insights for each competency statement.
- Competencies that reached a 75% agreement were excluded from further rounds to focus on unresolved issues.
- Statements were modified based on feedback to reconcile discrepancies between scores and comments, ensuring accurate representation of expert judgment.

- Expert language was incorporated into revised statements to enhance clarity and precision.
- New competencies were added based on feedback to address gaps and strengthen the framework.

Round 1

In Round 1, an online survey was distributed via email to 168 participants, with a link to a Google Forms version. The survey presented a list of 120 competencies for evaluation using a 5-point Likert scale. Participants were also invited to suggest revisions, additions, or deletions to the competency list.

Consensus criteria

Our study employed the percent agreement method with a 75% consensus threshold, consistent with Delphi studies in healthcare [21, 36]. Items were included in the final list if at least 75% of experts (56 in Round 1, 50 in Round 2) rated them 4 or 5 on a Likert scale. While percent agreement offers a straightforward consensus measure, additional statistical methods such as median and interquartile range (IQR) provide deeper insights into the central tendency and dispersion of expert opinions. A comprehensive consensus assessment benefits from combining these statistical approaches [44].

Round 2

After receiving all completed surveys, the researchers analyzed the demographic data and compiled responses for each competency item, including new additions. Data analysis was conducted with a 75% consensus threshold, requiring at least 75% of the panel to score a competency as 4 or 5 on the Likert scale. Statistical measures such as mean, standard deviation (SD), median, and IQR were calculated using Microsoft Excel. Non-parametric tests were applied due to the ordinal nature of the Likert scale, and descriptive statistics (median and IQR) were used for interpretation, as they are robust against outliers, a practice supported by existing literature [40].

After identifying items where consensus was reached, the competencies were refined based on feedback from the first round. New competencies suggested in the free-text comments were aligned with academic standards and Bloom's taxonomy before being included in the second round. The second survey also revisited competencies that did not achieve consensus in the initial round, as well as those modified based on feedback (e.g., splitting or merging competencies). Participants followed the same evaluation process as in Round 1. The second survey included statistical measures (mean, SD, median, IQR, percentage of agreement) for all competencies, excluding new suggestions, and provided experts with their prior ratings and comments from the previous round [45].

Experts were asked to review and re-evaluate the importance of each competency in the second Delphi round, using a 5-point Likert scale while considering feedback from the first round. Focus was placed on competencies that did not reach consensus (scores ≤ 74%). Participants were encouraged to provide insights and suggestions, with all feedback documented. A 3-week timeframe was given, with reminders at 1- and 2-week intervals to ensure engagement. The survey link was distributed anonymously via email to maintain confidentiality and unbiased responses.

Round 3

After collecting all the surveys in the second round, researchers calculated the mean, SD, median, IQR, and percentage of agreement for each competency item. A 75% consensus threshold was used to determine which competencies advanced to the final round, while those that did not achieve consensus were removed from the list.

The final survey contained all accepted competencies from the first and second rounds and was sent to the directors of the neonatology fellowship program (group 4) for final approval. The agreement rate for the final round was set to 90% to ensure that academic experts overseeing the neonatology fellowship in Syria would comply with the recommended competencies and subsequently integrate them into the curriculum.

Finally, weighted responses were employed to rank and prioritize these competencies in the final list. All knowledge, skills, and attitudes competencies with a weighted response of 4.20 or higher (out of a maximum of 5.0, representing an 84.0% agreement level) were classified as essential skills. The distribution ranges for these weighted responses are further detailed in Table SM-2 in Supplementary Materials-2.

Ethical considerations

Ethical approval for this study was granted by The Research Ethical Committee at the Syrian Virtual University, Ministry of Higher Education, Syria, (ref: 517/0, 26/4/2022). All participants provided informed consent prior to participation, and measures were taken to ensure anonymity and confidentiality.

Results

A literature review and focus groups yielded a preliminary list of 120 neonatal competencies, comprising 30 knowledge-based (25%), 73 skill-based (60.8%), and 17 attitude-based competencies (14.2%).

The focus group discussions emphasized resource constraints, the importance of foundational skills, and the need for interdisciplinary collaboration, highlighting practical competencies essential for neonatal care in

Syria's resource-limited healthcare system. For details, refer to Table SM-3 in Supplementary Materials-2.

Response rate

Of 168 invited experts, 135 (80.36%) completed Round 1, 86 (63.7%) completed Round 2, and all 20 participants completed Round 3. Reasons for non-participation included time constraints, perceived lack of expertise, or lack of interest.

Participants

The study comprised a diverse cohort of 135 healthcare professionals (Table SM-4, SM-5 in Supplementary Materials-2): neonatologists ($n=28$), pediatricians ($n=75$), pediatric subspecialists ($n=15$), and other specialists ($n=17$). Participants represented various healthcare settings (private and public hospitals, clinics, governmental healthcare institutions such as Damascus Hospital under the Ministry of Health, academic centers like Children's Hospitals affiliated with the Ministry of Higher Education, NICUs). Notably, nearly half ($n=68$) had over 15 years of experience, indicating a high level of expertise, as shown in Table 1. While gender distribution remained consistent across rounds, male participation slightly exceeded female participation.

The certified neonatology experts ($n=28$) possess significant clinical experience (median: 15.5 years), with a diverse age range (32–60 years) and varying levels of academic involvement (median: 4.5 years). This diversity provides a well-rounded perspective on neonatology training, integrating both clinical proficiency and educational expertise, thereby enhancing the study's validity in identifying core competencies. (Table SM-6 in Supplementary Materials-2).

Table 1 Participant characteristics across three rounds of the Delphi study

Characteristic	Round 1	Round 2	Round 3
Number of Participants	168	135	20
Number of Respondents	135	86	20
Response Rate (%)	80.4	63.7	100
Gender (Male)	79 (58.5%)	48 (55.8%)	12 (60%)
Certification			
* Syrian Board in Pediatrics	43 (31.9%)	22 (25.6%)	0
* Arab Board in Pediatrics	31 (23.0%)	18 (20.9%)	6 (30%)
* High Studies in Pediatrics	26 (19.3%)	19 (22.1%)	3 (15%)
* Western Board	18 (13.3%)	14 (16.3%)	9 (45%)
* Others	17 (12.6%)	13 (15.1%)	2 (10%)
Years of Experience			
* 5–10 years	30 (22.2%)	21 (24.4%)	3 (15%)
* 11–15 years	38 (28.2%)	29 (33.7%)	5 (25%)
* More than 15 years	67 (49.6%)	36 (41.9%)	12 (60%)
Place of Work			
* Hospitals of Ministry of Higher Education	28 (20.7%)	18 (20.9%)	10 (50%)
* Hospitals of Ministry of Health	42 (31.1%)	32 (37.2%)	8 (40%)
* Hospitals of Ministry of Defense	11 (8.1%)	6 (7.0%)	2 (10%)
* Private Hospitals and Clinics	31 (23.0%)	16 (18.6%)	0
* Others	23 (17.0%)	14 (16.3%)	0

Round 1 findings

Round 1 achieved consensus (75% agreement) on 102 of 120 (85%) competencies, including 21 knowledge-based, 66 skill-based, and 15 attitude-based. Participants also proposed 12 new competencies and suggested modifications to 10 existing ones (Table 2).

In addition to the quantitative data, the experts provided valuable qualitative feedback throughout the Delphi process. A recurring theme in the comments was the need to prioritize competencies that are feasible and relevant within the resource constraints of the Syrian healthcare system. For example, one participant noted, "While advanced procedures like ECMO are valuable, our fellows need to be proficient in managing common neonatal conditions with limited resources". Another participant emphasized the importance of foundational skills, stating, "It's more important to focus on basic resuscitation and infection control than on highly specialized interventions that are rarely available". These comments highlight the importance of considering the local context when defining core competencies for neonatology fellowship training in Syria.

The comparison of responses between neonatologists and other specialists indicates that certified neonatologists consistently rated their competencies higher than other specialists across skills, knowledge, and attitude domains. They scored significantly higher in areas like S-39, S-62, S-41, and S-69 for skills, and K-1, K-2, K-3, K-10, K-12, and K-25 for knowledge. Their responses showed lower variability, indicating more consistency in their self-assessments. Despite statistical differences, the practical implications were minimal, suggesting general alignment between neonatologists and other specialists in evaluating neonatology competencies.

Round 2 findings

Round 2 achieved consensus (75% agreement) on 33 of 37 (89.19%) competencies (17 knowledge, 14 skills, 2 attitudes). The knowledge domain showed a marked improvement in consensus rates from Round 1 (70%, 21/30) to Round 2 (94.4%, 17/18) (Table 2).

Unlike the knowledge domain, the skills domain showed a slight decrease in consensus from Round 1 (90.4%, 66/73) to Round 2 (82.3%, 14/17). The attitudes domain demonstrated the highest and most consistent level of agreement, reaching 88% consensus in Round 1 (15/17) and unanimous agreement (100%, 2/2) in Round 2.

Table 2 Competency development for neonatal fellowship training in Syria: from initial list to final core competencies

	Domain	Knowledge	Skills	Attitudes	Total
Round 1	No.[1]	30	73	17	120
	Approved[2] (%)	21 (70)	66 (90.41)	15 (88.23)	102 (85)
	Not Approved[3]	5	3	0	8
	Changed[4]	4[7]	4[7]	2[8]	10
	New Suggested[5]	5	6	1	12
Round 2	No.[1]	18	17	2	37
	Approved[2] (%)	17 (94.44)	14 (82.35)	2 (100)	33 (89.19)
	Rejected[6]	1	3	0	4 (2.88%)
Round 3	Final List	38	80	17	135
	Approved	100%			
Core competencies (%)		17 (44.73)	58 (72.5)	14 (82.35)	89 (65.92)

[1] Total statements scored and commented on

[2] Statements reaching 75% agreement (accepted)

[3] Statements revised based on comments and rescored in next round

[4]Statements that did not reach consensus and were modified

[5] New statements generated from participants feedback

[6] Statements removed due to lack of consensus

[7]Divided

[8]Merged

Four competency statements were eliminated due to a lack of consensus (75% threshold): one knowledge-based statement (risk management 2 K-13) and three skill-based statements (high-frequency ventilation 2 S-31, hip ultrasound 2 S-32, pericardiocentesis 2 S-34) (Table 2, Table SM-7 and SM-8 in Supplementary Materials-2).

Round 3 findings

Round 3 resulted in 100% consensus on the final 135 competencies, categorized into three domains (knowledge, skills, attitudes) with thematic subdomains (Tables SM-9, SM-10, and SM-11 in Supplementary Materials-2). Following prioritization, 89 competencies (65.9%) were identified as core competencies (17 knowledge, 58 skills, 14 attitudes) (Tables SM-12, SM-13, and SM-14 in Supplementary Materials-2), forming the basis for a revised Syrian neonatology fellowship curriculum.

A three-round Delphi survey subsequently achieved consensus on 135 competencies across three domains (knowledge, skills, attitudes), detailed in Tables 3, 4, and 5.

Discussion

This study utilized a three-round modified Delphi process to establish a comprehensive framework of core competencies for Syrian neonatology fellowship training. This resulted in 135 competencies encompassing knowledge, skills, and attitudes, providing a foundational structure for curriculum development within the Syrian context. A previous study [21] established competencies for undergraduate medical students within Syrian neonatology curricula. However, this work represents the first attempt to define competencies specifically tailored to Syrian neonatology fellowship training, addressing the limitations of the current time-based curriculum that lacks explicit competency structures.

The study's robust methodology, characterized by high participant engagement and adherence to established criteria for expert selection, ensures the validity and reliability of the identified competencies. The rigorous methodology, integrating a literature review with focus group discussions ensured a comprehensive understanding of the specific challenges and priorities within the Syrian healthcare system. The focus group discussions, using moderated, open, and structured dialogue, provided valuable insights and nuanced perspectives, enriching the development and interpretation of our findings [27].

Given the interdisciplinary nature of neonatology, particularly in resource-limited settings like Syria, the study employed a multi-stakeholder approach, engaging a diverse panel of Syrian healthcare professionals with experience in neonatal care (Table SM-4 in Supplementary Materials-2). This selection aligns with our criteria for "experts in neonatal care," ensuring that the framework reflects the practical realities of Syria's healthcare system, where resource constraints necessitate interdisciplinary collaboration without diminishing the central role of neonatologists.

High response rates across the three Delphi rounds (80.36%, 63.7%, and 100%) demonstrate strong participant engagement, while the inclusion of program directors in the final round secured their approval, further enhancing the credibility of the identified competencies. This systematic, inclusive approach ensures a contextually relevant competency framework, facilitating the

Table 3 Final list of knowledge competencies (Round 3, *N* = 38 competencies)

Code	Knowledge Competency	Mean (SD)	Median (IQR)	Agreement (%)
K-1	Recall principles of advanced resuscitation physiology in neonates.	4.72 (0.45)	5 (1)	100.0
K-3	Recall principles and goals of palliative care in neonates.	4.11 (0.76)	4 (1)	86.7
K-5	Recognize pathophysiology and treatments of pulmonary hemorrhage in neonates.	4.39 (0.62)	4 (1)	97.0
K-6	Describe classification, pathophysiology, prognosis, and outcomes of chronic lung disease in neonates.	4.11 (0.85)	4 (1)	88.9
K-7	List evidence-based indications for respiratory syncytial virus prophylaxis in neonates.	3.99 (0.79)	4 (0)	86.7
K-9	Recognize importance of echocardiography to diagnose congenital heart disease in neonates.	4.06 (0.87)	4 (1)	85.9
K-10	Discuss rationale and principles for managing duct-dependent cardiac lesions in neonates.	4.00 (0.97)	4 (1)	80.0
K-13	Recall causes, grading, and consequences of intraventricular hemorrhage in neonates.	4.32 (0.70)	4 (1)	94.1
K-14	Describe pathophysiology and implications of periventricular leukomalacia in preterm neonates.	3.81 (0.98)	4 (0)	77.8
K-15	Comprehend principles guiding management and long–term implications of hypoxic-ischemic encephalopathy in neonates.	4.27 (0.72)	4 (1)	92.6
K-16	Distinguish long term neurological outcomes in high risk neonates.	4.16 (0.56)	4 (0)	94.1
K-17	Recognize importance of newborn hearing screening for at-risk infants.	4.36 (0.66)	4 (1)	92.6
K-18	Describe common antenatal diagnosed renal disorders in neonates.	3.90 (0.81)	4 (0)	83.0
K-19	Identify red flags that indicate the need for urgent nephrology referral in neonatal patients.	3.93 (0.78)	4 (0)	82.2
K-20	Identify characteristic signs, symptoms, and principles of managing common chromosomal disorders presenting in neonates e.g. Trisomy 13, 18, and 21.	4.13 (0.80)	4 (1)	88.9
K-21	Recall causes and principles of managing neonatal thrombocytopenia.	4.27 (0.73)	4 (1)	92.6
K-22	Recognize the indications and adverse reactions of blood transfusion for neonates.	4.53 (0.58)	5 (1)	97.0
K-23	Describe principles and process of phototherapy for treating neonatal jaundice.	4.64 (0.51)	5 (1)	98.5
K-24	Describe common inherited metabolic disorders manifesting in neonates.	3.99 (0.82)	4 (0)	83.7
K-25	Recall fundamentals of managing newborns with ambiguous genitalia.	4.00 (0.88)	4 (1)	84.4
K-26	Identify common nosocomial infections and catheter-related sepsis in neonates.	4.49 (0.60)	5 (1)	94.8
2 K-1	Identify differences in physiology between term and preterm infants.	4.14 (0.98)	4 (1)	79.1
2 K-2	Describe impact of physiologic differences on pharmacology, therapies, and oxygen usage in preterm infants.	4.27 (0.92)	4.5 (1)	83.7
2 K-3	List various forms of mechanical ventilation used in neonates.	4.57 (0.58)	5 (1)	95.3
2 K-4	Recall indications and potential complications of different mechanical ventilation forms in neonates.	4.16 (0.79)	4 (1)	83.7
2 K-5	List compositions and varieties of therapeutic formulas for neonates.	4.37 (0.72)	4 (1)	90.7
2 K-6	Recall indications for use of therapeutic formulas in neonates.	4.33 (0.71)	4 (1)	90.7
2 K-7	Explain indications and potential complications of parenteral feeding in neonates.	4.17 (0.73)	4 (1)	84.9
2 K-8	Describe indications and potential complications of enteral feeding in neonates.	4.02 (0.86)	4 (1)	80.2
2 K-9	Recognize significance of mortality review conferences in enhancing neonatal care quality and safety.	3.99 (0.72)	4 (0)	80.2
2 K-10	Describe principles and process of developing evidence-based clinical guidelines.	4.05 (0.79)	4 (1)	77.9
2 K-11	Demonstrate understanding of basics of ECG interpretation in neonates.	4.05 (0.83)	4 (1)	76.7
2 K-12	Define concepts of root cause analysis and critical incident management as applied in neonatology.	3.97 (0.86)	4 (1)	76.7
2 K-14	Demonstrates in-depth knowledge of newborn vaccinations, including dosage, scheduling, and indications.	4.33 (0.72)	4 (1)	89.5
2 K-15	Demonstrates expertise in the proper operation and troubleshooting of neonatal incubators and other equipment used in caring for sick or premature newborns.	4.21 (0.73)	4 (1)	89.5
2 K-16	Explain in detail medications contraindicated in pregnancy and lactation and their possible negative impacts on the fetus and newborn.	4.43 (0.67)	5 (1)	91.9
2 K-17	Possess in-depth knowledge of management approaches for common neonatal injuries such as cephalohematoma, caput succedaneum, and Erb's palsy.	4.31 (0.77)	4 (1)	86.0
2 K-18	Comprehend the necessity of administering audiometric screenings for high-risk neonates.	4.05 (0.78)	4 (1)	82.6

* Note: Competencies with a mean score of 4.2 or higher are considered essential

transition to CBME in Syrian neonatology fellowship programs.

Analysis of IQR and SD values indicates strong consensus among participants regarding the importance of the identified competencies. Low IQR values (0–1 for knowledge and attitudes, 0.5–1 for skills) and generally low SD values for competencies with high mean scores confirm substantial agreement and a relatively low level of variability in the responses, particularly among the middle 50th percentile of respondents.

The identified competencies align with international standards [24, 46] and reflect the six core competencies established by the ACGME and ABMS: medical knowledge, patient care, procedural skills, practice-based

Table 4 Final list of skill competencies (Round 3, *N* = 80 competencies)

Code	Skill competency*	Mean (SD)	Median (IQR)	Agreement (%)
S-13	Conduct a comprehensive clinical examination for newborns, including determining gestational age.	4.58 (0.59)	5 (1)	98.52
S-1	Perform endotracheal intubation and manages the airway for newborns, including extremely premature infants.	4.72 (0.53)	5 (0.5)	97.78
S-2	Utilize appropriate ventilation modalities including mask, laryngeal mask and non-invasive ventilation.	4.71 (0.53)	5 (1)	97.78
S-3	Select and utilize appropriate devices for managing difficult airway during neonatal resuscitation.	4.69 (0.57)	5 (1)	97.78
S-5	Manage critical newborn conditions professionally including respiratory distress, shock and sepsis in delivery rooms, nurseries and emergency departments.	4.64 (0.62)	5 (1)	97.78
S-8	Compare different types of jaundice in newborns, including physiological jaundice.	4.62 (0.6)	5 (1)	97.78
S-20	Provide routine care for the newborn in the delivery room.	4.55 (0.63)	5 (1)	97.78
S-21	Demonstrate proficiency in interpreting and explaining data from invasive and non-invasive monitoring modalities used in neonatal intensive care, including cardiac and respiratory monitoring.	4.53 (0.63)	5 (1)	97.78
S-9	Obtain a detailed medical history for the newborn, including the history of pregnancy and delivery.	4.61 (0.67)	5 (1)	97.04
S-10	Inserts the nasogastric tube safely and skillfully.	4.6 (0.61)	5 (1)	97.04
S-17	Interpret common blood test results, such as liver function, thyroid function, and complete blood count, and correlate them with the newborn's condition.	4.56 (0.62)	5 (1)	97.04
S-34	Expertly assess and track newborns/infants' growth and nutritional status.	4.41 (0.72)	4 (1)	97.04
S-7	Proficiently recognize and manage neonates with severe hemolytic conditions such as ABO and Rh blood group incompatibilities.	4.63 (0.64)	5 (1)	96.30
S-23	Proficiently utilize devices in the neonatal unit, including pulse oximeters, apnea monitors, incubators, and intravenous infusion pumps.	4.52 (0.63)	5 (1)	96.30
S-24	Diagnose and provide appropriate acute and ongoing management of a neonate with pneumothorax.	4.51 (0.68)	5 (1)	96.30
S-25	Provide appropriate post-resuscitation care.	4.5 (0.71)	5 (1)	96.30
S-26	Diagnose and manage benign conditions in newborns, including skin conditions.	4.5 (0.69)	5 (1)	96.30
S-32	Manage common digestive problems in newborns, such as gastroesophageal reflux, diarrhea, feeding intolerance, and intestinal obstruction.	4.45 (0.71)	5 (1)	96.30
S-4	Skillfully perform lumbar puncture in neonates.	4.68 (0.62)	5 (1)	95.56
S-14	Proficiently manage respiratory distress syndrome in neonatal patients utilizing evidence-based therapies and interventions.	4.58 (0.66)	5 (1)	95.56
S-16	Master the ventilator weaning and extubating.	4.56 (0.74)	5 (1)	95.56
S-6	Manage common infections in the neonatal period, such as sepsis, meningitis, pneumonia, osteomyelitis, and omphalitis.	4.64 (0.66)	5 (1)	94.81
S-15	Take a leadership role in guiding the resuscitation team under challenging conditions, including severe asphyxia, congenital anomalies, and fetal distress.	4.56 (0.72)	5 (1)	94.81
S-22	Demonstrate skill in handling electrolyte disorders, encompassing sodium, potassium, calcium, and magnesium.	4.53 (0.71)	5 (1)	94.81
S-28	Diagnose and manage neonatal necrotizing enterocolitis.	4.47 (0.75)	5 (1)	94.81
S-29	Diagnose and manage polycythemia and hyperviscosity in the newborn.	4.47 (0.7)	5 (1)	94.81
S-18	Diagnose developmental dysplasia of the hip in neonates.	4.56 (0.68)	5 (1)	94.07
S-31	Skillfully insert urinary catheters in both male and female newborns.	4.47 (0.71)	5 (1)	94.07
S-37	Perform neurodevelopmental assessments on infants under 2 years old.	4.35 (0.77)	4 (1)	94.07
S-12	Demonstrate proficiency in accurately diagnosing common neonatal surgical emergencies including esophageal atresia, neural tube defects, and intestinal obstructions.	4.59 (0.67)	5 (1)	93.33
S-27	Manage diaphragmatic hernia in newborns, employing expert diagnostic and resuscitation skills.	4.47 (0.74)	5 (1)	93.33
S-41	Efficiently conduct daily clinical rounds on neonatal patients under direct or indirect supervision of an attending specialist.	4.33 (0.7)	4 (1)	93.33
S-46	Demonstrate skill in selecting appropriate investigations for newborns, including radiological investigations such as X-rays and CT scans, based on clinical presentation.	4.3 (0.76)	4 (1)	93.33
S-30	Exhibit proficient technique in venous, arterial, and umbilical catheter insertion for neonatal patients.	4.47 (0.77)	5 (1)	92.59
S-35	Effectively manage hypotension in newborns.	4.36 (0.8)	4 (1)	92.59
S-38	Demonstrate expertise in diagnosing and managing pulmonary hypertension in neonatal patients.	4.34 (0.73)	4 (1)	92.59
S-43	Administer pharmacologic and surgical therapies for patent ductus arteriosus in preterm infants with a high degree of proficiency, utilizing current evidence-based protocols.	4.32 (0.83)	4 (1)	92.59
S-58	Provide compassionate counseling and emotional support to families with a critically ill or terminally ill infant.	4.16 (0.79)	4 (1)	92.59
S-36	Interpret neonatal X-rays, CT scans, and other radiologic studies skillfully.	4.35 (0.8)	4 (1)	91.85

Table 4 (continued)

Code	Skill competency*	Mean (SD)	Median (IQR)	Agreement (%)
S-44	Exhibit expertise in evaluating neonatal seizures.	4.31 (0.82)	4 (1)	91.85
S-49	Accurately differentiate between cyanotic heart disease and primary pulmonary hypertension in neonates.	4.26 (0.85)	4 (1)	91.85
S-33	Demonstrate mastery of neonatal cardiopulmonary resuscitation skills.	4.44 (0.83)	5 (1)	91.11
S-40	Educate students and residents in newborn resuscitation skills and protocols.	4.33 (0.75)	4 (1)	91.11
S-39	Investigate congenital TORCH infections in newborns and recommend appropriate treatment plans.	4.34 (0.76)	4 (1)	90.37
S-42	Verify correct placement of catheters, tubes and other devices in neonatal patients using appropriate radiologic imaging modalities.	4.32 (0.85)	4 (1)	90.37
S-48	Expertly manage heart failure cases in newborn patients.	4.26 (0.88)	4 (1)	90.37
S-50	Skillfully obtain and document informed consent from parents, providing clear explanations of procedure/surgery risks, benefits, and importance.	4.24 (0.78)	4 (1)	88.89
S-52	Safely transfer critically ill newborns using transport incubators, prepared for potential transport complications.	4.23 (0.91)	4 (1)	88.89
S-51	Participate in basic and advanced neonatal resuscitation simulation training.	4.23 (0.84)	4 (1)	88.15
S-54	Manage acute kidney failure in newborns.	4.19 (0.84)	4 (1)	87.41
S-55	Investigate common coagulation disorders in newborn patients utilizing laboratory studies and clinical evidence.	4.19 (0.79)	4 (1)	87.41
S-56	Conduct thorough investigation of carbohydrate metabolism disorders such as hypoglycemia, hyperinsulinism, and hyperglycemia in neonates.	4.19 (0.83)	4 (1)	86.67
S-57	Provide comprehensive perioperative care for neonatal surgical patients encompassing stabilization, postoperative management, and pain management.	4.19 (0.81)	4 (1)	85.93
S-47	Perform intraosseous needle insertion rapidly in neonates when unable to obtain intravenous access.	4.27 (0.89)	4 (1)	85.19
S-59	Perform suprapubic bladder aspiration in neonatal patients with proficiency.	4.1 (0.97)	4 (1)	85.19
S-60	Communicate efficiently with referral hospitals regarding transport of critically ill neonates.	4.05 (0.92)	4 (1)	85.19
S-61	Diagnose and manage hypertension in neonatal patients using evidence-based protocols and guidelines.	4.05 (0.92)	4 (1)	84.44
S-64	Critically appraise neonatal scientific literature and guidelines to provide evidence-based care for newborns.	4.04 (0.83)	4 (1)	84.44
S-62	Refer premature infants with retinopathy of prematurity to ophthalmology promptly for specialized evaluation and management.	4.05 (0.86)	4 (1)	83.70
S-67	Distinguish cardiac dysrhythmias in neonates through interpretation of EKG and clinical findings.	4.01 (0.96)	4 (1)	83.70
S-66	Demonstrate expertise in biostatistics, clinical trial design, and publishing methodology for neonatal translational research.	4.01 (0.78)	4 (0)	82.96
S-68	Proficiently perform paracentesis for ascites drainage using age-appropriate techniques in neonates.	3.96 (1.01)	4 (1)	82.96
S-70	Counsel parents on suspected genetic disorders and obtain informed consent for confirmatory genetic testing.	3.9 (0.98)	4 (0)	82.22
S-65	Perform thoracentesis and inserting chest tubes competently in neonatal patients when indicated.	4.04 (1.02)	4 (1)	81.48
S-63	Use transillumination proficiently to detect pneumothorax, hydrocele, and optimize neonatal IV insertion in neonates.	4.05 (0.99)	4 (1)	80.00
S-69	Provide comprehensive long-term follow-up care for neonates discharged with chronic lung disease requiring home oxygen.	3.91 (0.89)	4 (0)	79.26
2 S-19	Proficiently perform therapeutic blood exchange procedures for severe hemolytic disorders in neonates.	4.42 (0.67)	5 (1)	91.86
2 S-20	Expertly manage complications arising during blood exchange transfusions in neonates.	4.38 (0.65)	4 (1)	93.02
2 S-21	Proficiently perform the full range of medical procedures relevant to neonates.	4.17 (0.73)	4 (1)	87.21
2 S-22	Recognize procedure risks and manage related complications.	4.23 (0.66)	4 (1)	89.53
2 S-23	Document neonatal patient data thoroughly in both written and electronic formats.	4.19 (0.72)	4 (1)	86.05
2 S-24	Compose accurate and detailed medical reports, referrals, and death reports for neonatal patients.	4.21 (0.73)	4 (1)	86.05
2 S-25	Proficiently demonstrate the skill of drawing venous, arterial, and capillary blood samples from newborns.	4.07 (0.85)	4 (1)	80.23
2 S-26	Secure peripheral intravenous access skillfully in neonatal patients.	4.23 (0.71)	4 (1)	86.05
2 S-27	Apply antibiotic guidelines to neonates skillfully.	4.28 (0.71)	4 (1)	87.21
2 S-28	Provide effective prenatal counseling to families regarding high-risk conditions such as extreme prematurity and congenital anomalies.	4.26 (0.65)	4 (1)	88.37
2 S-29	Proficiently provide care for infants born to mothers with conditions such as SLE and hepatitis B.	4.09 (0.77)	4 (1)	79.07
2 S-30	Demonstrate skilled ability in developing and delivering effective lectures, conferences, and seminars on neonatal care practices.	4.28 (0.64)	4 (1)	89.53

Table 4 (continued)

Code	Skill competency*	Mean (SD)	Median (IQR)	Agreement (%)
2 S-33	Assist neurosurgery team with neonatal ventriculocentesis procedures when clinically warranted.	3.95 (0.76)	4 (0.25)	75.58
2 S-35	Utilize cranial ultrasound to identify Intraventricular hemorrhage in high-risk neonates.	4.24 (0.70)	4 (1)	89.53

* Note: Competencies with a mean score of 4.2 or higher are considered essential

Table 5 Final list of attitude competencies (Round 3, $N = 17$ competencies)

Code	Competency*	Mean (SD)	Median (IQR)	Agreement (%)
A-1	Encourage parents to provide breastmilk feedings to hospitalized neonates.	4.7 (0.52)	5 (1)	98.52
A-2	Collaborate respectfully with the neonatal intensive care multi-disciplinary team to effectively coordinate patient care.	4.42 (0.67)	4 (1)	96.3
A-3	Adhere diligently to neonatal infection control guidelines.	4.65 (0.56)	5 (1)	97.04
A-4	Provide family-centered care in the neonatal setting without discrimination based on sex, race, or socioeconomic status.	4.64 (0.57)	5 (1)	97.04
A-6	Respect confidentiality of neonatal patient and family information.	4.62 (0.53)	5 (1)	97.78
A-7	Recognize importance of effective patient handoffs and communication to ensure continuity of care for neonatal patients.	4.55 (0.56)	5 (1)	97.04
A-8	Actively engage in hospital initiatives to enhance quality, strengthen safety practices, and reduce risks in delivery of neonatal care.	4.22 (0.76)	4 (1)	87.41
A-9	Engage in quality initiatives to critically evaluate care processes and implement improvements in the delivery of evidence-based neonatal care.	3.98 (0.89)	4 (1)	79.26
A-10	Strive to continually improve personal time management abilities to increase efficiency and institutional involvement.	4.16 (0.78)	4 (1)	87.41
A-11	Pursue continuous professional development to improve expertise in neonatal care.	4.44 (0.59)	4 (1)	96.3
A-12	Instill professional values and compassion in neonatal trainees through excellent teaching and positive role modeling.	4.38 (0.57)	4 (1)	95.56
A-13	Accept constructive feedback from neonatology colleagues to improve own practice.	4.4 (0.58)	4 (1)	95.56
A-14	Model exemplary professionalism in neonatal care through ethical, competent, compassionate practice.	4.42 (0.57)	4 (1)	96.3
A-15	Demonstrate ethical awareness and reasoned judgment in responding to dilemmas in neonatal care.	4.51 (0.53)	5 (1)	98.52
A-17	Interact collegially and cooperate effectively within the neonatal care team.	4.58 (0.59)	5 (1)	96.3
2 A-36	Compassionately communicates difficult news to NICU families by actively listening, validating emotions, and providing support with respect.	4.43 (0.62)	4.5 (1)	93%
2 A-37	Demonstrates a high level of interest and curiosity for the most recent evidence-based practices and guidelines in neonatology.	4.17 (0.78)	4 (1)	84%

* Note: Competencies with a mean score of 4.2 or higher are considered essential

learning, professionalism, and systems-based practice [47, 48]. This underscores their significance in neonatology fellowship training (Table SM-15 in Supplementary Materials-2).

At the same time, these competencies are adapted to the specific context of neonatology training in Syria, where resource limitations and ongoing conflict present significant challenges [13, 49]. Training prioritizes low-technology solutions—such as thermoregulation, CPAP, feeding protocols, and basic clinical skills (e.g., resuscitation, infection control)—over advanced procedures like high-frequency ventilation and ECMO. This approach aligns with findings from similar resource-limited settings [50, 51] and ensures the immediate applicability of skills to manage common neonatal conditions.

The focus on teamwork, communication, and cost-effective diagnostics underscores the importance of collaboration in systems facing personnel shortages and limited access to advanced technologies. Similar to international frameworks [47, 48], our study emphasizes basic clinical skills, ethical decision-making, and family communication, suggesting that certain universal principles of neonatology training are applicable across diverse settings.

This high level of consensus is exemplified by competencies such as advanced resuscitation physiology (K-1), endotracheal intubation (S-1), ventilation modalities (S-2), and infection control guidelines (A-3), all of which demonstrated high mean scores and low SDs.

Neonatal resuscitation plays a critical role in intensive care, with approximately 10% of newborns requiring

assistance at birth and 1% needing advanced interventions such as intubation and chest compressions [52]. This study underscores the importance of specific resuscitation competencies, emphasizing proficiency in endotracheal intubation, airway management, ventilation, and leadership within resuscitation teams (competencies K-1, S-1, S-2, S-3, S-5, S-15, S-33, S-40, and S-51). The coordinated application of these competencies is essential for effective emergency responses and improved outcomes in the NICUs [20].

Infectious diseases play a significant role in neonatal morbidity and mortality in Syrian NICUs (unpublished data, Abu Baker, 2019), underscoring the critical need for robust infection management and prevention strategies. This study identifies key competencies in infection control, including managing critical infections (S-5), treating common neonatal infections (S-6), investigating congenital infections (S-39), and adhering to infection control guidelines (A-3). Additional competencies, such as antibiotic stewardship (2 S-27), managing infants born to hepatitis B-positive mothers (2 S-29), newborn vaccinations (2 K-14), and respiratory syncytial virus prophylaxis (K-7), emphasize the importance of prevention, specialized expertise, and up-to-date knowledge.

In parallel, the identified competencies strongly emphasize breastfeeding and optimal infant nutrition, equipping fellows with the skills to understand various feeding methods (2 K-5, 2 K-6, 2 K-7, 2 K-8), monitor infant growth and nutritional status (S-34), and advocate for breastmilk feedings in hospitalized neonates (A-1), aligning with international guidelines supporting breastfeeding [53].

High-quality care for medically complex infants, especially during critical interventions like newborn resuscitation, relies on cohesive teamwork, effective communication, and collaboration to ensure successful outcomes [47]. Ediger et al. [54] highlight the significant influence of non-technical factors, such as teamwork, on resuscitation outcomes. This study reinforces this importance, identifying numerous competencies (A-2, A-7, S-15, S-41, S-60, 2 S-24, A-17) related to collaboration, communication, leadership, handoffs, and fostering a supportive work environment (Tables 4 and 5).

The lack of consensus on four competencies highlights Syria's resource constraints and practical healthcare challenges [49]. The need for specialized equipment (e.g., high-frequency ventilation) and expertise (e.g., hip ultrasound, pericardiocentesis) likely influenced expert decisions, as these procedures are often delegated to radiologists and cardiologists. Additionally, mastering these skills requires simulation training and mentorship, which are scarce due to the ongoing crisis and brain drain [13, 49]. Similarly, the exclusion of risk management and audit procedures suggests a greater focus on direct patient care, as these tasks typically fall under quality management rather than neonatologists' core responsibilities.

Simulation-based training is vital for modern neonatal fellowships, improving technical skills and teamwork in NICU emergency management [55, 56]. While integrated into European neonatology curricula [20], this study did not identify such competencies due to significant resource limitations in Syria. High costs, specialized infrastructure needs [57], and the necessity of faculty development pose implementation challenges. Therefore, exploring cost-effective alternatives and adapting training programs to available resources are crucial for integrating simulation-based training in Syria.

The exclusion of NPE from the competency framework, despite its growing prominence for hemodynamic assessment in Europe [58], reflects the current resource constraints in Syria. While NPE would be a valuable skill for neonatologists, given the scarcity of pediatric cardiologists, its inclusion is not currently feasible. This pragmatic approach prioritizes readily accessible competencies while acknowledging the potential future integration of NPE as resources improve.

This study outlines a core framework of essential competencies for Syrian neonatology fellowship training, focusing on integrating key skills and knowledge into the curriculum rather than specifying teaching methods. Educational milestones should be developed to align with these competencies, enabling the creation of tailored, comprehensive training for fellows.

To effectively integrate these competencies, a multifaceted approach is required. The curriculum must be revised to explicitly incorporate the competencies, aligning them with clear learning objectives, diverse assessment methods, and robust feedback mechanisms [59]. This may involve adapting existing modules or developing new ones, alongside faculty development programs to equip instructors with the skills for effective teaching and assessment [60].

However, successful implementation may face resistance from those accustomed to traditional methods, limited resources for curriculum development, and challenges in assessing subjective competencies like attitudes. To mitigate these obstacles, we recommend engaging faculty and trainees in curriculum revision to foster ownership, seeking external funding for support, and employing varied assessment methods, including direct observation and simulation [9, 60].

Achieving consensus on these core competencies will facilitate their integration into local programs, professional organizations, and accreditation bodies. These competencies will also serve as primary learning objectives for training courses and curricula [21]. For training centers lacking the resources to meet all competency

objectives, alternative strategies should be explored, such as external training at better-equipped centers in Damascus or Aleppo or recruiting specialized faculty.

As Syria's healthcare and educational systems recover, increased resource availability—including simulation training and advanced technologies (high-frequency ventilation, ultrasound, ECMO)—will necessitate a reassessment of competency requirements. To ensure the ongoing relevance and effectiveness of this competency framework, we recommend a structured review and update process to be conducted every 5 years to reflect advancements in neonatology [61], evolving societal needs, resource availability, local expertise, and stakeholder expectations. This process should involve a review committee comprising experienced neonatologists, program directors, faculty members, and potentially representatives from the Syrian Ministry of Health and other relevant organizations. The committee should gather data on current needs and challenges through surveys, focus groups, or interviews, alongside a review of the latest research in neonatology training. The existing competencies should then be evaluated for relevance and alignment with the field's needs, informing revisions that would be submitted for approval by a relevant governing body. This process will ensure a competency framework that remains a valuable and adaptive resource for Syrian neonatology fellowship training.

Limitations

This study has several limitations. First, its exclusive focus on Syrian neonatologists and reliance on expert consensus within a resource-constrained healthcare context limit the generalizability of the findings to other healthcare systems with differing socioeconomic contexts and resource availability. Future research should involve a broader range of stakeholders from diverse geographical settings, particularly those in similarly resource-constrained environments, and explore methods beyond expert consensus to ensure a more inclusive range of perspectives is considered.

Second, the exclusion of patient representatives (parents and caregivers) from the Delphi panel constitutes a significant limitation, potentially overlooking crucial aspects of patient-centered care. As a result, the identified competencies may not fully reflect the perspectives of parents and caregivers. Future research should prioritize integrating their voices (either directly or through patient advocacy groups) to ensure a more comprehensive and representative understanding of essential neonatal competencies, thereby promoting a patient-centered approach to care.

Conclusion

This study established 135 core competencies for Syrian neonatology fellowship training using the modified Delphi method, providing a foundation for standardized education and clear training expectations. These competencies serve as a blueprint for a national neonatology curriculum, promoting competency-based education while addressing Syria's unique healthcare challenges, ultimately advancing neonatology training in the region.

To ensure the successful implementation of this framework, future research should focus on testing and validating these competencies in practice. This could involve pilot studies in Syrian neonatology fellowship programs to assess the feasibility and effectiveness of implementing the competencies into the curriculum. Further research is also needed to explore the perspectives of patient representatives (parents and caregivers) on essential neonatal competencies and to develop methods for incorporating their voices into the training process. Finally, longitudinal studies are needed to evaluate the long-term impact of CBME on the performance of Syrian neonatologists and the outcomes of their patients.

Abbreviations

ACGME	Accreditation council for graduate medical education
CBME	Competency-based medical education
IQR	Interquartile ranges
NICUs	Neonatal intensive care units
NPE	Neonatologist-performed echocardiography
PCC	Participant, concept, and context
SD	Standard deviation
SLE	Systemic lupus erythematosus
SM	Supplementary materials
TORCH	Toxoplasmosis, other (syphilis, varicella-zoster, herpes simplex), rubella, cytomegalovirus, and herpes
USA	United states of america

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-025-07696-5.

Supplementary Material 1

Supplementary Material 2

Author contributions

IZ is the principal researcher collected focus group and Delphi technique data, and wrote the first manuscript. IZ, SZ, MM conducted the literature review. MD supervised the study. IZ, SZ, MM, and MD participated in designing the study, data analysis and interpretation. SZ, MM, and MD provided critical input to the manuscript and revised it before submission. All authors read and approved the final manuscript.

Funding

This work was not supported by any external funding.

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethical approval

Ethical approval has been granted from the ethical committee at the Syrian Virtual University No. 517/0, dated 26/4/2022.

Competing interests

The authors declare no competing interests.

Received: 12 August 2024 / Accepted: 14 July 2025
Published online: 28 July 2025

References

1. McGaghie WC, Sajid AW, Telder TV, Miller GE. Competency-based curriculum development in medical education: an introduction. Geneva: World Health Organization 1978.
2. Gonsalves C, Zaidi Z. Hands in medicine: Understanding the impact of competency-based education on the formation of medical students' identities in the united States. J Educ Eval Health Prof. 2016;13:31.
3. Holmboe ES. The transformational path ahead: Competency-Based medical education in family medicine. Fam Med. 2021. https://doi.org/10.22454/FamMed.2021.296914
4. Shah N, Desai C, Jorwekar G, Badyal D, Singh T. Competency-based medical education: an overview and application in Pharmacology. Indian J Pharmacol. 2016;48:5.
5. Khan WU, Twomey J, Ryan E, Martin T, Kamal M, Lok Boris Cheng P, et al. Barriers and enablers to achieving clinical procedure competency-based outcomes in a National paediatric training/residency program—a multi-centered qualitative study. BMC Med Educ. 2023;23:954.
6. Vasquez JA, Marcotte K, Gruppen LD. The parallel evolution of competency-based education in medical and higher education. J Competency-Based Educ. 2021;6.
7. Shah N, Desai C, Jorwekar G, Badyal D, Singh T. Competency-based medical education: an overview and application in Pharmacology. Indian J Pharmacol. 2016;48:S5–9.
8. Nousiainen MT, Caverzagie KJ, Ferguson PC, Frank JR. Implementing competency-based medical education: what changes in curricular structure and processes are needed? Med Teach. 2017;39:594–8.
9. Caverzagie KJ, Nousiainen MT, Ferguson PC, ten Cate O, Ross S, Harris KA, et al. Overarching challenges to the implementation of competency-based medical education. Med Teach. 2017;39:588–93.
10. Sahloul MZ, Monla-Hassan J, Sankari A, Kherallah M, Atassi B, Badr S, et al. War is the enemy of health. Pulmonary, critical care, and sleep medicine in War-Torn Syria. Ann Am Thorac Soc. 2016;13:147–55.
11. Fouad FM, Sparrow A, Tarakji A, Alameddine M, El-Jardali F, Coutts AP, et al. Health workers and the weaponisation of health care in Syria: a preliminary inquiry for the lancet–American university of Beirut commission on Syria. Lancet. 2017;390:2516–26.
12. Alfakhry G, Kodmani R. Managing patient care and medical training in under-resourced hospital settings: the experience of Syrian residents. J Health Prof Edu Innov. 2024;1:39–41.
13. Alhaffar MHDBA, Janos S. Public health consequences after ten years of the Syrian crisis: a literature review. Global Health. 2021;17:111.
14. Akik C, Semaan A, Shaker-Berbari L, Jamaluddine Z, Saad GE, Lopes K, et al. Responding to health needs of women, children and adolescents within Syria during conflict: intervention coverage, challenges and adaptations. Confl Health. 2020;14:37.
15. Gray MM, Bruno C, French H, Myers P, Carbajal MM, Reber KM, et al. Changes, challenges, and variations in Neonatal-Perinatal medicine fellowship: A view from the program directors. Am J Perinatol. 2024;41:e163–73.
16. French H, Eichenwald E. The maturation of a proficient neonatologist: from the delivery room to independent practice. Pediatrics. 2020;146(1):e20200212.
17. Dyess NF, Myers P, Dammann CEL, Chess PR, Abramson EL, Andy C, et al. Scholarly activity during Neonatal–Perinatal medicine fellowship. Am J Perinatol. 2025;42:075–83.
18. Frank JR, Mungroo R, Ahmad Y, Wang M, De Rossi S, Horsley T. Toward a definition of competency-based education in medicine: a systematic review of published definitions. Med Teach. 2010;32:631–7.
19. Penciner R, Langhan T, Lee R, Mcewen J, Woods RA, Bandiera G. Using a Delphi process to Establish consensus on emergency medicine clerkship competencies. Med Teach. 2011;33:e333–9.
20. Bay ET, Breindahl N, Nielsen MM, Roehr CC, Szczapa T, Gagliardi L, et al. Technical skills curriculum in neonatology: A modified European Delphi study. Neonatology. 2024;121:314–26.
21. Zoukar I, Dashash M. Using a modified Delphi method for identifying competencies in a Syrian undergraduate neonatology curriculum. Matern Child Health J. 2023. https://doi.org/10.1007/s10995-023-03719-z
22. Saeed H, Hamid S, Zoukar I, Khiami A, Al Hawat L, Khoja M, et al. Post-quake call for action: developing core competencies matrix for Syrian health workers in emergency time. Confl Health. 2024;18:5.
23. American Board of Pediatrics (ABP). Entrustable Professional Activities For Subspecialties. 2024. https://www.abp.org/content/entrustable-professional-activities-subspecialties. Accessed 6 Jan 2024.
24. Royal College of Physicians and Surgeons of Canada. Neonatal-perinatal medicine competencies. 2021;:1–19. https://www.royalcollege.ca/rcsite/documents/ibd/neonatal-perinatal-medicine-competencies-e.pdf. Accessed 10 May 2022.
25. Pediatric Section of the Union of European Medical Specialists, the European Board of Neonatology. European Training Requirements in Neonatology. UEMS 2021.18 European Training Requirements in Neonatology. 2021;:1–32. https://www.uems.eu/__data/assets/pdf_file/0018/134109/UEMS-2021.18-European-Training-Requirements-in-Neonatology.pdf. Accessed 23 Apr 2024.
26. Long HA, French DP, Brooks JM. Optimising the value of the critical appraisal skills programme (CASP) tool for quality appraisal in qualitative evidence synthesis. Res Methods Med Health Sci. 2020;1:31–42.
27. Halcomb EJ, Gholizadeh L, DiGiacomo M, Phillips J, Davidson PM. Literature review: considerations in undertaking focus group research with culturally and linguistically diverse groups. J Clin Nurs. 2007;16:1000–11.
28. Tausch AP, Menold N. Methodological aspects of focus groups in health research. Glob Qual Nurs Res. 2016;3:233339361663046.
29. Sinha IP, Smyth RL, Williamson PR. Using the Delphi technique to determine which outcomes to measure in clinical trials: recommendations for the future based on a systematic review of existing studies. PLoS Med. 2011;8:e1000393.
30. Okoli C, Pawlowski SD. The Delphi method as a research tool: an example, design considerations and applications. Inf Manag. 2004;42:15–29.
31. Avella R. Delphi panels: research design, procedures, advantages, and challenges. Int J Doctoral Stud. 2016;11:305–21.
32. Nawagi F, Munabi IG, Vyt A, Kiguli S, Rabin T, Waggie F, et al. Using the modified Delphi technique to develop a framework for interprofessional education during international electives in health professions training institutions in Sub-Saharan Africa. Front Med (Lausanne). 2023;10:1225475.
33. Google. Google Forms: Free Online Surveys for Personal Use. 2022. https://www.google.com/forms/about/
34. Banayan J, Blood A, Park YS, Shahul S, Scavone BM. A modified Delphi method to create a scoring system for assessing team performance during maternal cardiopulmonary arrest. Hypertens Pregnancy. 2015;34:314–31.
35. Taylor E. We agree, don't we?? The Delphi method for health environments research. HERD: Health Environ Res Des J. 2020;13:11–23.
36. Robinson KR, Leighton P, Logan P, Gordon AL, Anthony K, Harwood RH, et al. Developing the principles of chair based exercise for older people: a modified Delphi study. BMC Geriatr. 2014;14:65.
37. Santaguida P, Dolovich L, Oliver D, Lamarche L, Gilsing A, Griffith LE, et al. Protocol for a Delphi consensus exercise to identify a core set of criteria for selecting health related outcome measures (HROM) to be used in primary health care. BMC Fam Pract. 2018;19:152.
38. Vogel C, Zwolinsky S, Griffiths C, Hobbs M, Henderson E, Wilkins E. A Delphi study to build consensus on the definition and use of big data in obesity research. Int J Obes. 2019;43:2573–86.
39. Murphy MK, Black NA, Lamping DL, McKee CM, Sanderson CF, Askham J, et al. Consensus development methods, and their use in clinical guideline development. Health Technol Assess. 1998;2:i–iv.
40. Mubarak N, Hatah E, Aris MAM, Shafie AA, Zin CS. Consensus among healthcare stakeholders on a collaborative medication therapy management model for chronic diseases in malaysia; A Delphi study. PLoS ONE. 2019;14:e0216563.
41. Jünger S, Payne SA, Brine J, Radbruch L, Brearley SG. Guidance on conducting and reporting DElphi studies (CREDES) in palliative care: recommendations based on a methodological systematic review. Palliat Med. 2017;31:684–706.
42. Keeney S, Hasson F, McKenna HP. A critical review of the Delphi technique as a research methodology for nursing. Int J Nurs Stud. 2001;38:195–200.

43. Diamond IR, Grant RC, Feldman BM, Pencharz PB, Ling SC, Moore AM, et al. Defining consensus: a systematic review recommends methodologic criteria for reporting of Delphi studies. J Clin Epidemiol. 2014;67:401–9.
44. n der Gracht HA. Consensus measurement in Delphi studies. Technol Forecast Soc Change. 2012;79:1525–36.
45. Barber CEH, Marshall DA, Alvarez N, Mancini GBJ, Lacaille D, Keeling S, et al. Development of cardiovascular quality indicators for rheumatoid arthritis: results from an international expert panel using a novel online process. J Rheumatol. 2015;42:1548–55.
46. Royal College of Pediatrics and Child Health. Neonatal medicine - sub-specialty. 2022. https://www.rcpch.ac.uk/resources/neonatal-medicine-sub-specialty. Accessed 3 May 2022.
47. Chabra S, Sawyer T. Ten commandments for Neonatal-Perinatal medicine fellows. J Med Educ Curric Dev. 2018;5:238212051879863.
48. The Accreditation Council for Graduate Medical Education. The Pediatrics Subspecialty Milestone Project. Neonatal-Perinatal Medicine Milestones. 2023;:1–32. https://www.acgme.org/globalassets/pdfs/milestones/neonatalperinatalmedicinemilestones.pdf. Accessed 16 Jun 2024.
49. Soqia J, Yakoub-Agha L, Mohamad L, Alhomsi R, Shamaa MA, Yazbek A, et al. Syrian crises effect on specialty choice and the decision to work in the country among residents of six major hospitals in Syria, Damascus. PLoS ONE. 2024;19:e0295310.
50. Swanson SJ, Martinez KK, Shaikh HA, Philipo GM, Martinez J, Mushi EJ. Every breath counts: lessons learned in developing a training NICU in Northern Tanzania. Front Pediatr. 2022;10.
51. Tuyisenge D, Byiringiro S, Manirakiza ML, Mutsinzi RG, Nshimyiryo A, Nyishime M, et al. Quality improvement strategies to improve inpatient management of small and sick newborns across all babies count supported hospitals in rural Rwanda. BMC Pediatr. 2021;21:89.
52. Aziz K, Chadwick M, Baker M, Andrews W. Ante- and intra-partum factors that predict increased need for neonatal resuscitation. Resuscitation. 2008;79:444–52.
53. Tomlinson C, Haiek LN. Breastfeeding and human milk in the NICU: from birth to discharge. Paediatr Child Health. 2023;28:510–7.
54. Ediger K, Rashid M, Law BHY. What is teamwork?? A mixed methods study on the perception of teamwork? in a specialized neonatal resuscitation team. Front Pediatr. 2022;10.
55. Sawyer T, Gray MM. Competency-based assessment in neonatal simulation-based training. Semin Perinatol. 2023;47:151823.
56. Stritzke A, Murthy P, Fiedrich E, Assaad M-A, Howlett A, Cheng A, et al. Advanced neonatal procedural skills: a simulation-based workshop: impact and skill decay. BMC Med Educ. 2023;23:26.
57. Bayoumi MAA, Elmalik EE, Ali H, D'Souza S, Furigay J, Romo A et al. Neonatal simulation program: A 5 years educational journey from Qatar. Front Pediatr. 2022;10.
58. Singh Y, Roehr CC, Tissot C, Rogerson S, Gupta S, Bohlin K, et al. Education, training, and accreditation of neonatologist performed echocardiography in Europe—framework for practice. Pediatr Res. 2018;84:13–7.
59. Steier CM. The Use of Objectives and Feedback in a Competency-Based Curriculum. 2021. pp. 142–54.
60. Ramanathan R, Shanmugam J, Gopalakrishnan SM, Palanisamy KT, Narayanan S. Challenges in the implementation of Competency-Based medical curriculum: perspectives of prospective academicians. Cureus. 2022. https://doi.org/10.7759/cureus.32838
61. Breindahl M, Blennow M, Fauchère J-C, Lluch MT, De Luca D, Marlow N, et al. The European database for subspecialist training in Neonatology– Transparency achieved. Neonatology. 2013;103:74–82.

Publisher's note