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Core competencies in neurocritical care training in China: consensus developed by a national Delphi consensus survey combined with nominal group technique

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-033441
Article Type:	Research
Date Submitted by the Author:	05-Aug-2019
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Keywords:	neurocritical care, training, core competency, consensus, Delphi, nominal group

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Core competencies in neurocritical care training in China: consensus developed by a national Delphi consensus survey combined with nominal group technique

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Keywords: neurocritical care, training, core competency, consensus, Delphi, nominal group

Word count: 2960

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ABSTRACT

Objectives: To define the core competencies essential for specialist training in neurocritical care in China.

Design: Modified Delphi method and nominal group technique.

Setting: National.

Participants: A nominal group of 11 members organized by the Neuro-Critical Care Committee affiliated with the Chinese Association of Critical Care Physicians and the National Center for Healthcare Quality Management in Neurological Diseases.

Results: 1094 respondents from 33 provinces in China participated in the online survey. A formal list containing 329 statements was generated for the rating by a nominal group. After five rounds of nominal group meetings and one round of comments and iterative review, 198 core competencies (54 on neurological diseases, 64 on general medical diseases, 42 on monitoring of practical procedures, 20 on professionalism and system management, 5 on ethical and legal aspects, 3 on the principles of research and certification, and 10 on scoring systems) formed the final list.

Conclusion: By using consensus techniques, we have developed a list of core competencies for neurocritical care training, which may serve as a reference for future specialist training programs in China.

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Main strengths and limitations of this study

1. To the best of our knowledge, this is the first time that core competencies for neurocritical care has been established in China.

2. Consensus techniques were employed in our study, which may serve as a reference for future specialist training programs in China.

3. All of the nominal group members came from tertiary academic hospitals so they might not have represented the views of lower-grade hospitals.

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INTRODUCTION

During the past three decades, neuro-intensive care units (NICUs) in China grew rapidly with the development of neuroscience and critical care medicine [1,2]. A recent survey demonstrated that most of the NICUs in China are operated under a "closed" model and that clinical practice is conducted by full-time dedicated neuro-intensivists [3]. Systemic professional training and the performance assessment of physicians involved in neurocritical care practice are among the cornerstones of the development of the NICU [4]. At present, professional training programs focusing on critical care medicine and neurosurgery have been put into practice in China [5]. However, there is no standardized national training program for neuro-intensivists.

The experience of critical care and neurocritical care training in other countries has already illustrated that identifying core competencies is important for establishing standardized training programs [6-8]. To date, no core competency lists are available for neurocritical care training in China. Recently, a list of competencies for general critical care training has been established [9]. However, since neurocritical care is a multidisciplinary subspecialty that contains the characteristics of neurology, neurosurgery and critical care medicine, it is inappropriate to directly apply critical care or neurological/neurosurgical lists for neurocritical care. The United Council for Neurologic Subspecialties (UCNS) and the American Academy of Neurology (AAN) have published their core competency lists for neurocritical care training, respectively [7,10]. Both were generated based on the opinions of experts. Additionally, due to the diversity of medical resources and educational systems in China, the establishment of NICUs is extremely imbalanced across different regions [3]. Therefore, consensus statements issued by other countries may not be applicable for NICUs in China.

The Neuro-Critical Care Committee affiliated with the Chinese Association of Critical Care Physicians (NCCC-CACCP) and the National Center for Healthcare Quality Management in Neurological Diseases called for a working group to generate a list of fundamental core competencies for neurocritical care training in China. The modified Delphi method and nominal group (NG) technique were used during consensus establishment. The methodology and results of the present study might provide a reference for future specialist training programs in different regions.

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METHODS

The present study was conducted in three phases from February 2018 to May 2019 (**Fig. 1**). In phase 1 (the first round Delphi), a nationwide questionnaire was published online to collect opinions on the core competencies that provided a basic perspective for the specialists training in neurocritical care. In phase 2, several rounds of voting were conducted by face-to-face NG meetings to generate a core competencies list. Then the minimum level of expertise, which is equated with the ability that should be attained at the end of training, was identified by one round of voting. During phase 3 (the second round Delphi), the draft was posted online for further comments.

Patient and public involvement

There was no patient or public involvement in this study.

Phase 1: generation and rearrangement competencies list (first round Delphi)

A list of potential core competencies was developed based on four previous publications, including the list introduced by the Competency-Based Training in Intensive Care Medicine in Europe Collaboration (CoBaTrICE) [6], the guidelines developed by UCNS [7], the Chinese College of Intensive and Critical Care Medicine (CCICCM) [9] and the Critical Care & Emergency Medicine fellowship core curriculum of AAN [10]. In principle, all core competencies proposed by the aforementioned publications were preserved, while the duplicated items were rearranged to simplify the list. Those items with a definition of the level of expertise were modified. For example, the items about shock in CCICCM (To recognize and manage different types of shock) and UCNS (Shock: hypotension) and its complications (vasodilatory and cardiogenic) were rewritten as “different types of shock” in the potential list. Furthermore, five items referring to the scoring system were added.

The potential competencies list was translated into Chinese and organized into an online questionnaire (https://www.wjx.cn/jq/21776519.aspx, accessed April 2, 2018), which comprised seven parts (general medical diseases, neurological diseases, monitoring practice, professionalism and system management, ethical and legal, research and certification, and scoring system). The respondents were asked to select “YES” or “NO” for each item. Respondents were also invited to answer an open question: “Which competencies are important for specialist training in neurocritical care, in addition to those listed above”.

The online questionnaire was disseminated via three types of media:

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(1) Members of the NCCC-CACCP from each province were responsible for the distribution of the questionnaire via email, WeChat or website links.

(2) The questionnaire was posted on the official website of the Chinese Society of Critical Care Medicine (http://www.csccm.org.cn, accessed April 2, 2018).

(3) The questionnaire was posted on the WeChat official account of the Department of Critical Care Medicine of Capital Medical University (https://www.wjx.cn/jq/21776519.aspx, accessed April 2, 2018).

The questionnaire was posted online for 90 days. After removing duplicate and meaningless responses from the "open question", the remaining responses and all those items that received at least one "YES" response were generated into a formal list for the NG meeting.

Phase 2: NG ratings

The leaders of the NCCC-CACCP and the National Center for Healthcare Quality Management in Neurological Diseases were responsible for the establishment of NG. Considering the imbalance of medical resources in China, 11 NG members from different regions were invited, covering areas from economic development to underdevelopment (six provinces: Beijing, Shanghai, Shandong, Shanxi, Guangdong, Xinjiang). There were four neuro-intensivists with neurological/neurosurgical background, three general intensivists in charge of NICUs, two trainees who had completed training in neurocritical care, one respiratory therapist and one experienced neurocritical care nurse. A researcher was selected as the coordinator to facilitate the process.

To improve efficiency, the first round of NG rating was conducted by sending the formal list generated after the online survey to the NG members by mail. All of the competencies were followed by the same question: "Is it important for specialists training in neurocritical care?" Meanwhile, the percentages of "YES" responses selected during the online questionnaire were provided. The NG members were asked to individually rate the importance of competencies using a 5-point Likert scale (ranging from 1 representing very unimportant to 5 representing very important) [6], and to return the feedback in one week.

The coordinator was in charge of analyzing the feedback of the questionnaires. Items achieving full consensus (100% NG members voting 4- or 5-point) were directly entered into the final list. Other undetermined items were emailed to the NG members one week before the plenary NG ratings. Data on personal and group ratings for each item during the first round were provided as well. The NG

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members were requested to read these materials carefully and compare the differences between their own opinions and those of other NG members.

A face-to-face NG meeting was held on July 21, 2018 (the second round NG rating). Each NG member was required to select at least the five most important items individually from those items entered in the second round of ratings. Each NG member was asked to explain the reasons for selecting these items in turn, and others were not allowed to interrupt during this process. Afterwards, an open discussion for debate was conducted. During the meeting, the NG members were frequently reminded to consider the resource disequilibrium of the national medical system and respect the opinions of the "vulnerable members" such as trainees, nurses and respiratory therapists. Finally, each member rated the importance of competencies independently, as in the first round. Items achieving full consensus entered into the final list; otherwise, they were entered into the third round. The third and fourth rounds were conducted in the same manner as the second round. Since no item achieved full consensus (100% NG members voting 4- or 5-point) during the fourth round, the iteration ended. All the items that did not achieve full consensus were eliminated. The resulting data from the previous rounds were presented to the NG members during the meeting.

The fifth round NG rating was held on July 22, 2018. The NG members were required to identify the minimum level of expertise for each competence item, which was defined at four levels: a, b, c and d (selected from the generic descriptors, online supplementary appendix 1, Table S1) [6]. A simple majority rule was implemented; that is, the level that gained the most votes was accepted as the final choice. When the number of votes was the same, the lower level would be accepted. For example, if five "b", five "c" and one "d" were voted, the level "b" would be accepted as the minimum level of expertise.

Phase 3: comments and iterative review (second round Delphi)

The draft of the final list was delivered by three types of media, as with the first round of Delphi. All participants who provided an email address during the online survey were contacted and invited to give comments.

Development of the final set

After the three phases of the study, the final competence set was constructed as the statements were made of three parts: "context", "level of expertise" and "content of competence" (online supplementary appendix 1, Table S2).

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The number of items in the final competence set was compared to those in guidelines and statements published by CoBaTrICE, UCNS, CCICCM and AAN.

Statistical analysis

Categorical data were presented as number (percentage). Continuous data were presented as the median and the interquartile range (IQR). All data were analyzed using SPSS version 17.0.

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RESULTS

Phase 1: generation and rearrangement competencies list (first round Delphi)

A total 1094 respondents from 33 administrative provinces (including Macao and Taiwan) participated in the first round of Delphi (**Table 1**). There were 916 (83.7%) respondents from tertiary hospitals, 536 (49.0%) of whom had been engaged in clinical practice for more than 10 years. Each item in the original online questionnaire won at least one vote, so all entered the NG rating. The open question received 394 additional suggestions, most of which had already been included in the original online questionnaire. Finally, 37 suggestions (22 relating to knowledge and skills and 15 relating to the scoring system) were included in the formal list after careful consideration. Following the rule that we not delete items but only analyze and integrate them, a formal list containing 329 statements was ultimately generated for the following NG ratings (online supplementary appendix 1, Table S3 and S4).

Phase 2: NG ratings

During the first round of ratings, 138 (41.8%) items achieved full consensus. Then, 52 (15.8%) and eight (2.4%) items were elected during the second and third rounds, respectively. In the fourth round, no additional items achieved full consensus; therefore, the rating was terminated. Finally, a list containing 198 items was generated (online supplementary appendix 1, Table S3). Another 131 items that did not reach full consensus were eliminated (online supplementary appendix 1, Table S4).

The minimum level of expertise was identified in the fifth round of rating. Following the established rules, most items were rated as level “c” (159, 80.3%), with one “a” (0.5%), 28 “b” (14.1%) and 10 “d” (5.0%) ratings. Nineteen items had the same rating results in two levels of expertise, and the lower level was accepted as the final level. For example, the item “9.5 Describes burns and electrical injury” was voted as five “a”, five “b” and one “c”. According to the rule, the level “a” was accepted.

Phase 3: comments and iterative review (second round of Delphi)

There were 111 replies received from 27 provinces (Table 1). No new competencies were proposed during this phase, so no change was made to the final competency list. It is worth noted that many participants expressed their urgent demand for standardized neurointensive training.

Development of the final set

The final competence set comprised 198 competency statements divided into seven parts (**Fig. 2**). Appendix in online supplementary appendix 2 shows the final competences list.

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The number of items in the final competence set (n=198) was more than the number in CoBaTrICE (n=102), CSCCM (n=129) and AAN (n=66) but was less than the number in UCNS (n=289) (**Fig. 3**).

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DISCUSSION

Based on past guidelines, we used consensus techniques, i.e., the modified Delphi method and NG technique, to develop a set of 198 core competencies for fundamental neurocritical care training in China. To the best of our knowledge, this is the first time that consensus techniques have been applied to the development of core competencies of neurocritical care in China.

The Delphi method and NG technique are the most commonly employed techniques for developing consensus [11]. These methods have been used successfully in critical care medicine, for instance, to identify the core competencies of critical care in Europe [6] and China [9] and to establish national research priorities of critical care in the UK [12]. The Delphi method is used to collect opinions and evaluate rating results. This technique was initially described by the RAND Air Force Corporation in America in the 1950s [13]. In the field of medical education, more than three quarters of publications using consensus techniques adopted the Delphi and modified Delphi [14]. This methodology permits individual thinking. Feedback is provided after each round so that revisions can be made. The NG technique is employed to select the most important items and define the minimum level of expertise. During face-to-face ratings, the interaction is controlled by a coordinator so that all participants have opportunities to express their views and the dominance of one or two vocal members can be avoided [11]. Later, the free period allows for more expression of ideas and discussions. The design of our study shares many similarities with CoBaTrICE [6], except for one step order. In our study, we adhered the principle that determining the core competencies is the top priority. The most important items were voted on prior to the determination of the minimum level of expertise. The purpose of this adjustment was to avoid the potential influence of the minimum level of expertise on the voting process on the importance of the competencies. For example, if the item was previously categorized as level “a”, it may have been interpreted as “unimportant” and ruled out during the voting on importance.

The number of our items was significantly reduced compared to UCNS [7] (**Fig. 3**). The main reason is that we wanted to obtain a basic list with the greatest consensus. Therefore, only those competencies agreed on by all NG members were included. For example, one NG member insisted that research capacity was not essential for junior physicians. Under the established admission criteria, most items relevant to research capacity were ruled out. In addition, the differences in the professional backgrounds of the NG members lead to divergences. For example, some NG members with a neuroscience background believed that the ultrasound technique was not so important, while NG

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members specialized in general critical care insisted that ultrasound was an essential skill for clinical practice. This phenomenon may be associated with the popularity of ultrasound in the two specialties [15,16]. After repeated discussions, three items were admitted in the third round (pleural effusion and ascites localization, assesses inferior caval vein, and vascular localization), although more advanced techniques such as lung ultrasound and echocardiography were excluded. Compared with CSCCM [9], our list not only added a large number of neurological items but also added some items related to systemic diseases related to neuroscience to adapt to neurocritical care training. More than 30 items related to general critical care were deleted, such as “Manages continuous renal replacement therapy”. Furthermore, the 15 newly added items were all from the first round of Delphi, which highlighted the importance of the Delphi method and avoided the loss of important items.

Neurocritical care is an interdisciplinary specialty involving neuroscience and critical care medicine [17,18]. In China, NICUs fall under different departments and are managed by neurosurgeons, neurologists or intensivists [3]. The training requirements of different regions and backgrounds are highly diverse. An all-embracing competency list could be a burden for a training program and may decrease efficiency. Our lists selected essential fundamental competencies for physicians who had just finished neurocritical care training, regardless of whether a training program was based on neurosurgery, neurology, critical care medicine or other specialties related to neurocritical care. Training program directors may reorganize this list by adding core competencies for any special local training. Those items that had been ruled out during the NG process might serve as optional competencies.

There are some potential limitations in our study. First, we used WeChat as one of the media to disseminate online questionnaires to maximize the efficiency and enthusiasm of the participants. Therefore, it is inevitable that some feedback was of low quality and given without consideration. Fortunately, among more than one thousand respondents, the proportion of low-quality responses was quite low, so there was not much impact on the final results. Second, although we had reminded the experts to pay attention to the opinions of vulnerable groups and the voting processes were independent, trainees, nurses and respiratory therapists were still less involved in the discussion. By analyzing the questionnaires, we could not rule out the suspicion of conformity in the selection of some items. Third, all of the NG members came from tertiary academic hospitals so they may not have represented the views of lower-grade hospitals. However, one-seventh of the replies were received

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from lower-grade hospitals in Phase 1, which provided a reference for the NG meetings. In addition, the NG members were reminded to consider the resource disequilibrium during the voting processes. Last, patients and their relatives were not invited to participate in our study, which therefore might have lacked their opinions. However, the CoBaTrICE invited patients and their relatives to give their opinions, and all these items were incorporated into our potential list.

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CONCLUSIONS

In summary, by using consensus techniques, we have developed a list of core competencies for Chinese neurocritical care training that may serve as a reference for future specialist training programs.

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Contributors: LZ and JXZ conceived the study. Statistical design and analysis were done by ZC and YMW. ZC, LZ and JXZ drafted the initial version of the manuscript. ZC, LG, QBH, LHL, BHQ, GZS, XYY, YW, LZ (RN), YMW, LZ and JXZ participated NG meeting. All authors revised and approved the final version of the paper.

Funding: This study did not receive funding.

Competing interests: None declared.

Patient consent: Not required.

Data sharing statement: Data can be accessed by contacting the corresponding author on reasonable request.

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FIGURE LEGENDS

Figure 1. The study was conducted in three phases. In phase 1, a competencies list was generated and arranged during the first round of Delphi. In phase 2, five rounds of nominal group (NG) meetings were conducted to confirm the competencies list and levels of expertise. In phase 3, comments and iterative review were recirculated during the second round of Delphi.

Figure 2. The numbers of competencies categorized into seven different themes. The number of competencies entering the nominal group (NG) rating that were finally accepted are shown.

Figure 3. The intersection among the competencies list developed in the present study (n=198, blue circle) with other guidelines and statements, including the Competency Based Training in Intensive Care Medicine in Europe Collaboration (CoBaTrICE) (n=102, red circle), the Chinese Society of Critical Care Medicine (CSCCM) (n=129, green circle), the United Council for Neurologic Subspecialties (UCNS) (n=289, magenta circle) and the American Academy of Neurology (AAN) (n=66, orange circle).

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Table 1. The professional background of participants in Delphi

Specialist	First round Delphi	Second round Delphi
General intensivists	412 (37.7%)	49 (44.1%)
Neurosurgeons	244 (22.3%)	18 (16.2%)
Neurologists	139 (12.7%)	9 (8.2%)
Neuro-intensivists	95 (8.7%)	22 (19.8%)
Medical physicians (except neurologists)	53 (4.8%)	6 (5.4%)
Surgeons (except neurosurgeons)	25 (2.3%)	1 (0.9%)
Emergency physicians	20 (1.8%)	1 (0.9%)
Anesthesiologists	13 (1.2%)	1 (0.9%)
Rehabilitation physicians	4 (0.4%)	0
Nurses	70 (6.4%)	2 (1.8%)
Respiratory therapists	7 (0.6%)	1 (0.9%)
Medical students	12 (1.1%)	1 (0.9%)
Total	1094	111

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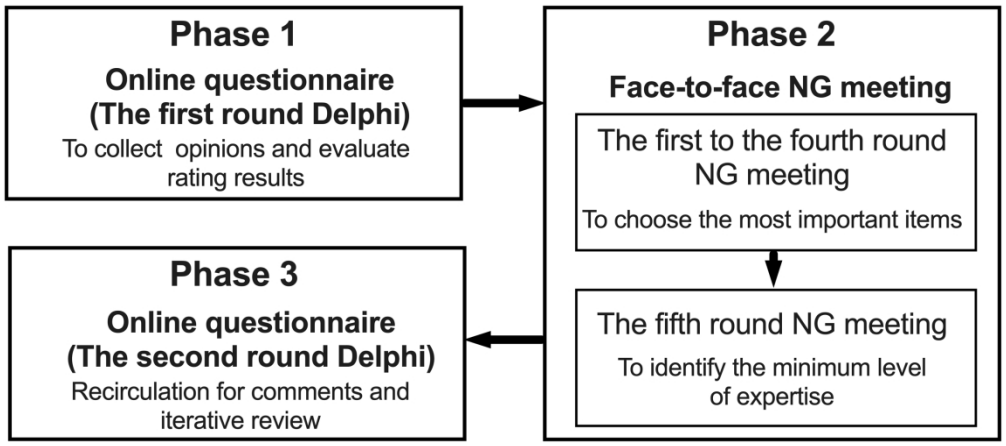

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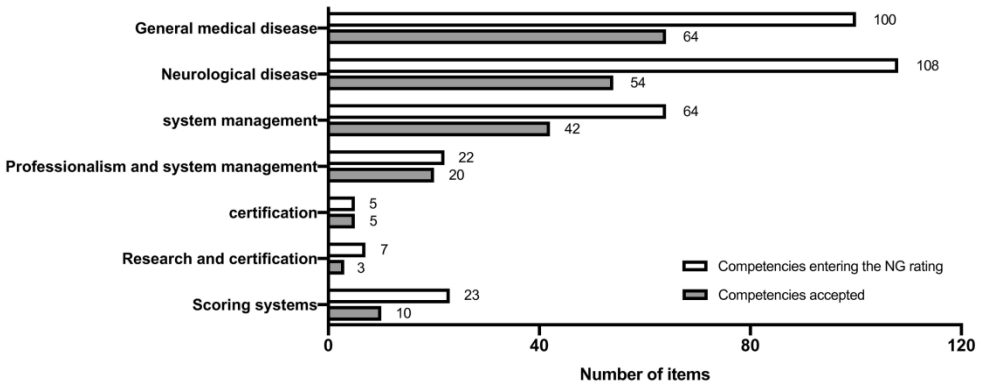

The numbers of competencies categorized into seven different themes. The number of competencies entering the nominal group (NG) rating that were finally accepted are shown.

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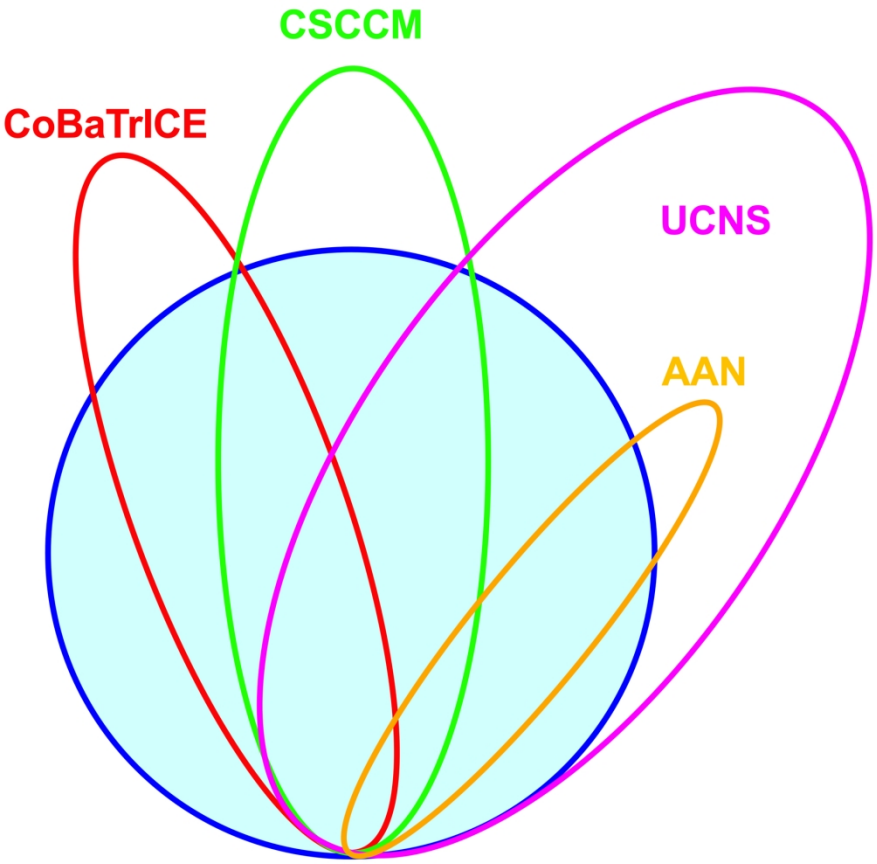

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Core competencies in neurocritical care training in China: consensus developed by a national Deiphi consensus survey combined with nominal group technique

Zhen Cui, MD, Liang Gao, MD, Qi-Bing Huang, MD, Li-Hong Li, MD, Bing-Hui Qiu, MD, Guang-Zhi Shi, MD, PhD, Xiang-You Yu, MD, Yan Wang, BS, Li Zhang, RN, Yu-Mei Wang, MD, Linlin Zhang, MD, PhD, Jian-Xin Zhou, MD, PhD, on behalf of the Working Group from Neuro-Critical Care Committee affiliated to the Chinese Association of Critical Care Physicians and the National Center for Healthcare Quality Management in Neurological Diseases.

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Online Supplementary Appendix 1

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Table S2. Constructing a competence statement

Table S3. Accepted items in the core competencies required for neurocritical care specialists and the supporting rate for each item

Table S4. Eliminated items during nominal group meeting

Table S1. The minimum level of expertise at the end of neurocritical care specialist training

Levels	Descriptions
a	Has knowledge of (describes) …
b	Performs (manages, conducts, demonstrates, assesses, interprets) … under supervision
c	Performs (manages, conducts, demonstrates, assesses, interprets) … independently
d	Teaches or supervises others to perform (manages) ...

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Table S2. Constructing a competence statement

Context	By the end of neurocritical care training, the trainee should be able to...			
Level of expertise	Level “a” Has knowledge of (describes)…	Level “b” Manages…under supervision	Level “c” Manages…independently	Level “d” Teaches or supervises others to perform (manage)...
	Describes...	Manages... Conducts... Demonstrates... Assesses... Interprets...		Teaches... Supervises...
Content of competence	...different types of shock...			

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Example	By the end of neurocritical care training, the trainee should be able to recognize and manage different types of shock independently.

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Table S3. Accepted items in the core competencies required for neurocritical care specialists and the supporting rate for each item

Domain	Competency statement	Online survey (%)	Source*	Agreement during round 1 to 4 NG rating (%)				Minimum level of expertise identified during round 5 NG meeting ‡
				Round 1	Round 2	Round 3	Round 4	
A. Neurological disease states								
	1. Cerebrovascular diseases							
	1.1. Manages infarction and ischemia							
	a. Massive hemispheric infarction	97.5	***U/A***	100				c
	b. Basilar artery occlusion and stenosis	95.2	***U/A***	100				c
	c. Carotid artery occlusion and stenosis	95.2	***U/A***	100				c
	d. Delayed cerebral ischemia	-	***O***	100				c
	1.2. Manages intracerebral hemorrhage							
	a. Supratentorial	94.7	***U/A***	91	100			c
	b. Cerebellar	97.0	***U/A***	100				c
	c. Brainstem	97.5	***U/A***	100				c
	d. Intraventricular	97.0	***U/A***	100				c

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e. Subarachnoid hemorrhage - aneurysmal and others	97.0	***U/A***	100		c
1.3 Manages arteriovenous malformations	95.6	***U***	100		c
1.4 Manages carotid-cavernous fistulae	80.9	***U***	100		c
1.5 Manages cervical and cerebral arterial dissections under supervision	88.3	***U***	100		b
2. Neurotrauma					
2.1 Manages traumatic brain injury					
a. Axonal shearing injury	85.8	***U/A***	91	100	c
b. Epidural hematoma	96.1	***U/A***	100		c
c. Subdural hematoma	96.3	***U/A***	100		c
d. Contusions and lacerations	95.7	***U/A***	100		c
e. Penetrating craniocerebral injuries	92.4	***U/A***	100		c
f. Traumatic SAH	95.8	***U/A***	100		c
2.2. Manages spinal cord injury	95.1	***U/A/C***	100		c
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3.1 Manages convulsive status epilepticus	97.8	***U/A/C***	100		c
3.2 Manages nonconvulsive status epilepticus	89.0	***U/A/C***	100		c
3.3 Manages myoclonic epilepsy	91.7	***U/A/C***	100		c
4. Neuromuscular diseases					
4.1 Manages myasthenia gravis	94.5	***U/A***	100		c
4.2 Manages Guillain-Barré syndrome	88.3	***U/A***	100		c
5. Infections					
5.1 Manages encephalitis (viral, bacterial, parasitic)	97.5	***U/A/C***	100		c
5.2 Manages meningitis (viral, bacterial, parasitic)	98.5	***U/A/C***	100		c
5.3 Manages brain and spinal epidural abscess under supervision	93.6	***U/C***	100		b
6. Toxic-metabolic disorders					
6.1 Manages drug overdose and withdrawal	90.3	***U/C/E***	91	100	c
6.2 Manages temperature-related injuries	93.6	***U***	91	100	c
6.3 Manages carbon monoxide poisoning and delayed encephalopathy	-	***O***	73	100	c

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7.Inflammatory and demyelinating diseases					
7.1 Manages central pontine myelinolysis	78.8	***U***	73	100	c
7.2 Manages osmotic demyelination syndrome	-	***O***	64	100	c
8. Encephalopathies					
8.1 Manages hepatic encephalopathy	91.9	***U***	100		c
8.2 Manages hypoxic-ischemic encephalopathy	97.8	***U***	100		c
8.3 Manages metabolic encephalopathy	-	***O***	100		c
8.4 Manages hypertensive encephalopathy and posterior reversible encephalopathy syndrome	95.3	***U***	91	100	c
9. Neuroendocrine disorders					
9.1 Manages pituitary apoplexy	94.6	***U***	100		c
9.2 Manages diabetes insipidus	95.5	***U***	100		c
10. Manages movement disorders (severe dystonia and opisthotonos)	91.6	***U***	100		c
11. Clinical syndromes					
11.1 Teaches or supervises others in the Manages coma	98.5	***U/A/C***	100		d

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11.2 Manages herniation syndromes	98.2	***U/A***	100		c
11.3 Manages elevated intracranial pressure	97.7	***U/C***	100		c
11.4 Manages intracranial hypotension/hypovolemia	95.9	***U***	100		c
11.5 Manages hydrocephalus	95.4	***U/A***	100		c
11.6 Manages delirium	98.1	***U/A***	100		c
12.Manages perioperative neurosurgical care					
12.1 Manages postcraniotomy hypertension	96.1	***U***	100		c
12.2 Manages postcraniotomy pain	93.3	***U***	100		c
12.3 Manages wound cerebrospinal fluid leaks	94.8	***U***	91	100	c
12.4 Manages wound infections	95.6	***U***	100		c
12.5 Manages postoperative brain edema	96.8	***U/A***	100		c
12.6 Manages postcraniotomy intracranial hemorrhage	96.3	***U***	100		c
12.7 Assesses and manages postcervical spine surgery airway	92.1	***U***	100		c
12.8 Assesses and manages high-risk	96.8	***U/C/E***	100		c

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neurosurgical patient postoperative					
13. Conducts neurorehabilitation	88.0	***U***	73	100	c
B. General medical disease states					
1. Cardiovascular					
1.1 Recognizes and manages different types of shock	96.7	***U/C/E***	100		c
1.2 Recognizes and manages myocardial infarction and unstable coronary syndromes	93.3	***U/C***	100		
1.3 Recognizes and manages neurogenic cardiac disturbances (electrocardiographic changes, stunned myocardium)	93.6	***U***	100		c
1.4 Assesses and manages life-threatening arrhythmia	94.7	***U/C/E***	100		c
1.5. Recognizes and manages left ventricular failure and/or acute pulmonary edema	95.0	***U/C***	100		c
1.6. Recognizes and manages neurogenic pulmonary edema	94.7	***U***	100		c
1.7 Recognizes and manages hypertension crisis	96.2	***U/C***	100		c

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1.8 Performs and interprets cardiac output and hemodynamic monitor	92.3	***U/A/C/E***	100			c
1.9 Performs electrocardiography and interprets the results	94.1	***C/E***	91	100		c
2. Respiratory						
2.1 Assesses and manages acute and chronic respiratory failure (type I and type II)	97.8	***U/C***	100			c
2.2 Manages chronic obstructive pulmonary disease and status asthmaticus under supervision	94.2	***U/C***	91	91	100	b
2.3 Recognizes (diagnosis and grading) and manages acute respiratory distress syndrome	96.7	***U/C/E***	100			c
2.4 Manages aspiration	96.1	***U***	100			c
2.5 Recognizes and manages upper airway obstruction	96.5	***U/C***	100			c
2.6 Recognizes and manages bronchopulmonary infections	97.4	***U***	100			c
2.7 Recognizes and manages pleural diseases (empyema, effusion, pneumothorax)	92.4	***U/C***	91	100		c
2.8 Recognizes and manages neurogenic breathing patterns (central hyperventilation, Cheyne-Stokes	95.9	***U***	91	100		c

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respirations, etc)				
2.9 Assesses and manages thromboembolic disease (including pulmonary embolism) under supervision	95.4	***C***	100	b
2.10 Interprets chest radiographs	95.0	***U/C/E***	100	c
2.11 Interprets chest CT image	96.1	***C***	100	c
2.12 Performs and interprets end tidal CO_2 monitoring	92.0	***U***	100	c
2.13 Performs and interprets arterial blood gas analysis	98.2	***C/E***	100	c
2.14 Manages noninvasive and invasive mechanical ventilation: indication, rationale, complication, and weaning	97.8	***U/A/C/E***	100	c
3. Renal				
3.1 Assesses and manages fluid, electrolytes disorders	98.2	***U/C/E***	100	c
3.2 Recognizes (diagnosis and grading) and manages acute kidney injury	95.8	***U/C/E***	100	c
3.3 Recognizes and manages derangements secondary to alterations in osmolality and	96.3	***U***	100	c

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electrolytes					
3.4 Manages acid–base disorders	97.9	***U/A/C***	100		c
3.5 Manages oliguria and polyuria	97.0	***U***	100		c
3.6 Manages rhabdomyolysis under supervision	96.5	***U***	91	100	b
3.7 Conducts drug dose adjustment in renal failure	93.9	***U/C***	91	100	c
3.8 Manages cerebral salt wasting	96.3	***U***	100		c
3.9 Manages syndrome of inappropriate antidiuretic hormone	98.2	***U***	91	100	c
4. Metabolic and endocrine effects of critical illness					
4.1 Manages diabetes mellitus (ketotic and hyperglycemic hyperosmolar coma, hypoglycemia)	97.7	***U/C***	100		c
4.2 Manages systemic inflammatory response syndrome	93.5	***U***	100		c
4.3 Performs enteral/parenteral nutritional support	97.7	***U/A/C/E***	100		c
4.4 Manages pituitary crisis under supervision	-	***O***	73	100	b
5. Infectious disease					
5.1 Complies with infection control measures	97.0	***U/C/E***	100		c

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5.2 Performs antimicrobial agent selection and determines dose in critically ill patients	97.1	***U/C/E***	100		c
5.3 Manages hospital acquired and opportunistic infections in the critically ill patient	97.8	***U/A/C***	100		c
5.4 Assesses and manages fever in critically ill patient	97.2	***U/C***	91	100	c
5.5 Conducts interpretation of antibiotic concentrations and sensitivities	96.9	***U/E***	100		c
5.6 Recognizes and manages sepsis, severe sepsis, and septic shock	95.2	***C/E***	100		c
5.7 Recognizes and manages multi-drug resistance bacteria infection	-	***O***	100		c
5.8 Performs antimicrobial agent selection in neurological infections	-	***O***	100		c
6. Acute hematologic disorders					
6.1 Manages disseminated intravascular coagulation under supervision	97.3	***U/C***	100		b
6.2 Conducts anticoagulation and fibrinolytic therapy	96.8	***U/A/C***	100		c

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6.3 Conducts blood component therapy	96.4	***U/C/E***	91	100	c
6.4 Conducts hemostatic therapy	96.8	***U***	100		c
6.5 Recognizes and manages hypercoagulable states under supervision	95.8	***U***	82	100	b
6.6 Recognizes and manages traumatic coagulopathy	94.5	***C***	91	100	c
7. Acute gastrointestinal and genitourinary disorders					
7.1 Assesses and manages gastrointestinal bleeding	97.7	***U/C***	91	100	c
7.2 Prescribes stress ulcer prophylaxis	96.4	***C***	91	100	c
7.3 Assesses and manages abdominal compartment syndrome	96.4	***U/C***	82	100	c
8. Immunology and transplantation					
8.1 Interprets principles of transplantation (brain death, organ donation, procurement, maintenance of organ donors, implantation) under supervision	85.5	***U/A/E***	73	100	b
9. General trauma and burns					

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9.1 Assesses and provides initial management of trauma patient	93.8	***U/C/E***	91	100		c
9.2 Manages spine and pelvis trauma	91.0	***U***	82	100		c
9.3 Manages chest and abdominal trauma	91.0	***U***	91	100		c
9.4 Manages crush syndrome	-	***O***	91	100		c
9.5 Describes burns and electrical injury	86.4	***U/E***	64	82	100	a
10. Transport						
10.1 Teaches or supervises patient assessment before transport	97.4	***C/E***	100			d
10.2 Prepares equipment for transport	95.9	***C***	100			c
10.3 Performs intrahospital transport	96.8	***C***	100			c
11.Others						
11.1 Assesses and manages multiorgan dysfunction syndrome	93.5	***C***	100			c
11.2 Manages ICU acquired weakness under supervision	-	***O***	82	100		b

C. Critical care monitoring practical procedures

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1. Monitoring					
1.1 Performs neuromonitoring	96.1	***U***	100		c
1.2 Interprets principles of ECG monitoring	98.2	***U***	100		c
1.3 Performs and interprets invasive hemodynamic monitor	95.2	***U/C***	100		c
1.4 Performs and interprets noninvasive hemodynamic monitor	95.4	***U/C***	100		c
1.5 Performs and interprets respiratory mechanics monitor under supervision	95.4	***U/C***	100		b
1.6 Performs and interprets metabolic monitoring under supervision (oxygen consumption, carbon dioxide production, respiratory quotient)	94.3	***U***	100		b
1.7 Conducts multimodality monitoring in NICU	95.2	***U***	91	100	c
2. General critical care practical procedures and therapeutic interventions					
2.1 Performs arterial catheterization	96.2	***U/A/C/E***	73	100	c
2.2 Teaches or supervises others central venous catheter insertion	96.4	***U/A/C/E***	100		d
2.3 Conducts vasoactive/inotropic medication therapy	97.4	***U/C/E***	100		c

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2.4 Teaches or supervises others to perform cardiopulmonary resuscitation, postresuscitation brain protection, to provide advanced life support for postresuscitation patient	98.2	***U/C/E***	100		d
2.5 Teaches or supervises others to perform cardioversion and defibrillation	98.1	***C/E***	100		d
2.6 Performs airway maintenance and ventilation in nonintubated/unconscious patients	97.4	***U/A/C/E***	100		c
2.7 Performs tracheal intubation	96.7	***U/A/C***	100		c
2.8 Performs difficult and failed airway management	90.7	***E***	100		c
2.9 Performs and interprets intra-abdominal pressure monitor	88.6	***C***	73	100	c
2.10 Teaches or supervises others to perform tracheal aspiration	94.9	***C/E***	82	100	d
2.11 Teaches or supervises others to perform oxygen therapy	97.4	***C/E***	100		d
2.12 Performs fibreoptic bronchoscopy and bronchoalveolar lavage in the intubated patient under supervision	92.0	***U /E***	91	100	b
2.13 Explains and performs recruitment maneuver: principle and practice under supervision	93.4	***C***	100		b

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2.14 Performs thoracocentesis via a chest drain	91.0	***U/C/E***	100			c
2.15 Performs percutaneous tracheostomy	91.2	***U/E***	100			c
2.16 Performs bedside ultrasound to localize pleural effusion and ascites under supervision	89.9	***C***	73	82	100	b
2.17 Assesses inferior caval vein by ultrasound under supervision	-	***O***	82	91	100	b
2.18 Performs ultrasound techniques for vascular localization	89.9	***E***	73	82	100	c
2.19 Performs thyrocricocentesis under supervision	-	***O***	82	91	100	b
3. Neurocritical care practical procedures and therapeutic interventions						
3.1 Performs lumbar puncture	93.8	***U/A/C/E***	100			c
3.2 Performs shunt and ventricular drain tap for CSF sampling	94.1	***U***	100			c
3.3 Manages external ventricular drains	93.8	***U***	100			c
3.4 Assesses and manages pain of neurocritical care patients	96.2	***U/A/C/E***	100			c
3.5 Assesses sedation and describes principle	97.0	***U/A/C***	100			c
3.6 Interprets and manages of ICP and cerebral perfusion	94.5	***U/A***	100			c

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pressure data						
3.7 Interprets of saturation of jugular venous oxygenation and brain tissue oxygen data under supervision	86.9	***U***	73	100		b
3.8 Performs systemic moderate hypothermia under supervision	95.4	***U***	100			b
3.9 Manages fluid and conducts osmotic dehydration treatment	96.3	***O***	100			c
3.10 Performs and interprets cerebral multimodality monitoring (pH, partial pressure of carbon dioxide, laser Doppler, microdialysis) under supervision	89.9	***U/A***	82	100		b
3.11Performs lumbar drain insertion	84.2	***U***	82	100		c
3.12 Manages and inserts ICP monitoring	87.4	***U/A***	82	100		c
3.13 Manages cerebral oximetric or perfusion monitoring under supervision	90.1	***U/A***	91	100		b
3.14 Performs brain ventricle puncture under supervision	-	***O***	91	100		b
3.15 Interprets CT/MRI of nervous system under supervision	94.8	***U***	73	82	100	b
3.16 Chooses neuromuscular blockade and describes indication of it under supervision	88.6	***C/E***	82	82	100	b

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D. Professionalism and system management					
1. Gather accurate, essential information from all sources, including medical interviews, physical examinations, medical records and Laboratory and radiological results	96.7	***U/C/E***	100		c
2. Integrates clinical findings with laboratory investigations to form a differential diagnosis	97.1	***U/C/E***	100		c
3. Involves patients (or their surrogates if applicable) in decisions about care and treatment (including informed consent and end-of-life care)	96.9	***U/A/C/E***	100		c
4. Promotes collaborative practice principles, including multidisciplinary cooperation and effective team working	97.0	***U/E***	100		c
5. Ensures continuity of care through effective handover of clinical information	97.7	***C/E***	100		c
6. Describes implications of chronic and comorbid disease in the acutely ill patient	93.5	***C/E***	91	100	c
7. Seeks learning opportunities and integrates new knowledge into clinical practice	98.2	***U/C/E***	100		c
8. Applies knowledge to clinical problem solving, clinical decision making, and critical thinking.	98.3	***U/E***	100		c
9. Develops a clinically applicable knowledge of the basic	98.1	***U***	100		c

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and clinical sciences that underlie the practice of neurointensive care					
10. Provides effective and professional consultation to physicians and health care professionals of other specialty	97.5	***U***	100		c
11. Maintains accurate medical records and documentation	97.5	***U/C/E***	100		c
12. Communicates the continuing care requirements of patients at ICU discharge to health care professionals, patients and relatives	96.9	***E***	100		b
13. Manages the safe and timely discharge of patients from ICU	93.5	***C/E***	100		c
14. Identifies and minimizes risk of critical incidents and adverse events	97.5	***C/E***	100		c
15. Recognizes and identifies deficiencies in peer performance	96.9	***U***	91	100	c
16. Identifies environmental hazards and promotes safety for patients and staff	97.3	***C/E***	82	100	c
17. Communicates effectively with patients, relatives and members of the healthcare team	98.6	***U/C/E***	100		c
18. Respects privacy, dignity, confidentiality, and legal constraints on the use of patient data	98.3	***U/C/E***	100		c

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19. Demonstrates sensitivity and responsiveness to gender, age, culture, religion, sexual preference, socioeconomic status, beliefs, behaviors and an awareness of their impact on decision making	97.5	***U/E***	100	c
20. Demonstrates respect, compassion, integrity, and altruism in relationships with patients, families, and colleagues.	97.9	***U***	100	c
E. Ethical and legal aspects of critical care medicine				
1. Evaluates death and dying, performs brainstem death testing under supervision	98.0	***U/A/E***	100	b
2. Manages palliative care of the critically ill patient, forgos life-sustaining treatment and orders not to resuscitate under supervision	96.7	***U/E***	100	b
3. Applies and describes practice to minimizes the physical and psychosocial consequences of critical illness for patients and families under supervision	96.4	***C/E***	100	b
4. Formulates clinical decisions with respect for ethical and legal principles	96.7	***U/C/E***	100	c
5. Adheres to principles of confidentiality, scientific/academic integrity, and informed consent.	96.8	***U***	100	c
F. Principles of research and certification				

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1. Presentation preparation and skills	90.7	***U***	73	100	c
2. Certification					
2.1 Basic life support	96.2	***C***	100		d
2.2 Advanced cardiac life support	97.0	***C***	100		c
G. Scoring systems					
1. General status scoring					
1.1 Acute physiology and chronic health evaluation II	95.1	***C***	100		c
1.2 Simplified acute physiology score II	89.2	***C***	73	100	c
2. Organs scoring:					
2.1 Acute kidney injury scoring (KDIGO)	90.6	-	73	100	c
2.2 Sequential organ failure assessment	89.5	***C***	91	100	c
3. Sedation, pain and delirium scoring:					
3.1 Critical care pain observation tool	91.3	-	100		d
3.2 Richmond agitation-sedation scale	94.9	-	100		c
3.3 The confusion assessment method for the diagnosis of delirium in the ICU	92.8	-	100		c

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3.4 Self-rating anxiety scale	94.6	***O***	100		c
4. Neural system scoring					
4.1 Glasgow coma scale	97.0	-	100		d
4.2 National institute of health stroke scale	89.8	***O***	82	100	c

* Source of list: ***U***: United Council for Neurologic Subspecialties, ***A***: American Academy of Neurology, ***C***: Chinese College of Intensive and Critical Care Medicine, ***E***: Competency-based Training Programme in ICM for Europe, ***O***: Online Delphi, **-**: during generation and rearrangement of competencies list before the first round of Delphi.

‡ Minimum level of expertise identified during the fifth round nominal group (NG) meeting:

Level a: Has knowledge of (describes) …

Level b: Performs (manages, conducts, demonstrates, assesses, interprets) … under supervision

Level c: Performs (manages, conducts, demonstrates, assesses, interprets) … independently

Level d: Teaches or supervises others to perform (manages) ...

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Table S4. Eliminated items during nominal group meeting

Domain	Eliminated items	Median (IQR) in the fourth round NG rating
A. Neurological disease states		
	1. Cerebrovascular diseases	
	1.1 Infarction and ischemia	
	a. Transient ischemic attacks aggravate	4 (4, 5)
	b. Occlusive vasculopathies (Moya-Moya, sickle cell)	4 (4, 5)
	c. Spinal cord infarction	4 (2, 4)
	1.2. Vascular malformations	
	a. AV fistulas	5 (4, 5)
	b. Cavernous angiomas	4 (4,5)
	c. Venous angiomas	4 (4, 5)
	1.3 Dural sinus thrombosis	5 (4, 5)
	1.4 Cerebral amyloid angiopathy	5 (4, 5)
	1.5 Stroke mimics	3 (2, 4)
	1.6 Traumatic aneurysm	5 (4, 5)

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2. Neurotrauma	
2.1 Traumatic brain injury	
a. Skull fracture	5 (5, 5)
b. Fat emboli	5 (3, 5)
3. Neuromuscular diseases	
3.1 Amyotrophic lateral sclerosis	4 (3, 4)
3.2 Rhabdomyolysis and toxic myopathies	5 (4, 5)
3.3 Critical illness myopathy and neuropathy	5 (4, 5)
3.4 Multiple sclerosis	4 (2, 4)
3.5 Mitochondrial encephalomyopathy	2 (1, 4)
3.6 Hypokalemic periodic paralysis	4 (2, 4)
4. Infections	
4.1 Tetanus	4 (4, 5)
4.2 Botulism	3 (3, 4)
5. Toxic-metabolic disorders	
5.1 Neuroleptic malignant syndrome/malignant hyperthermia	5 (4, 5)

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5.2 Serotonin syndrome	2 (2, 3)
5.3 Wernicke's encephalopathy	3 (2, 4)
6. Inflammatory and demyelinating diseases	
6.1 Multiple sclerosis	4 (3, 4)
6.2 Neurosarcoidosis	4 (2, 5)
6.3 Acute disseminated encephalomyelitis	4 (3, 5)
6.4 Central nervous system vasculitis	4 (2, 5)
6.5 Chemical or sterile meningitis (i.e., posterior fossa syndrome, nonsteroidal antiinflammatory drug-induced)	4 (2, 5)
6.6 Autoimmune encephalitis	4 (4, 5)
7.Encephalopathies	
7.1 Eclampsia, including hemolysis, elevated liver enzymes, low platelet count syndrome	5 (5, 5)
7.2 Uremic encephalopathy	5 (4, 5)
7.3 Mitochondrial encephalopathy, lactic acidosis, and stroke like (episodes) and related disorders	4 (2, 5)
7.4 Creutzfeldt-jakob encephalopathy	3 (2, 4)
8.Neuroendocrine disorders	
8.1 Panhypopituitarism	4 (4, 5)

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8.2 Multinle endocrine neoplasia	3 (2, 4)
9. Movement disorders	
9.1 Hemiballismus	2 (1, 4)
9.2 Acute dystonic reactions	3 (1, 4)
9.3 Amyotrophic lateral sclerosis	4 (2, 4)
10. Clinical Syndromes	
10.1 Vegetative state	5 (5, 5)
10.2 Abulia	5 (5, 5)
10.3 Dysautonomia (central fever, hyperventilation, etc)	5 (5, 5)
10.4 Psychiatric emergencies	5 (4, 5)
10.5 Locked-in syndrome	4 (3, 5)
10.6 Cord compression	5 (4, 5)
10.7 Brain death	5 (4, 5)
11. Perioperative neurosurgical care	
11.1 Intracranial pneumatosis	5 (4, 5)
11.2 Postcraniotomy CSF hypovolemia	5 (5, 5)

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	11.3 Postcarotid endarterectomy/stenting hyperperfusion syndrome	5 (4, 5)
	12. Neuro-Oncology	
	12.1 Brain tumors and metastases	5 (5, 5)
	12.2 Spinal cord tumors and metastases	4 (4, 5)
	12.3 Carcinomatous meningitis	3 (2, 4)
	12.4 Paraneoplastic syndromes	4 (2, 4)
	13. Pharmacotherapeutics	5 (4, 5)
B. General medical disease states		
	1. Cardiovascular	
	1.1 Acute aortic and peripheral vascular disorders (i.e., dissection, pseudoaneurysm)	5 (4, 5)
	1.2 Rupture of aneurysm (bleeding and cardiac tamponade)	5 (4, 5)
	1.3 Acute myocarditis	4 (2, 5)
	1.4 Cardiac-cerebralsyndrome	4 (4, 5)
	1.5 Right heart failure	5 (4, 5)
	2. Respiratory	
	2.1 Pulmonary hemorrhage and massive hemoptysis	5 (5, 5)

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2.2 Sleep apnea	4 (2, 5)
2.3 Obesity-hypoventilation syndrome	4 (2, 4)
2.4 Smoke inhalation, airway burns	4 (2, 5)
3. Renal	
3.1 Critically ill patients with chronic renal failure	4 (4, 5)
3.2 Continuous renal replacement therapy	5 (3, 5)
4. Metabolic and endocrine effects of critical illness	
4.1 Thyroid storm	5 (4, 5)
4.2 Adrenal crisis	5 (4, 5)
4.3 Pheochromocytoma	4 (4, 5)
4.4 Disorders of calcium and magnesium balance	5 (3, 5)
4.5 Hypothyroidism	4 (4, 5)
4.6 Low serum T3 syndrome	3 (2, 5)
5. Infectious disease	
5.1 Severe community acquired infection (e.g., severe community-acquired pneumonia)	4 (4, 5)
5.2 HIV/AIDS	4 (3, 5)

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5.3 Atypical pathogens and viral infections	4 (4, 5)
5.4 Fever in critically ill patient	5 (4, 5)
6. Acute hematologic disorders	
6.1 Acute hemolytic disorders including thrombotic microangiopathies	5 (4, 5)
7. Acute GI and genitourinary disorders	
7.1 Acute and fulminant hepatic failure (including drug dosing)	5 (4, 5)
7.2 Ileus and toxic megacolon	4 (3, 5)
7.3 Acute perforations of the gastrointestinal tract	4 (4, 5)
7.4 Acute vascular disorders of the intestine, including mesenteric infarction	4 (3, 5)
7.5 Acute intestinal obstruction, volvulus	4 (3, 5)
7.6 Pancreatitis	4 (4, 5)
7.7 Urinary tract bleeding	4 (3, 5)
7.8 Obstructive uropathy, acute urinary retention	4 (3, 5)
7.9 Intra-abdominal infection and gastrointestinal leakage	5 (4, 5)
8. Immunology and transplantation	
8.1 Immunosuppression, especially the neurotoxicity of these agents	3 (2, 5)

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9.Others	
9.1 Acute illness in pregnancy	5 (4, 5)
9.2 Acute illness in pediatric	4 (3, 5)
9.3 Initial approach to the manages multisystem trauma	5 (4, 5)
9.4.ICU sleep disorders	5 (4, 5)
C. Critical care monitoring practical procedures	
1. General critical care practical procedures and therapeutic interventions	
1.1 Peripheral venous line placement	5 (4, 5)
1.2 Nasogastric tube placement	4 (3, 5)
1.3 Urinary catheterization	4 (3, 5)
1.4 Administration of nitric oxide or prostacyclin	3 (2, 4)
1.5 Fibreoptic laryngoscopy	4 (4, 5)
1.6 Echocardiography	4 (4, 5)
1.7 Pulmonary ultrasonography	4 (4, 5)
1.8 Percutaneous gastrostomy	2 (1, 4)
1.9 Extracorporeal membrane oxygenation and other circulatory support systems	3 (2, 5)

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1.10 Enteral nutrititon nasogastrojejunal tube placement	5 (4, 5)
1.11 Pericardiocentesis	4 (3, 5)
1.12 Sengstaken tube (or equivalent) placement	3 (3, 5)
1.13 Indications for gastroscopy	4 (4, 5)
2. Neurocritical care practical procedures and therapeutic interventions	
2.1 Interpretation of continuous electroencephalogram monitoring	5 (4, 5)
2.2 Jugular venous bulb catheterization	4 (3, 5)
2.3 Plasmapheresis and intravenous immunoglobulin	4 (4, 5)
2.4 Administration of intravenous and intraventricular thrombolysis	4 (3, 5)
2.5 Intrathecal administration of chemotherapy, and radiographic agents	5 (4, 5)
2.6 Nervous system ultrasound	4 (3, 5)
2.7 Interpretation of single photon emission-CT and positron emission tomography	3 (2, 3)
2.8 Positron emission tomography	3 (2, 3)
2.9 Endovascular neurosurgical training (e.g., Guglielmi detachable coil placement, arterial stenting, cerebral angioplasty, intraarterial thrombolysis)	3 (2, 4)
D. Professionalismand system management	

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1. Describes and explains the managerial and administrative responsibilities of the ICM specialist	5 (4, 5)
2. Medical economics: health care reimbursement, budget development	4 (4, 5)
F. Principles of research and certification	
1. Study design	4 (4, 5)
2. Biostatistics	4 (4, 5)
3. Grant funding and protocol writing	4 (4, 4)
4. Manuscript preparation	4 (4, 5)
5. Institutional review boards and health insurance portability and accountability act	4 (3, 5)
G. Scoring systems	
1.General status scoring:	
1.1 Therapeutic Intervention Scoring System	4 (4, 4)
1.2 Multiple organ dysfunction score	4 (3, 5)
2. Organs scoring:	
2.1 Killip class	4 (4, 5)
2.2 NYHA class	5 (4, 5)
2.3 Acute lung injury scoring	4 (4, 5)

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2.4 The Child-Pugh score	4 (4, 4)
2.5 Acute kidney injury scoring (AKIN, RIFLE)	4 (3, 5)
2.6 Acute pancreatitis scoring	4 (4, 5)
3. Sedation, pain and delirium scoring:	
3.1.Ramsay sedation score	4 (2, 5)
3.2 CHADS-2 risk scores in chronic atrial fibrillation	4 (3, 5)
4. Trauma scoring	
4.1 Injury severity score	4 (4, 5)
4.2 Abbrebiated injury scale	4 (4, 5)

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Core competencies in neurocritical care training in China: consensus developed by a national Deiphi consensus survey combined with nominal group technique

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Online Supplementary Appendix 2

Appendix

Final set of core competencies required for neurocritical care specialist training

A. Neurological disease states

1. Cerebrovascular diseases

1.1. By the end of neurocritical care training, the trainee should be able to manage infarction and ischemia independently

1.1.1. Massive hemispheric infarction

1.1.1. Basilar artery occlusion and stenosis

1.1.1. Carotid artery occlusion and stenosis

1.1.1. Delayed cerebral ischemia

1.2. By the end of neurocritical care training, the trainee should be able to manage intracerebral hemorrhage independently

1.2.1. Supratentorial

1.2.2. Cerebellar

1.2.3. Brainstem

1.2.4. Intraventricular

1.2.5 Subarachnoid hemorrhage - aneurysmal and others

1.3. By the end of neurocritical care training, the trainee should be able to manage arteriovenous malformations independently

1.4. By the end of neurocritical care training, the trainee should be able to manage carotid-cavernous fistulae independently

1.5. By the end of neurocritical care training, the trainee should be able to manage cervical and cerebral arterial dissections under supervision

2. Neurotrauma

2.1. By the end of neurocritical care training, the trainee should be able to manage traumatic brain injury independently

2.1.1. Axonal shearing injury

2.1.2. Epidural hematoma

2.1.3. Subdural hematoma

2.1.4. Contusions and lacerations

2.1.5. Penetrating craniocerebral injuries

2.1.6. Traumatic SAH

2.2 By the end of neurocritical care training, the trainee should be able to manage spinal cord injury independently

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3. Status epilepticus

3.1. By the end of neurocritical care training, the trainee should be able to manage convulsive status epilepticus independently

3.2. By the end of neurocritical care training, the trainee should be able to manage nonconvulsive status epilepticus independently

3.3. By the end of neurocritical care training, the trainee should be able to manage myoclonic epilepsy independently

4. Neuromuscular diseases

4.1. By the end of neurocritical care training, the trainee should be able to manage myasthenia gravis independently

4.2. By the end of neurocritical care training, the trainee should be able to manage Guillain-Barré syndrome independently

5. Infections

5.1. By the end of neurocritical care training, the trainee should be able to manage encephalitis (viral, bacterial, parasitic) independently

5.2. By the end of neurocritical care training, the trainee should be able to manage meningitis (viral, bacterial, parasitic) independently

5.3. By the end of neurocritical care training, the trainee should be able to manage brain and spinal epidural abscess under supervision

6. Toxic-metabolic disorders

6.1. By the end of neurocritical care training, the trainee should be able to manage drug overdose and withdrawal independently

6.2. By the end of neurocritical care training, the trainee should be able to manage temperature-related injuries independently

6.3. By the end of neurocritical care training, the trainee should be able to manage carbon monoxide poisoning and delayed encephalopathy independently

7. Inflammatory and demyelinating diseases

7.1. By the end of neurocritical care training, the trainee should be able to manage central pontine myelinolysis independently

7.2. By the end of neurocritical care training, the trainee should be able to manage osmotic demyelination syndrome independently

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8. Encephalopathies

8.1. By the end of neurocritical care training, the trainee should be able to manage hepatic encephalopathy independently

8.2. By the end of neurocritical care training, the trainee should be able to manage hypoxic-ischemic encephalopathy independently

8.3. By the end of neurocritical care training, the trainee should be able to manage metabolic encephalopathy independently

8.4. By the end of neurocritical care training, the trainee should be able to manage hypertensive encephalopathy and posterior reversible encephalopathy syndrome (PRES) independently

9. Neuroendocrine disorders

9.1. By the end of neurocritical care training, the trainee should be able to manage pituitary apoplexy independently

9.2. By the end of neurocritical care training, the trainee should be able to manage diabetes insipidus independently

10. Movement disorders

10.1. By the end of neurocritical care training, the trainee should be able to manage movement disorders (severe dystonia and opisthotonos) independently

11. Clinical syndromes

11.1. By the end of neurocritical care training, the trainee should be able to teach or supervise others to manages coma

11.2. By the end of neurocritical care training, the trainee should be able to manage herniation syndromes independentl

11.3. By the end of neurocritical care training, the trainee should be able to manage elevated intracranial pressure independently

11.4. By the end of neurocritical care training, the trainee should be able to manage intracranial hypotension/ hypovolemia independently

11.5. By the end of neurocritical care training, the trainee should be able to manage hydrocephalus independently

11.6. By the end of neurocritical care training, the trainee should be able to manage delirium independently

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12. Perioperative neurosurgical care

12.1. By the end of neurocritical care training, the trainee should be able to manage postcraniotomy hypertension independently

12.2. By the end of neurocritical care training, the trainee should be able to manage postcraniotomy pain independently

12.3. By the end of neurocritical care training, the trainee should be able to manage wound cerebrospinal fluid (CSF) leaks independently

12.4. By the end of neurocritical care training, the trainee should be able to manage wound infections independently

12.5. By the end of neurocritical care training, the trainee should be able to manage postoperative brain edema independently

12.6. By the end of neurocritical care training, the trainee should be able to manage postcraniotomy intracranial hemorrhage independently

12.7. By the end of neurocritical care training, the trainee should be able to assess and manage postcervical spine surgery airway independently

12.8. By the end of neurocritical care training, the trainee should be able to assess and manage high-risk postoperative neurosurgical patient independently

13. By the end of neurocritical care training, the trainee should be able to conduct neurorehabilitation independently

B. General medical disease states

1. Cardiovascular

1.1. By the end of neurocritical care training, the trainee should be able to recognize and manage different types of shock independently

1.2. By the end of neurocritical care training, the trainee should be able to recognize and manage myocardial infarction and unstable coronary syndromes independently

1.3. By the end of neurocritical care training, the trainee should be able to recognize and manage neurogenic cardiac disturbances (electrocardiographic changes, stunned myocardium) independently

1.4. By the end of neurocritical care training, the trainee should be able to assess and manage life-threatening arrhythmia independently

1.5. By the end of neurocritical care training, the trainee should be able to recognize and manage left ventricular failure and/or acute pulmonary edema independently

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1.6. By the end of neurocritical care training, the trainee should be able to recognize and manage neurogenic pulmonary edema independently

1.7. By the end of neurocritical care training, the trainee should be able to manage hypertension crisis independently

1.8. By the end of neurocritical care training, the trainee should be able to perform and interpret cardiac output and hemodynamic monitor independently

1.9. By the end of neurocritical care training, the trainee should be able to perform electrocardiography and interpretsthe results independently

2. Respiratory

2.1. By the end of neurocritical care training, the trainee should be able to assess and manage acute and chronic respiratory failure (type I and type II) independently

2.2. By the end of neurocritical care training, the trainee should be able to manage chronic obstructive pulmonary disease (COPD) and status asthmaticus under supervision

2.3. By the end of neurocritical care training, the trainee should be able to recognize (diagnosis and grading) and manage acute respiratory distress syndrome (ARDS) independently

2.4. By the end of neurocritical care training, the trainee should be able to manage aspiration independently

2.5. By the end of neurocritical care training, the trainee should be able to recognize and manage upper airway obstruction independently

2.6. By the end of neurocritical care training, the trainee should be able to recognize and manage bronchopulmonary infections independently

2.7. By the end of neurocritical care training, the trainee should be able to recognize and manage pleural diseases (empyema, effusion, pneumothorax) independently

2.8. By the end of neurocritical care training, the trainee should be able to recognize and manage neurogenic breathing patterns (central hyperventilation, Cheyne-Stokes respirations, et cetera) independently

2.9. By the end of neurocritical care training, the trainee should be able to assess and manage thromboembolic disease (including pulmonary embolism) under supervision independently

2.10. By the end of neurocritical care training, the trainee should be able to interpret chest radiographs independently

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2.11. By the end of neurocritical care training, the trainee should be able to interpret chest CT image independently

2.12. By the end of neurocritical care training, the trainee should be able to perform and interpret end tidal CO_2 monitoring independently

2.13. By the end of neurocritical care training, the trainee should be able to perform and interpret arterial blood gas analysis independently

2.14. By the end of neurocritical care training, the trainee should be able to manage noninvasive and invasive echanical ventilation independently (indication,rational, complication, and weaning)

3. Renal

3.1. By the end of neurocritical care training, the trainee should be able to assess and manage fluid, electrolytes disorders independently

3.2. By the end of neurocritical care training, the trainee should be able to recognize (diagnosis and grading) and manage acute kidney injury independently

3.3. By the end of neurocritical care training, the trainee should be able to recognize and manage derangements secondary to alterations in osmolality and electrolytes independently

3.4. By the end of neurocritical care training, the trainee should be able to manage acid-base disorders independently

3.5. By the end of neurocritical care training, the trainee should be able to manage oliguria and polyuria independently

3.6. By the end of neurocritical care training, the trainee should be able to manage rhabdomyolysis under supervision

3.7. By the end of neurocritical care training, the trainee should be able to conduct drug dose adjustment in renal failure independently

3.8. By the end of neurocritical care training, the trainee should be able to manage cerebral salt wasting independently

3.9. By the end of neurocritical care training, the trainee should be able to manage syndrome of inappropriate antidiuretic hormone (SAIDH) independently

4. Metabolic and endocrine effects of critical illness

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4.1. By the end of neurocritical care training, the trainee should be able to manage diabetes mellitus (ketotic and hyperglycemic hyperosmolar coma, hypoglycemia) independently

4.2. By the end of neurocritical care training, the trainee should be able to manage systemic inflammatory response syndrome (SIRS) independently

4.3. By the end of neurocritical care training, the trainee should be able to perform enteral/ parenteral nutritional support independently

4.4. By the end of neurocritical care training, the trainee should be able to manage pituitary crisis under supervision

5. Infectious Disease

5.1. By the end of neurocritical care training, the trainee should be able to comply with infection control measures independently

5.2. By the end of neurocritical care training, the trainee should be able to perform antimicrobial agent selection and determine dose in critically ill patients independently

5.3. By the end of neurocritical care training, the trainee should be able to manage hospital acquired and opportunistic infections in the critically ill patient independently

5.4. By the end of neurocritical care training, the trainee should be able to assess and manage fever in critically ill patient independently

5.5. By the end of neurocritical care training, the trainee should be able to conduct interpretation of antibiotic concentrations and sensitivities independently

5.6. By the end of neurocritical care training, the trainee should be able to recognize and manage sepsis, severe sepsis, and septic shock independently

5.7. By the end of neurocritical care training, the trainee should be able to recognize and manage multi-drug resistance bacteria infection independently

5.8. By the end of neurocritical care training, the trainee should be able to perform antimicrobial agent selection in neurological infections independently

6. Acute hematologic disorders

6.1. By the end of neurocritical care training, the trainee should be able to manage disseminated intravascular coagulation under supervision

6.2. By the end of neurocritical care training, the trainee should be able to conduct anticoagulation and fibrinolytic therapy independently

6.3. By the end of neurocritical care training, the trainee should be able to conduct blood component therapy independently

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6.4. By the end of neurocritical care training, the trainee should be able to conduct hemostatic therapy independently

6.5. By the end of neurocritical care training, the trainee should be able to recognize and manage hypercoagulable states under supervision

6.6. By the end of neurocritical care training, the trainee should be able to recognize and manage traumatic coagulopathy independently

7. Acute gastrointestinal and genitourinary disorders

7.1. By the end of neurocritical care training, the trainee should be able to assess and manage gastrointestinal bleeding independently

7.2. By the end of neurocritical care training, the trainee should be able to prescribe stress ulcer prophylaxis independently

7.3. By the end of neurocritical care training, the trainee should be able to assess and manage abdominal compartment syndrome independently

8. Immunology and transplantation

8.1. By the end of neurocritical care training, the trainee should be able to interpret principles of transplantation (brain death, organ donation, procurement, maintenance of organ donors, implantation) under supervision

9. General trauma and burns

9.1. By the end of neurocritical care training, the trainee should be able to assess and provide initial management of the trauma patient independently

9.2. By the end of neurocritical care training, the trainee should be able to manage spine and pelvis trauma independently

9.3. By the end of neurocritical care training, the trainee should be able to manage chest and abdominal trauma independently

9.4. By the end of neurocritical care training, the trainee should be able to manage crush syndrome independently

9.5. By the end of neurocritical care training, the trainee should be able to describe burns and electrical injury independently

10. Transport

10.1 By the end of neurocritical care training, the trainee should be able to teach of supervises patient assessment before transport

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10.2. By the end of neurocritical care training, the trainee should be able to prepare equipment for transport independently

10.3. By the end of neurocritical care training, the trainee should be able to perform intrahospital transport independently

11. Others

11.1. By the end of neurocritical care training, the trainee should be able to assess and manage multiorgan dysfunction syndrome independently

11.2. By the end of neurocritical care training, the trainee should be able to manage ICU acquired weakness under supervision

C. **Critical care monitoring practical procedures**

1. Monitoring

1.1. By the end of neurocritical care training, the trainee should be able to perform neuromonitoring independently

1.2. By the end of neurocritical care training, the trainee should be able to interpret principles of ECG monitoring independently

1.3. By the end of neurocritical care training, the trainee should be able to perform and interpret invasive hemodynamic monitor independently

1.4. By the end of neurocritical care training, the trainee should be able to perform and interpret noninvasive hemodynamic monitor independently

1.5. By the end of neurocritical care training, the trainee should be able to perform and interpret respiratory mechanics monitor under supervision

1.6. By the end of neurocritical care training, the trainee should be able to perform and interpret metabolic monitoring under supervision (oxygen consumption, carbon dioxide production, respiratory quotient)

1.7. By the end of neurocritical care training, the trainee should be able to conduct multimodality monitoring in NICU independently

2. General critical care practical procedures and therapeutic interventions

2.1. By the end of neurocritical care training, the trainee should be able to perform arterial catheterisation independently

2.2. By the end of neurocritical care training, the trainee should be able to teach or supervise others central venous catheter insertion

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2.3. By the end of neurocritical care training, the trainee should be able to conduct vasoactive/inotropic medication therapy independently

2.4. By the end of neurocritical care training, the trainee should be able to teach or supervise others to perform cardiopulmonary resuscitation, postresuscitation brain protection, to provide advanced life support for postresuscitation patient

2.5. By the end of neurocritical care training, the trainee should be able to teach or supervise others to perform cardioversion and defibrillation

2.6. By the end of neurocritical care training, the trainee should be able to perform airway maintenance and ventilation in nonintubated/unconscious patients independently

2.7. By the end of neurocritical care training, the trainee should be able to perform tracheal intubation independently

2.8. By the end of neurocritical care training, the trainee should be able to perform difficult and failed airway management independently

2.9. By the end of neurocritical care training, the trainee should be able to perform and interpret intra-abdominal pressure monitor independently

2.10. By the end of neurocritical care training, the trainee should be able to teach or supervise others to perform tracheal aspiration

2.11. By the end of neurocritical care training, the trainee should be able to teach or supervise others to perform oxygen therapy

2.12. By the end of neurocritical care training, the trainee should be able to perform fibreoptic bronchoscopy and bronchoalveolar lavage in the intubated patient under supervision

2.13. By the end of neurocritical care training, the trainee should be able to explain and perform recruitment maneuver: principle and practice under supervision

2.14. By the end of neurocritical care training, the trainee should be able to perform thoracocentesis via a chest drain independently

2.15. By the end of neurocritical care training, the trainee should be able to perform percutaneous tracheostomy independently

2.16. By the end of neurocritical care training, the trainee should be able to performsbedside ultrasound to localize pleural effusion and ascites under supervision

2.17. By the end of neurocritical care training, the trainee should be able to assess inferior caval vein by ultrasound under supervision

2.18. By the end of neurocritical care training, the trainee should be able to perform ultrasound techniques for vascular localisation independently

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2.19. By the end of neurocritical care training, the trainee should be able to perform thyrocricocentesis under supervision

3. Neurocritical care practical procedures and therapeutic interventions

3.1. By the end of neurocritical care training, the trainee should be able to perform lumbar puncture independently

3.2. By the end of neurocritical care training, the trainee should be able to perform shunt and ventricular drain tap for CSF sampling independently

3.3. By the end of neurocritical care training, the trainee should be able to manage external ventricular drains independently

3.4. By the end of neurocritical care training, the trainee should be able to assess and manage pain of neurocritical care patients independently

3.5. By the end of neurocritical care training, the trainee should be able to assess sedation and describe principle it independently

3.6. By the end of neurocritical care training, the trainee should be able to interpret and manage of ICP and cerebral perfusion pressure data independently

3.7. By the end of neurocritical care training, the trainee should be able to interpret saturation and jugular venous oxygenation and brain tissue oxygen data under supervision

3.8. By the end of neurocritical care training, the trainee should be able to perform systemic moderate hypothermia under supervision

3.9. By the end of neurocritical care training, the trainee should be able to manage fluid and conduct osmotic dehydration treatment independently

3.10. By the end of neurocritical care training, the trainee should be able to perform and interpret cerebral multimodality monitoring (pH, partial pressure of carbon dioxide [pCO_2], laser Doppler, microdialysis) under supervision

3.11. By the end of neurocritical care training, the trainee should be able to perform lumbar drain insertion independently

3.12. By the end of neurocritical care training, the trainee should be able to manage and insert ICP monitoring independently

3.13. By the end of neurocritical care training, the trainee should be able to manage cerebral oximetric or perfusion monitoring under supervision

3.14. By the end of neurocritical care training, the trainee should be able to perform brain ventricle puncture under supervision

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3.15. By the end of neurocritical care training, the trainee should be able to interpret CT/MRI of nervous system under supervision

3.16. By the end of neurocritical care training, the trainee should be able to choose neuromuscular blockade and describe indication of it under supervision

D.Professionalism and system management

1. By the end of neurocritical care training, the trainee should be able to gather accurate, essential information from all sources, including medical interviews, physical examinations, medical records and Laboratory and radiological results independently

2. By the end of neurocritical care training, the trainee should be able to integrate clinical findings with laboratory investigations to form a differential diagnosis independently

3. By the end of neurocritical care training, the trainee should be able to involve patients (or their surrogates if applicable) in decisions about care and treatment (including informed consent and end-of-life care) independently

4. By the end of neurocritical care training, the trainee should be able to promote collaborative practice independently, including multidisciplinary cooperation and effective team working

5. By the end of neurocritical care training, the trainee should be able to ensure continuity of care through effective handover of clinical information independently

6. By the end of neurocritical care training, the trainee should be able to describe implications of chronic and comorbid disease in the acutely ill patient independently

7. By the end of neurocritical care training, the trainee should be able to seek learning opportunities and integrate new knowledge into clinical practice independently

8. By the end of neurocritical care training, the trainee should be able to apply knowledge to clinical problem solving, clinical decision making, and critical thinking independently.

9. By the end of neurocritical care training, the trainee should be able to develop a clinically applicable knowledge of the basic and clinical sciences that underlie the practice of neurointensive care

For peer review only

10. By the end of neurocritical care training, the trainee should be able to provide effective and professional consultation to physicians and health care professionals of other specialty independently

11. By the end of neurocritical care training, the trainee should be able to maintain accurate medical records and documentation independently

12. By the end of neurocritical care training, the trainee should be able to communicate the continuing care requirements of patients at ICU discharge to health care professionals, patients and relatives under supervision

13. By the end of neurocritical care training, the trainee should be able to manage the safe and timely discharge of patients from ICU independently

14. By the end of neurocritical care training, the trainee should be able to identify and minimise risk of critical incidents and adverse events independently

15. By the end of neurocritical care training, the trainee should be able to recognize and identifys deficiencies in peer performance independently

16. By the end of neurocritical care training, the trainee should be able to identify environmental hazards and promote safety for patients and staff independently

17. By the end of neurocritical care training, the trainee should be able to communicate effectively with patients, relatives and members of the healthcare team independently

18. By the end of neurocritical care training, the trainee should be able to respect privacy, dignity, confidentiality, and legal constraints on the use of patient data

19. By the end of neurocritical care training, the trainee should be able to demonstrate sensitivity and responsiveness to gender, age, culture, religion, sexual preference, socioeconomic status, beliefs, behaviors and an awareness of their impact on decision making

20. By the end of neurocritical care training, the trainee should be able to demonstrate respect, compassion, integrity, and altruism in relationships with patients, families, and colleagues

E. Ethical and legal aspects of critical care medicine

1. By the end of neurocritical care training, the trainee should be able to evaluate death and dying, and perform brainstem death testing under supervision

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2. By the end of neurocritical care training, the trainee should be able to manage palliative care of the critically ill patient, forgo life-sustaining treatment and order not to resuscitate under supervision

3. By the end of neurocritical care training, the trainee should be able to apply and describe practice to minimizes the physical and psychosocial consequences of critical illness for patients and families under supervision

4. By the end of neurocritical care training, the trainee should be able to formulate clinical decisions with respect for ethical and legal principles independently

5. By the end of neurocritical care training, the trainee should be able to adhere to principles of confidentiality, scientific/academic integrity, and informed consent independently

F. Principles of research and certification

1. By the end of neurocritical care training, the trainee should be able to perform presentation independently

2. Certification

2.1 By the end of neurocritical care training, the trainee should acquire the certification of basic life support

2.2 By the end of neurocritical care training, the trainee should acquire the certification of advanced cardiac life support

G. Scoring systems

1. General status scoring

1.1. By the end of neurocritical care training, the trainee should be able to describe and assess patient with acute physiology and chronic health evaluation II score independently

1.2. By the end of neurocritical care training, the trainee should be able to describe and assess patient with simplified acute physiology score II score independently

2. Organs scoring

For peer review only

2.1. By the end of neurocritical care training, the trainee should be able to describe and assess patient with acute kidney injury scoring (KDIGO) independently

2.2. By the end of neurocritical care training, the trainee should be able to describe and assess patient with sequential organ failure assessment score independently

3. Sedation, pain and delirium scoring

3.1. By the end of neurocritical care training, the trainee should be able to teach and supervise others to perform Critical-Care Pain Observation Tool independently

3.2. By the end of neurocritical care training, the trainee should be able to describe and assess patient with Richmond Agitation-Sedation Scale independently

3.3. By the end of neurocritical care training, the trainee should be able to describe and assess patient with the confusion assessment method for the diagnosis of delirium in the ICU independently

3.4. By the end of neurocritical care training, the trainee should be able to describe and assess patient with self-rating anxiety scale independently

4. Neural system scoring

4.1 By the end of neurocritical care training, the trainee should be able to teach and supervise others to perform Glasgow Coma Scale

4.2 By the end of neurocritical care training, the trainee should be able to describe and assess patient with National Institute of Health Stroke Scale independently

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BMJ Open

Core competencies in neurocritical care training in China: consensus developed by a national Delphi consensus survey combined with nominal group technique

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-033441.R1
Article Type:	Original research
Date Submitted by the Author:	13-Nov-2019
Complete List of Authors:	Cui, Zhen; Ji Shui Tan Hospital and Fourth Medical College of Peking University, Department of Critical Care Medicine Gao, Liang; Shanghai Tenth People's Hospital, Department of Neurosurgery Huang, Qi Bing; Shandong University Qilu Hospital, Department of Neurosurgery Li, Li Hong; Tangdu Hospital Fourth Military Medical University, Department of Neurosurgery Qiu, Bing Hui; Southern Medical University Nanfang Hospital, Department of Neurosurgery Shi, Guang Zhi; Beijing Tiantan Hospital, Department of Critical Care Medicine Yu, Xiang You; Xinjiang Medical University Affiliated First Hospital, Department of Critical Care Medicine Wang, Yan; Xinjiang Medical University Affiliated First Hospital, Department of Critical Care Medicine Zhang, Li ; Xinjiang Medical University Affiliated First Hospital, Department of Critical Care Medicine Wang, Yumei; Beijing Tiantan Hospital, Department of Critical Care Medicine Zhang, Linlin; Beijing Tiantan Hospital, Department of Critical Care Medicine Zhou, Jian-Xin; Beijing Tiantan Hospital, Department of Critical Care Medicine
Primary Subject Heading:	Intensive care
Secondary Subject Heading:	Neurology
Keywords:	neurocritical care, training, core competency, consensus, Delphi, nominal group

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Core competencies in neurocritical care training in China: consensus developed by a national Delphi consensus survey combined with nominal group technique

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Keywords: neurocritical care, training, core competency, consensus, Delphi, nominal group

Word count: 3454

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ABSTRACT

Objectives: To define the core competencies essential for specialist training in neurocritical care in China.

Design: Modified Delphi method and nominal group technique.

Setting: National.

Participants: A total of 1094 respondents from 33 provinces in China participated in the online survey. A nominal group of 11 members was organized by the Neuro-Critical Care Committee affiliated with the Chinese Association of Critical Care Physicians and the National Center for Healthcare Quality Management in Neurological Diseases.

Results: 1094 respondents from 33 provinces in China participated in the online survey. A formal list containing 329 statements was generated for the rating by a nominal group. After five rounds of nominal group meetings and one round of comments and iterative review, 198 core competencies (54 on neurological diseases, 64 on general medical diseases, 42 on monitoring of practical procedures, 20 on professionalism and system management, 5 on ethical and legal aspects, 3 on the principles of research and certification, and 10 on scoring systems) formed the final list.

Conclusion: By using consensus techniques, we have developed a list of core competencies for neurocritical care training, which may serve as a reference for future specialist training programs in China.

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Main strengths and limitations of this study

1. To the best of our knowledge, this is the first time that core competencies for neurocritical care has been established in China.

2. Consensus techniques were employed in our study, which may serve as a reference for future specialist training programs in China.

3. All of the nominal group members came from tertiary academic hospitals so they might not have represented the views of lower-grade hospitals.

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INTRODUCTION

During the past three decades, neuro-intensive care units (NICUs) in China grew rapidly with the development of neuroscience and critical care medicine [1,2]. A recent survey demonstrated that most of the NICUs in China are operated under a "closed" model and that clinical practice is conducted by full-time dedicated neuro-intensivists [3]. Systemic professional training and the performance assessment of physicians involved in neurocritical care practice are among the cornerstones of the development of the NICU [4]. At present, professional training programs focusing on critical care medicine and neurosurgery have been put into practice in China [5]. However, there is no standardized national training program for neuro-intensivists.

The experience of critical care and neurocritical care training in other countries has already illustrated that identifying core competencies is important for establishing standardized training programs [6-8]. To date, no core competency lists are available for neurocritical care training in China. Recently, a list of competencies for general critical care training has been established [9]. However, since neurocritical care is a multidisciplinary subspecialty that contains the characteristics of neurology, neurosurgery and critical care medicine, it is inappropriate to directly apply critical care or neurological/neurosurgical lists for neurocritical care. The United Council for Neurologic Subspecialties (UCNS) and the American Academy of Neurology (AAN) have published their core competency lists for neurocritical care training, respectively [7,10]. Both were generated based on the opinions of experts. Additionally, due to the diversity of medical resources and educational systems in China, the establishment of NICUs is extremely imbalanced across different regions [3]. Therefore, consensus statements issued by other countries may not be applicable for NICUs in China.

The Neuro-Critical Care Committee affiliated with the Chinese Association of Critical Care Physicians (NCCC-CACCP) and the National Center for Healthcare Quality Management in Neurological Diseases called for a working group to generate a list of fundamental core competencies for neurocritical care training in China. The modified Delphi method and nominal group (NG) technique were used during consensus establishment. The methodology and results of the present study might provide a reference for future specialist training programs in different regions.

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METHODS

The study protocol was approved by the IRB of Beijing Tiantan Hospital, Capital Medical University (No. KY2017-034-02). Since no patients were involved in the study, our local IRB approved a waiver of informed consent.

The present study was conducted in three phases from February 2018 to May 2019 (**Fig. 1**). In phase 1 (the first round Delphi), a nationwide questionnaire was published online to collect opinions on the core competencies that provided a basic perspective for the specialists training in neurocritical care. In phase 2, several rounds of voting were conducted by face-to-face NG meetings to generate a core competencies list. Then the minimum level of expertise, which is equated with the ability that should be attained at the end of training, was identified by one round of voting. During phase 3 (the second round Delphi), the draft was posted online for further comments.

Patient and public involvement

There was no patient or public involvement in this study.

Phase 1: generation and rearrangement competencies list (first round Delphi)

A list of potential core competencies was developed based on four previous publications, including the list introduced by the Competency-Based Training in Intensive Care Medicine in Europe Collaboration (CoBaTrICE) [6], the guidelines developed by UCNS [7], the Chinese College of Intensive and Critical Care Medicine (CCICCM) [9] and the Critical Care & Emergency Medicine fellowship core curriculum of AAN [10]. In principle, all core competencies proposed by the aforementioned publications were preserved, while the duplicated items were rearranged to simplify the list. Those items with a definition of the level of expertise were modified. For example, the items about shock in CCICCM (To recognize and manage different types of shock) and UCNS (Shock: hypotension) and its complications (vasodilatory and cardiogenic) were rewritten as “different types of shock” in the potential list. Furthermore, since there were very few items in the published guidelines relevant to scoring system for patient assessment, we added five new items related to the scoring system.

The potential competencies list was translated into Chinese and organized into an online questionnaire (https://www.wjx.cn/jq/21776519.aspx, accessed April 2, 2018), which comprised seven parts (general medical diseases, neurological diseases, monitoring practice, professionalism and system management, ethical and legal, research and certification, and scoring system). The respondents were asked to select “YES” or “NO” for each item. Respondents were also invited to answer an open question: “Which

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competencies are important for specialist training in neurocritical care, in addition to those listed above".

The online questionnaire was disseminated via three types of media:

(1) Members of the NCCC-CACCP from each province were responsible for the distribution of the questionnaire via email, WeChat or website links.

(2) The questionnaire was posted on the official website of the Chinese Society of Critical Care Medicine (http://www.csccm.org.cn, accessed April 2, 2018).

(3) The questionnaire was posted on the WeChat official account of the Department of Critical Care Medicine of Capital Medical University (https://www.wjx.cn/jq/21776519.aspx, accessed April 2, 2018).

We used WeChat as the primary disseminating means because it is the most popular social media not only in China but in the entire Chinese community. WeChat integrates the functions of WhatsApp, Instagram and Facebook.

The questionnaire was posted online for 90 days. After removing duplicate and meaningless responses from the "open question", the remaining responses and all those items that received at least one "YES" response were generated into a formal list for the NG meeting.

Phase 2: NG ratings

The leaders of the NCCC-CACCP and the National Center for Healthcare Quality Management in Neurological Diseases were responsible for the establishment of NG. Considering the imbalance of medical resources in China, 11 NG members from different regions were invited, covering areas from economic development to underdevelopment (six provinces: Beijing, Shanghai, Shandong, Shanxi, Guangdong, Xinjiang). There were four neuro-intensivists with neurological/neurosurgical background, three general intensivists in charge of NICUs, two trainees who had completed training in neurocritical care, one respiratory therapist and one experienced neurocritical care nurse. A researcher was selected as the coordinator to facilitate the process. The four neuro-intensivists and three general intensivists were all engaged in graduate, postgraduate medical education and in charge of physician training program. The three general intensivists in the nominal group were specialist training (similar with fellowship training in U.S.) directors of critical care medicine and the four neuro-intensivists were residency training directors on neurology or neurosurgery.

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To improve efficiency, the first round of NG rating was conducted by sending the formal list generated after the online survey to the NG members by mail. All of the competencies were followed by the same question: “Is it important for specialists training in neurocritical care?” Meanwhile, the percentages of “YES” responses selected during the online questionnaire were provided. The NG members were asked to individually rate the importance of competencies using a 5-point Likert scale (ranging from 1 representing very unimportant to 5 representing very important) [6], and to return the feedback in one week.

The coordinator was in charge of analyzing the feedback of the questionnaires. Items achieving full consensus (100% NG members voting 4- or 5-point) were directly entered into the final list. Other undetermined items were emailed to the NG members one week before the plenary NG ratings. Data on personal and group ratings for each item during the first round were provided as well. The NG members were requested to read these materials carefully and compare the differences between their own opinions and those of other NG members.

A face-to-face NG meeting was held on July 21, 2018 (the second round NG rating). Each NG member was required to select at least the five most important items individually from those items entered in the second round of ratings. Each NG member was asked to explain the reasons for selecting these items in turn, and others were not allowed to interrupt during this process. Afterwards, an open discussion for debate was conducted. During the meeting, the NG members were frequently reminded to consider the resource disequilibrium of the national medical system and respect the opinions of the “vulnerable members” such as trainees, nurses and respiratory therapists. Finally, each member rated the importance of competencies independently, as in the first round. Items achieving full consensus entered into the final list; otherwise, they were entered into the third round. The third and fourth rounds were conducted in the same manner as the second round. Since no item achieved full consensus (100% NG members voting 4- or 5-point) during the fourth round, the iteration ended. All the items that did not achieve full consensus were eliminated. The resulting data from the previous rounds were presented to the NG members during the meeting.

The fifth round NG rating was held on July 22, 2018. The NG members were required to identify the minimum level of expertise for each competence item, which was defined at four levels: a, b, c and d. We used the CoBaTrICE approach [6] to describe the level of expertise in the competence statements: a = has knowledge of or describes … ; b = performs, manages, conducts, demonstrates, assesses or

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interprets … under supervision; c = performs, manages, conducts, demonstrates, assesses, interprets … independently; d = teaches or supervises others to perform (selected from the generic descriptors, online supplementary appendix 1, Table S1). A simple majority rule was implemented; that is, the level that gained the most votes was accepted as the final choice. When the number of votes was the same, the lower level would be accepted. For example, if five "b", five "c" and one "d" were voted, the level "b" would be accepted as the minimum level of expertise.

All NG members participated in all of the five rounds NG meetings.

Phase 3: comments and iterative review (second round Delphi)

The draft of the final list was delivered by three types of media, as with the first round of Delphi. All participants who provided an email address during the online survey were contacted and invited to give comments.

Development of the final set

After the three phases of the study, the final competence set was constructed as the statements were made of three parts: "context", "level of expertise" and "content of competence" (online supplementary appendix 1, Table S2).

The number of items in the final competence set was compared to those in guidelines and statements published by CoBaTrICE, UCNS, CCICCM and AAN.

Statistical analysis

Categorical data were presented as number (percentage). Continuous data were presented as the median and the interquartile range (IQR). All data were analyzed using SPSS version 17.0.

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RESULTS

Phase 1: generation and rearrangement competencies list (first round Delphi)

A total 1094 respondents from 33 administrative provinces (including Macao and Taiwan) participated in the first round of Delphi (**Table 1**). There were 916 (83.7%) respondents from tertiary hospitals, 536 (49.0%) of whom had been engaged in clinical practice for more than 10 years. Each item in the original online questionnaire won at least one vote, so all entered the NG rating. The open question received 394 additional suggestions, most of which had already been included in the original online questionnaire. Finally, 37 suggestions (22 relating to knowledge and skills and 15 relating to the scoring system) were included in the formal list after careful consideration. Following the rule that we not delete items but only analyze and integrate them, a formal list containing 329 statements was ultimately generated for the following NG ratings (online supplementary appendix 1, Table S3 and S4).

Phase 2: NG ratings

During the first round of ratings, 138 (41.8%) items achieved full consensus. Then, 52 (15.8%) and eight (2.4%) items were elected during the second and third rounds, respectively. In the fourth round, no additional items achieved full consensus; therefore, the rating was terminated. Finally, a list containing 198 items was generated (online supplementary appendix 1, Table S3). Another 131 items that did not reach full consensus were eliminated (online supplementary appendix 1, Table S4).

The minimum level of expertise was identified in the fifth round of rating. Following the established rules, most items were rated as level “c” (159, 80.3%), with one “a” (0.5%), 28 “b” (14.1%) and 10 “d” (5.0%) ratings. Nineteen items had the same rating results in two levels of expertise, and the lower level was accepted as the final level. For example, the item “9.5 Describes burns and electrical injury” was voted as five “a”, five “b” and one “c”. According to the rule, the level “a” was accepted.

Phase 3: comments and iterative review (second round of Delphi)

There were 111 replies received from 27 provinces (Table 1). No new competencies were proposed during this phase, so no change was made to the final competency list. It is worth noted that many participants expressed their urgent demand for standardized neurointensive training.

Development of the final set

The final competence set comprised 198 competency statements divided into seven parts (**Fig. 2**, online supplementary appendix 2). Online supplementary appendix 2 also shows the overlap of our core competences with those from other international organizations.

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The number of items in the final competence set (n=198) was more than the number in CoBaTrICE (n=102), CCICCM (n=129) and AAN (n=66) but was less than the number in UCNS (n=289) (**Fig. 3**).

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DISCUSSION

Based on past guidelines, we used consensus techniques, i.e., the modified Delphi method and NG technique, to develop a set of 198 core competencies for fundamental neurocritical care training in China. To the best of our knowledge, this is the first time that consensus techniques have been applied to the development of core competencies of neurocritical care in China. On behalf of the Working Group of the National Center of Healthcare Quality Management in Neurological System Diseases, we will implement this document of core competencies through this administration organization, and the implementation of this consensus will be one of the indicators for quality management of neurocritical care.

The Delphi method and NG technique are the most commonly employed techniques for developing consensus [11]. These methods have been used successfully in critical care medicine, for instance, to identify the core competencies of critical care in Europe [6] and China [9] and to establish national research priorities of critical care in the UK [12]. The Delphi method is used to collect opinions and evaluate rating results. This technique was initially described by the RAND Air Force Corporation in America in the 1950s [13]. In the field of medical education, more than three quarters of publications using consensus techniques adopted the Delphi and modified Delphi [14]. This methodology permits individual thinking. In phase 1 Delphi, our survey was open to respondents with different backgrounds to collect ideas and suggestions as much as possible on topics such as ethics and professionalism. The NG technique is employed to select the most important items and define the minimum level of expertise. During face-to-face ratings, the interaction is controlled by a coordinator so that all participants have opportunities to express their views and the dominance of one or two vocal members can be avoided [11]. Later, the free period allows for more expression of ideas and discussions. The design of our study shares many similarities with CoBaTrICE [6], except for one step order. In our study, we adhered the principle that determining the core competencies is the top priority. The most important items were voted on prior to the determination of the minimum level of expertise. The purpose of this adjustment was to avoid the potential influence of the minimum level of expertise on the voting process on the importance of the competencies. For example, if the item was previously categorized as level “a”, it may have been interpreted as “unimportant” and ruled out during the voting on importance.

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The number of our items was significantly reduced compared to UCNS [7] (**Fig. 3**). The main reason is that we wanted to obtain a basic list with the greatest consensus. Therefore, only those competencies agreed on by all NG members were included. For example, one NG member insisted that research capacity was not essential for junior physicians. Under the established admission criteria, most items relevant to research capacity were ruled out. In addition, the differences in the professional backgrounds of the NG members lead to divergences. For example, some NG members with a neuroscience background believed that the ultrasound technique was not so important, while NG members specialized in general critical care insisted that ultrasound was an essential skill for clinical practice. This phenomenon may be associated with the popularity of ultrasound in the two specialties [15,16]. After repeated discussions, three items were admitted in the third round (pleural effusion and ascites localization, assesses inferior caval vein, and vascular localization), although more advanced techniques such as lung ultrasound and echocardiography were excluded. Compared with CCICCM [9], our list not only added a large number of neurological items but also added some items related to systemic diseases related to neuroscience to adapt to neurocritical care training. More than 30 items related to general critical care were deleted, such as “Manages continuous renal replacement therapy”. Furthermore, the 15 newly added items were all from the first round of Delphi, which highlighted the importance of the Delphi method and avoided the loss of important items. The comparison of our core competences with those from CoBaTrICE, CCICCM, AAN and UCNS (Online supplementary appendix 2) might help these international organizations to modify and enhance their core competencies.

Neurocritical care is an interdisciplinary specialty involving neuroscience and critical care medicine [17,18]. In China, NICUs fall under different departments and are managed by neurosurgeons, neurologists or intensivists [3]. The training requirements of different regions and backgrounds are highly diverse. An all-embracing competency list could be a burden for a training program and may decrease efficiency. Our lists selected essential fundamental competencies for physicians who had just finished neurocritical care training, regardless of whether a training program was based on neurosurgery, neurology, critical care medicine or other specialties related to neurocritical care. Training program directors may reorganize this list by adding core competencies for any special local training. Those items that had been ruled out during the NG process might serve as optional competencies. For those trainees after neurological and neurosurgical training, general critical care

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training items may be added according to our core competencies list and those from CCICCM [9]. Although all of the items have reached consensus after the NG rating, the content and minimum level of expertise on some items may be controversial. In addition, some clinically relevant conditions, such as brain death, were not included in the final lists. However, we must report according to the results of the vote. Readers and training program directors should be aware of potential disputes and make adjustment as needed.

There are some potential limitations in our study. First, we used WeChat as one of the media to disseminate online questionnaires to maximize the efficiency and enthusiasm of the participants. Therefore, it is inevitable that some feedback was of low quality and given without consideration. Fortunately, among more than one thousand respondents, the proportion of low-quality responses was quite low, so there was not much impact on the final results. Additionally, in both rounds of Delphi, we used the WeChat to deliver our questionnaires. Although the WeChat is powerful and highly efficient, we have to admit that by this way, we are unable to obtain the exact number of participants who the questionnaires were sent to. Therefore, we cannot tell the 'denominator' for the number of stakeholders invited to participate in either round of the Delphi. Thus, the response rate cannot be identified. Second, although we had reminded the experts to pay attention to the opinions of vulnerable groups and the voting processes were independent, trainees, nurses and respiratory therapists were still less involved in the discussion. By analyzing the questionnaires, we could not rule out the suspicion of conformity in the selection of some items. Third, all of the NG members came from tertiary academic hospitals so they may not have represented the views of lower-grade hospitals. However, one-seventh of the replies were received from lower-grade hospitals in Phase 1, which provided a reference for the NG meetings. In addition, the NG members were reminded to consider the resource disequilibrium during the voting processes. Last, patients and their relatives were not invited to participate in our study, which therefore might have lacked their opinions. However, the CoBaTrICE invited patients and their relatives to give their opinions, and all these items were incorporated into our potential list.

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CONCLUSIONS

In summary, by using consensus techniques, we have developed a list of core competencies for Chinese neurocritical care training that may serve as a reference for future specialist training programs.

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Funding: This study did not receive funding.

Competing interests: None declared.

Patient consent: Not required.

Data sharing statement: Data can be accessed by contacting the corresponding author on reasonable request.

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FIGURE LEGENDS

Figure 1. The study was conducted in three phases. In phase 1, a competencies list was generated and arranged during the first round of Delphi. In phase 2, five rounds of nominal group (NG) meetings were conducted to confirm the competencies list and levels of expertise. In phase 3, comments and iterative review were recirculated during the second round of Delphi.

Figure 2. The numbers of competencies categorized into seven different themes. The number of competencies entering the nominal group (NG) rating that were finally accepted are shown.

Figure 3. The intersection among the competencies list developed in the present study (n=198, blue circle) with other guidelines and statements, including the Competency Based Training in Intensive Care Medicine in Europe Collaboration (CoBaTrICE) (n=102, red circle), the Chinese College of Intensive and Critical Care Medicine (CCICCM) (n=129, green circle), the United Council for Neurologic Subspecialties (UCNS) (n=289, magenta circle) and the American Academy of Neurology (AAN) (n=66, orange circle).

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Table 1. The professional background of participants in Delphi

Specialist	First round Delphi	Second round Delphi
General intensivists	412 (37.7%)	49 (44.1%)
Neurosurgeons	244 (22.3%)	18 (16.2%)
Neurologists	139 (12.7%)	9 (8.2%)
Neuro-intensivists	95 (8.7%)	22 (19.8%)
Medical physicians (except neurologists)	53 (4.8%)	6 (5.4%)
Surgeons (except neurosurgeons)	25 (2.3%)	1 (0.9%)
Emergency physicians	20 (1.8%)	1 (0.9%)
Anesthesiologists	13 (1.2%)	1 (0.9%)
Rehabilitation physicians	4 (0.4%)	0
Nurses	70 (6.4%)	2 (1.8%)
Respiratory therapists	7 (0.6%)	1 (0.9%)
Medical students	12 (1.1%)	1 (0.9%)
Total	1094	111

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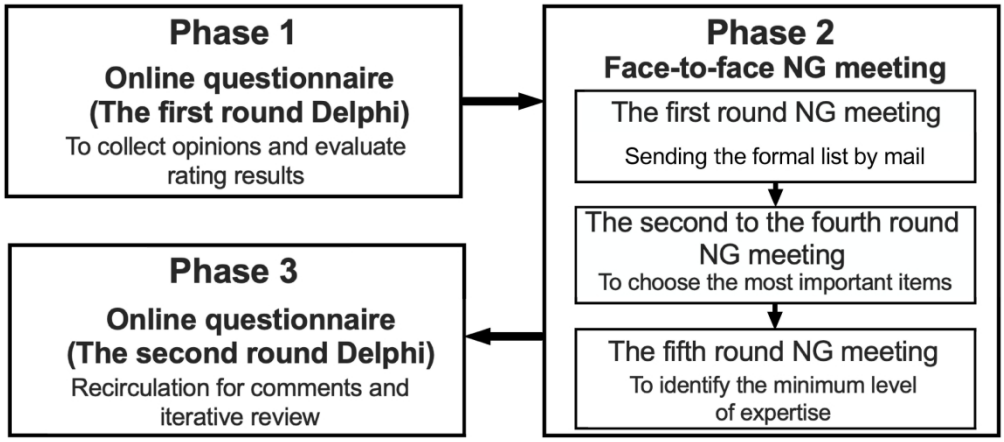

Figure 1. The study was conducted in three phases. In phase 1, a competencies list was generated and arranged during the first round of Delphi. In phase 2, five rounds of nominal group (NG) meetings were conducted to confirm the competencies list and levels of expertise. In phase 3, comments and iterative review were recirculated during the second round of Delphi.

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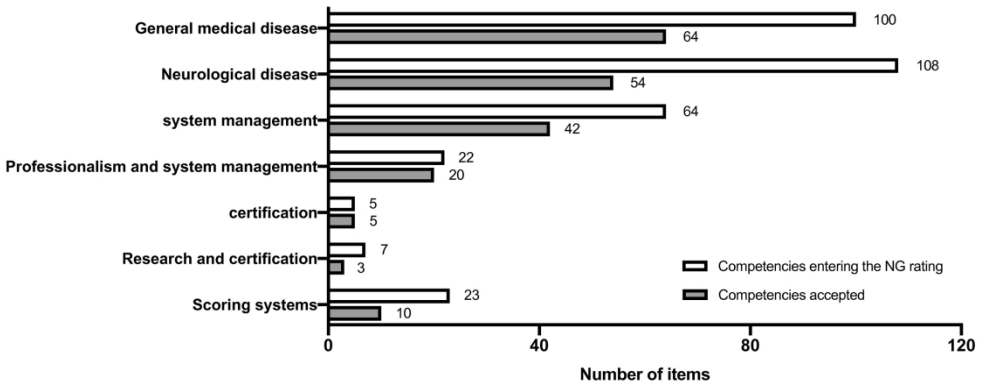

The numbers of competencies categorized into seven different themes. The number of competencies entering the nominal group (NG) rating that were finally accepted are shown.

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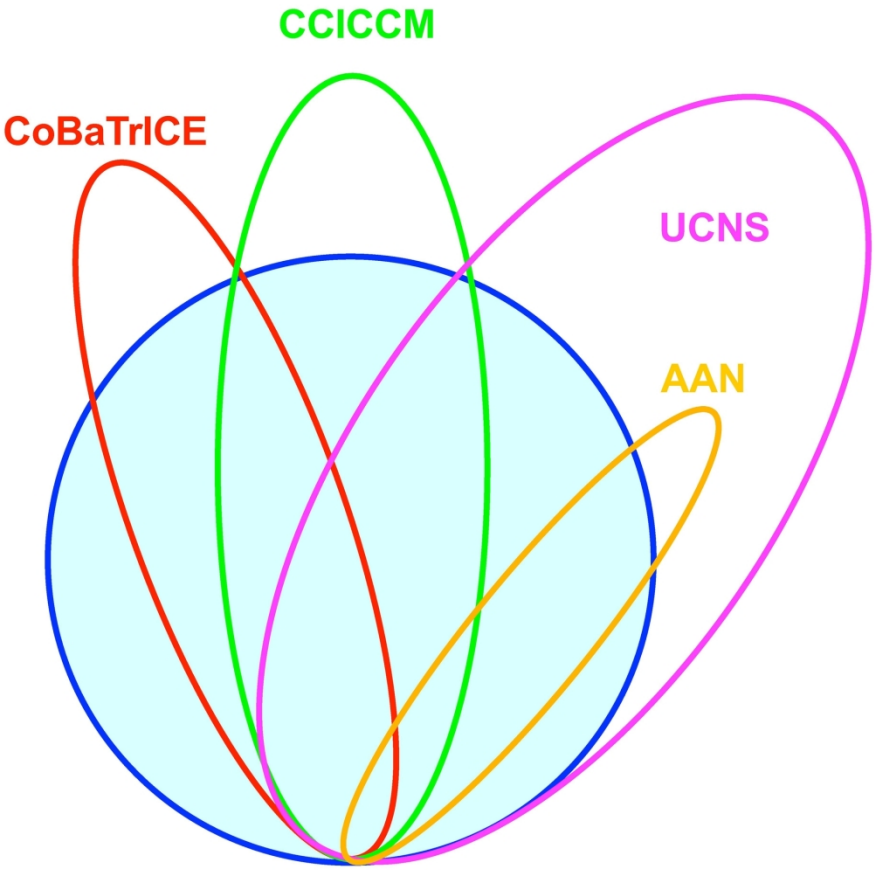

Figure 3. The intersection among the competencies list developed in the present study (n=198, blue circle) with other guidelines and statements, including the Competency Based Training in Intensive Care Medicine in Europe Collaboration (CoBaTrICE) (n=102, red circle), Chinese College of Intensive and Critical Care Medicine (CCICCM) (n=129, green circle), the United Council for Neurologic Subspecialties (UCNS) (n=289, magenta circle) and the American Academy of Neurology (AAN) (n=66, orange circle).

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Core competencies in neurocritical care training in China: consensus developed by a national Deiphi consensus survey combined with nominal group technique

Zhen Cui, MD, Liang Gao, MD, Qi-Bing Huang, MD, Li-Hong Li, MD, Bing-Hui Qiu, MD, Guang-Zhi Shi, MD, PhD, Xiang-You Yu, MD, Yan Wang, BS, Li Zhang, RN, Yu-Mei Wang, MD, Linlin Zhang, MD, PhD, Jian-Xin Zhou, MD, PhD, on behalf of the Working Group from Neuro-Critical Care Committee affiliated to the Chinese Association of Critical Care Physicians and the National Center for Healthcare Quality Management in Neurological Diseases.

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Online Supplementary Appendix 1

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Table S1. The minimum level of expertise at the end of neurocritical care specialist training

Levels	Descriptions
a	Has knowledge of (describes) …
b	Performs (manages, conducts, demonstrates, assesses, interprets) … under supervision
c	Performs (manages, conducts, demonstrates, assesses, interprets) … independently
d	Teaches or supervises others to perform (manages) ...

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Table S2. Constructing a competence statement

Context	By the end of neurocritical care training, the trainee should be able to...			
Level of expertise	Level “a” Has knowledge of (describes)…	Level “b” Manages…under supervision	Level “c” Manages…independently	Level “d” Teaches or supervises others to perform (manage)...
	Describes...	Manages... Conducts... Demonstrates... Assesses... Interprets...		Teaches... Supervises...
Content of competence	...different types of shock...			

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Example	By the end of neurocritical care training, the trainee should be able to recognize and manage different types of shock independently.

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Table S3. Accepted items in the core competencies required for neurocritical care specialists and the supporting rate for each item

Domain	Competency statement	Online survey (%)	Source*	Agreement during round 1 to 4 NG rating (%)				Minimum level of expertise identified during round 5 NG meeting ‡
				Round 1	Round 2	Round 3	Round 4	
A. Neurological disease states								
	1. Cerebrovascular diseases							
	1.1. Manages infarction and ischemia							
	a. Massive hemispheric infarction	97.5	***U/A***	100				c
	b. Basilar artery occlusion and stenosis	95.2	***U/A***	100				c
	c. Carotid artery occlusion and stenosis	95.2	***U/A***	100				c
	d. Delayed cerebral ischemia	-	***O***	100				c
	1.2. Manages intracerebral hemorrhage							
	a. Supratentorial	94.7	***U/A***	91	100			c
	b. Cerebellar	97.0	***U/A***	100				c
	c. Brainstem	97.5	***U/A***	100				c
	d. Intraventricular	97.0	***U/A***	100				c

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e. Subarachnoid hemorrhage - aneurysmal and others	97.0	***U/A***	100		c
1.3 Manages arteriovenous malformations	95.6	***U***	100		c
1.4 Manages carotid-cavernous fistulae	80.9	***U***	100		c
1.5 Manages cervical and cerebral arterial dissections under supervision	88.3	***U***	100		b
2. Neurotrauma					
2.1 Manages traumatic brain injury					
a. Axonal shearing injury	85.8	***U/A***	91	100	c
b. Epidural hematoma	96.1	***U/A***	100		c
c. Subdural hematoma	96.3	***U/A***	100		c
d. Contusions and lacerations	95.7	***U/A***	100		c
e. Penetrating craniocerebral injuries	92.4	***U/A***	100		c
f. Traumatic SAH	95.8	***U/A***	100		c
2.2. Manages spinal cord injury	95.1	***U/A/C***	100		c
3. Status epilepticus					

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3.1 Manages convulsive status epilepticus	97.8	***U/A/C***	100		c
3.2 Manages nonconvulsive status epilepticus	89.0	***U/A/C***	100		c
3.3 Manages myoclonic epilepsy	91.7	***U/A/C***	100		c
4. Neuromuscular diseases					
4.1 Manages myasthenia gravis	94.5	***U/A***	100		c
4.2 Manages Guillain-Barré syndrome	88.3	***U/A***	100		c
5. Infections					
5.1 Manages encephalitis (viral, bacterial, parasitic)	97.5	***U/A/C***	100		c
5.2 Manages meningitis (viral, bacterial, parasitic)	98.5	***U/A/C***	100		c
5.3 Manages brain and spinal epidural abscess under supervision	93.6	***U/C***	100		b
6. Toxic-metabolic disorders					
6.1 Manages drug overdose and withdrawal	90.3	***U/C/E***	91	100	c
6.2 Manages temperature-related injuries	93.6	***U***	91	100	c
6.3 Manages carbon monoxide poisoning and delayed encephalopathy	-	***O***	73	100	c

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7.Inflammatory and demyelinating diseases					
7.1 Manages central pontine myelinolysis	78.8	***U***	73	100	c
7.2 Manages osmotic demyelination syndrome	-	***O***	64	100	c
8. Encephalopathies					
8.1 Manages hepatic encephalopathy	91.9	***U***	100		c
8.2 Manages hypoxic-ischemic encephalopathy	97.8	***U***	100		c
8.3 Manages metabolic encephalopathy	-	***O***	100		c
8.4 Manages hypertensive encephalopathy and posterior reversible encephalopathy syndrome	95.3	***U***	91	100	c
9. Neuroendocrine disorders					
9.1 Manages pituitary apoplexy	94.6	***U***	100		c
9.2 Manages diabetes insipidus	95.5	***U***	100		c
10. Manages movement disorders (severe dystonia and opisthotonos)	91.6	***U***	100		c
11. Clinical syndromes					
11.1 Teaches or supervises others in the Manages coma	98.5	***U/A/C***	100		d

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11.2 Manages herniation syndromes	98.2	***U/A***	100		c
11.3 Manages elevated intracranial pressure	97.7	***U/C***	100		c
11.4 Manages intracranial hypotension/hypovolemia	95.9	***U***	100		c
11.5 Manages hydrocephalus	95.4	***U/A***	100		c
11.6 Manages delirium	98.1	***U/A***	100		c
12.Manages perioperative neurosurgical care					
12.1 Manages postcraniotomy hypertension	96.1	***U***	100		c
12.2 Manages postcraniotomy pain	93.3	***U***	100		c
12.3 Manages wound cerebrospinal fluid leaks	94.8	***U***	91	100	c
12.4 Manages wound infections	95.6	***U***	100		c
12.5 Manages postoperative brain edema	96.8	***U/A***	100		c
12.6 Manages postcraniotomy intracranial hemorrhage	96.3	***U***	100		c
12.7 Assesses and manages postcervical spine surgery airway	92.1	***U***	100		c
12.8 Assesses and manages high-risk	96.8	***U/C/E***	100		c

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neurosurgical patient postoperative					
13. Conducts neurorehabilitation	88.0	***U***	73	100	c
B. General medical disease states					
1. Cardiovascular					
1.1 Recognizes and manages different types of shock	96.7	***U/C/E***	100		c
1.2 Recognizes and manages myocardial infarction and unstable coronary syndromes	93.3	***U/C***	100		
1.3 Recognizes and manages neurogenic cardiac disturbances (electrocardiographic changes, stunned myocardium)	93.6	***U***	100		c
1.4 Assesses and manages life-threatening arrhythmia	94.7	***U/C/E***	100		c
1.5. Recognizes and manages left ventricular failure and/or acute pulmonary edema	95.0	***U/C***	100		c
1.6. Recognizes and manages neurogenic pulmonary edema	94.7	***U***	100		c
1.7 Recognizes and manages hypertension crisis	96.2	***U/C***	100		c

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1.8 Performs and interprets cardiac output and hemodynamic monitor	92.3	***U/A/C/E***	100			c
1.9 Performs electrocardiography and interprets the results	94.1	***C/E***	91	100		c
2. Respiratory						
2.1 Assesses and manages acute and chronic respiratory failure (type I and type II)	97.8	***U/C***	100			c
2.2 Manages chronic obstructive pulmonary disease and status asthmaticus under supervision	94.2	***U/C***	91	91	100	b
2.3 Recognizes (diagnosis and grading) and manages acute respiratory distress syndrome	96.7	***U/C/E***	100			c
2.4 Manages aspiration	96.1	***U***	100			c
2.5 Recognizes and manages upper airway obstruction	96.5	***U/C***	100			c
2.6 Recognizes and manages bronchopulmonary infections	97.4	***U***	100			c
2.7 Recognizes and manages pleural diseases (empyema, effusion, pneumothorax)	92.4	***U/C***	91	100		c
2.8 Recognizes and manages neurogenic breathing patterns (central hyperventilation, Cheyne-Stokes	95.9	***U***	91	100		c

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respirations, etc)				
2.9 Assesses and manages thromboembolic disease (including pulmonary embolism) under supervision	95.4	***C***	100	b
2.10 Interprets chest radiographs	95.0	***U/C/E***	100	c
2.11 Interprets chest CT image	96.1	***C***	100	c
2.12 Performs and interprets end tidal CO_2 monitoring	92.0	***U***	100	c
2.13 Performs and interprets arterial blood gas analysis	98.2	***C/E***	100	c
2.14 Manages noninvasive and invasive mechanical ventilation: indication, rationale, complication, and weaning	97.8	***U/A/C/E***	100	c
3. Renal				
3.1 Assesses and manages fluid, electrolytes disorders	98.2	***U/C/E***	100	c
3.2 Recognizes (diagnosis and grading) and manages acute kidney injury	95.8	***U/C/E***	100	c
3.3 Recognizes and manages derangements secondary to alterations in osmolality and	96.3	***U***	100	c

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electrolytes					
3.4 Manages acid–base disorders	97.9	***U/A/C***	100		c
3.5 Manages oliguria and polyuria	97.0	***U***	100		c
3.6 Manages rhabdomyolysis under supervision	96.5	***U***	91	100	b
3.7 Conducts drug dose adjustment in renal failure	93.9	***U/C***	91	100	c
3.8 Manages cerebral salt wasting	96.3	***U***	100		c
3.9 Manages syndrome of inappropriate antidiuretic hormone	98.2	***U***	91	100	c
4. Metabolic and endocrine effects of critical illness					
4.1 Manages diabetes mellitus (ketotic and hyperglycemic hyperosmolar coma, hypoglycemia)	97.7	***U/C***	100		c
4.2 Manages systemic inflammatory response syndrome	93.5	***U***	100		c
4.3 Performs enteral/parenteral nutritional support	97.7	***U/A/C/E***	100		c
4.4 Manages pituitary crisis under supervision	-	***O***	73	100	b
5. Infectious disease					
5.1 Complies with infection control measures	97.0	***U/C/E***	100		c

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5.2 Performs antimicrobial agent selection and determines dose in critically ill patients	97.1	***U/C/E***	100		c
5.3 Manages hospital acquired and opportunistic infections in the critically ill patient	97.8	***U/A/C***	100		c
5.4 Assesses and manages fever in critically ill patient	97.2	***U/C***	91	100	c
5.5 Conducts interpretation of antibiotic concentrations and sensitivities	96.9	***U/E***	100		c
5.6 Recognizes and manages sepsis, severe sepsis, and septic shock	95.2	***C/E***	100		c
5.7 Recognizes and manages multi-drug resistance bacteria infection	-	***O***	100		c
5.8 Performs antimicrobial agent selection in neurological infections	-	***O***	100		c
6. Acute hematologic disorders					
6.1 Manages disseminated intravascular coagulation under supervision	97.3	***U/C***	100		b
6.2 Conducts anticoagulation and fibrinolytic therapy	96.8	***U/A/C***	100		c

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6.3 Conducts blood component therapy	96.4	***U/C/E***	91	100	c
6.4 Conducts hemostatic therapy	96.8	***U***	100		c
6.5 Recognizes and manages hypercoagulable states under supervision	95.8	***U***	82	100	b
6.6 Recognizes and manages traumatic coagulopathy	94.5	***C***	91	100	c
7. Acute gastrointestinal and genitourinary disorders					
7.1 Assesses and manages gastrointestinal bleeding	97.7	***U/C***	91	100	c
7.2 Prescribes stress ulcer prophylaxis	96.4	***C***	91	100	c
7.3 Assesses and manages abdominal compartment syndrome	96.4	***U/C***	82	100	c
8. Immunology and transplantation					
8.1 Interprets principles of transplantation (brain death, organ donation, procurement, maintenance of organ donors, implantation) under supervision	85.5	***U/A/E***	73	100	b
9. General trauma and burns					

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9.1 Assesses and provides initial management of trauma patient	93.8	***U/C/E***	91	100		c
9.2 Manages spine and pelvis trauma	91.0	***U***	82	100		c
9.3 Manages chest and abdominal trauma	91.0	***U***	91	100		c
9.4 Manages crush syndrome	-	***O***	91	100		c
9.5 Describes burns and electrical injury	86.4	***U/E***	64	82	100	a
10. Transport						
10.1 Teaches or supervises patient assessment before transport	97.4	***C/E***	100			d
10.2 Prepares equipment for transport	95.9	***C***	100			c
10.3 Performs intrahospital transport	96.8	***C***	100			c
11.Others						
11.1 Assesses and manages multiorgan dysfunction syndrome	93.5	***C***	100			c
11.2 Manages ICU acquired weakness under supervision	-	***O***	82	100		b

C. Critical care monitoring practical procedures

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1. Monitoring					
1.1 Performs neuromonitoring	96.1	***U***	100		c
1.2 Interprets principles of ECG monitoring	98.2	***U***	100		c
1.3 Performs and interprets invasive hemodynamic monitor	95.2	***U/C***	100		c
1.4 Performs and interprets noninvasive hemodynamic monitor	95.4	***U/C***	100		c
1.5 Performs and interprets respiratory mechanics monitor under supervision	95.4	***U/C***	100		b
1.6 Performs and interprets metabolic monitoring under supervision (oxygen consumption, carbon dioxide production, respiratory quotient)	94.3	***U***	100		b
1.7 Conducts multimodality monitoring in NICU	95.2	***U***	91	100	c
2. General critical care practical procedures and therapeutic interventions					
2.1 Performs arterial catheterization	96.2	***U/A/C/E***	73	100	c
2.2 Teaches or supervises others central venous catheter insertion	96.4	***U/A/C/E***	100		d
2.3 Conducts vasoactive/inotropic medication therapy	97.4	***U/C/E***	100		c

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2.4 Teaches or supervises others to perform cardiopulmonary resuscitation, postresuscitation brain protection, to provide advanced life support for postresuscitation patient	98.2	***U/C/E***	100		d
2.5 Teaches or supervises others to perform cardioversion and defibrillation	98.1	***C/E***	100		d
2.6 Performs airway maintenance and ventilation in nonintubated/unconscious patients	97.4	***U/A/C/E***	100		c
2.7 Performs tracheal intubation	96.7	***U/A/C***	100		c
2.8 Performs difficult and failed airway management	90.7	***E***	100		c
2.9 Performs and interprets intra-abdominal pressure monitor	88.6	***C***	73	100	c
2.10 Teaches or supervises others to perform tracheal aspiration	94.9	***C/E***	82	100	d
2.11 Teaches or supervises others to perform oxygen therapy	97.4	***C/E***	100		d
2.12 Performs fibreoptic bronchoscopy and bronchoalveolar lavage in the intubated patient under supervision	92.0	***U /E***	91	100	b
2.13 Explains and performs recruitment maneuver: principle and practice under supervision	93.4	***C***	100		b

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2.14 Performs thoracocentesis via a chest drain	91.0	***U/C/E***	100			c
2.15 Performs percutaneous tracheostomy	91.2	***U/E***	100			c
2.16 Performs bedside ultrasound to localize pleural effusion and ascites under supervision	89.9	***C***	73	82	100	b
2.17 Assesses inferior caval vein by ultrasound under supervision	-	***O***	82	91	100	b
2.18 Performs ultrasound techniques for vascular localization	89.9	***E***	73	82	100	c
2.19 Performs thyrocricocentesis under supervision	-	***O***	82	91	100	b
3. Neurocritical care practical procedures and therapeutic interventions						
3.1 Performs lumbar puncture	93.8	***U/A/C/E***	100			c
3.2 Performs shunt and ventricular drain tap for CSF sampling	94.1	***U***	100			c
3.3 Manages external ventricular drains	93.8	***U***	100			c
3.4 Assesses and manages pain of neurocritical care patients	96.2	***U/A/C/E***	100			c
3.5 Assesses sedation and describes principle	97.0	***U/A/C***	100			c
3.6 Interprets and manages of ICP and cerebral perfusion	94.5	***U/A***	100			c

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pressure data						
3.7 Interprets of saturation of jugular venous oxygenation and brain tissue oxygen data under supervision	86.9	***U***	73	100		b
3.8 Performs systemic moderate hypothermia under supervision	95.4	***U***	100			b
3.9 Manages fluid and conducts osmotic dehydration treatment	96.3	***O***	100			c
3.10 Performs and interprets cerebral multimodality monitoring (pH, partial pressure of carbon dioxide, laser Doppler, microdialysis) under supervision	89.9	***U/A***	82	100		b
3.11Performs lumbar drain insertion	84.2	***U***	82	100		c
3.12 Manages and inserts ICP monitoring	87.4	***U/A***	82	100		c
3.13 Manages cerebral oximetric or perfusion monitoring under supervision	90.1	***U/A***	91	100		b
3.14 Performs brain ventricle puncture under supervision	-	***O***	91	100		b
3.15 Interprets CT/MRI of nervous system under supervision	94.8	***U***	73	82	100	b
3.16 Chooses neuromuscular blockade and describes indication of it under supervision	88.6	***C/E***	82	82	100	b

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D. Professionalism and system management					
1. Gather accurate, essential information from all sources, including medical interviews, physical examinations, medical records and Laboratory and radiological results	96.7	***U/C/E***	100		c
2. Integrates clinical findings with laboratory investigations to form a differential diagnosis	97.1	***U/C/E***	100		c
3. Involves patients (or their surrogates if applicable) in decisions about care and treatment (including informed consent and end-of-life care)	96.9	***U/A/C/E***	100		c
4. Promotes collaborative practice principles, including multidisciplinary cooperation and effective team working	97.0	***U/E***	100		c
5. Ensures continuity of care through effective handover of clinical information	97.7	***C/E***	100		c
6. Describes implications of chronic and comorbid disease in the acutely ill patient	93.5	***C/E***	91	100	c
7. Seeks learning opportunities and integrates new knowledge into clinical practice	98.2	***U/C/E***	100		c
8. Applies knowledge to clinical problem solving, clinical decision making, and critical thinking.	98.3	***U/E***	100		c
9. Develops a clinically applicable knowledge of the basic	98.1	***U***	100		c

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and clinical sciences that underlie the practice of neurointensive care					
10. Provides effective and professional consultation to physicians and health care professionals of other specialty	97.5	***U***	100		c
11. Maintains accurate medical records and documentation	97.5	***U/C/E***	100		c
12. Communicates the continuing care requirements of patients at ICU discharge to health care professionals, patients and relatives	96.9	***E***	100		b
13. Manages the safe and timely discharge of patients from ICU	93.5	***C/E***	100		c
14. Identifies and minimizes risk of critical incidents and adverse events	97.5	***C/E***	100		c
15. Recognizes and identifies deficiencies in peer performance	96.9	***U***	91	100	c
16. Identifies environmental hazards and promotes safety for patients and staff	97.3	***C/E***	82	100	c
17. Communicates effectively with patients, relatives and members of the healthcare team	98.6	***U/C/E***	100		c
18. Respects privacy, dignity, confidentiality, and legal constraints on the use of patient data	98.3	***U/C/E***	100		c

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19. Demonstrates sensitivity and responsiveness to gender, age, culture, religion, sexual preference, socioeconomic status, beliefs, behaviors and an awareness of their impact on decision making	97.5	***U/E***	100	c
20. Demonstrates respect, compassion, integrity, and altruism in relationships with patients, families, and colleagues.	97.9	***U***	100	c
E. Ethical and legal aspects of critical care medicine				
1. Evaluates death and dying, performs brainstem death testing under supervision	98.0	***U/A/E***	100	b
2. Manages palliative care of the critically ill patient, forgos life-sustaining treatment and orders not to resuscitate under supervision	96.7	***U/E***	100	b
3. Applies and describes practice to minimizes the physical and psychosocial consequences of critical illness for patients and families under supervision	96.4	***C/E***	100	b
4. Formulates clinical decisions with respect for ethical and legal principles	96.7	***U/C/E***	100	c
5. Adheres to principles of confidentiality, scientific/academic integrity, and informed consent.	96.8	***U***	100	c
F. Principles of research and certification				

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1. Presentation preparation and skills	90.7	***U***	73	100	c
2. Certification					
2.1 Basic life support	96.2	***C***	100		d
2.2 Advanced cardiac life support	97.0	***C***	100		c
G. Scoring systems					
1. General status scoring					
1.1 Acute physiology and chronic health evaluation II	95.1	***C***	100		c
1.2 Simplified acute physiology score II	89.2	***C***	73	100	c
2. Organs scoring:					
2.1 Acute kidney injury scoring (KDIGO)	90.6	-	73	100	c
2.2 Sequential organ failure assessment	89.5	***C***	91	100	c
3. Sedation, pain and delirium scoring:					
3.1 Critical care pain observation tool	91.3	-	100		d
3.2 Richmond agitation-sedation scale	94.9	-	100		c
3.3 The confusion assessment method for the diagnosis of delirium in the ICU	92.8	-	100		c

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3.4 Self-rating anxiety scale	94.6	***O***	100		c
4. Neural system scoring					
4.1 Glasgow coma scale	97.0	-	100		d
4.2 National institute of health stroke scale	89.8	***O***	82	100	c

* Source of list: ***U***: United Council for Neurologic Subspecialties, ***A***: American Academy of Neurology, ***C***: Chinese College of Intensive and Critical Care Medicine, ***E***: Competency-based Training Programme in ICM for Europe, ***O***: Online Delphi, **-**: during generation and rearrangement of competencies list before the first round of Delphi.

‡ Minimum level of expertise identified during the fifth round nominal group (NG) meeting:

Level a: Has knowledge of (describes) …

Level b: Performs (manages, conducts, demonstrates, assesses, interprets) … under supervision

Level c: Performs (manages, conducts, demonstrates, assesses, interprets) … independently

Level d: Teaches or supervises others to perform (manages) ...

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Table S4. Eliminated items during nominal group meeting

Domain	Eliminated items	Median (IQR) in the fourth round NG rating
A. Neurological disease states		
	1. Cerebrovascular diseases	
	1.1 Infarction and ischemia	
	a. Transient ischemic attacks aggravate	4 (4, 5)
	b. Occlusive vasculopathies (Moya-Moya, sickle cell)	4 (4, 5)
	c. Spinal cord infarction	4 (2, 4)
	1.2. Vascular malformations	
	a. AV fistulas	5 (4, 5)
	b. Cavernous angiomas	4 (4,5)
	c. Venous angiomas	4 (4, 5)
	1.3 Dural sinus thrombosis	5 (4, 5)
	1.4 Cerebral amyloid angiopathy	5 (4, 5)
	1.5 Stroke mimics	3 (2, 4)
	1.6 Traumatic aneurysm	5 (4, 5)

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2. Neurotrauma	
2.1 Traumatic brain injury	
a. Skull fracture	5 (5, 5)
b. Fat emboli	5 (3, 5)
3. Neuromuscular diseases	
3.1 Amyotrophic lateral sclerosis	4 (3, 4)
3.2 Rhabdomyolysis and toxic myopathies	5 (4, 5)
3.3 Critical illness myopathy and neuropathy	5 (4, 5)
3.4 Multiple sclerosis	4 (2, 4)
3.5 Mitochondrial encephalomyopathy	2 (1, 4)
3.6 Hypokalemic periodic paralysis	4 (2, 4)
4. Infections	
4.1 Tetanus	4 (4, 5)
4.2 Botulism	3 (3, 4)
5. Toxic-metabolic disorders	
5.1 Neuroleptic malignant syndrome/malignant hyperthermia	5 (4, 5)

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5.2 Serotonin syndrome	2 (2, 3)
5.3 Wernicke's encephalopathy	3 (2, 4)
6. Inflammatory and demyelinating diseases	
6.1 Multiple sclerosis	4 (3, 4)
6.2 Neurosarcoidosis	4 (2, 5)
6.3 Acute disseminated encephalomyelitis	4 (3, 5)
6.4 Central nervous system vasculitis	4 (2, 5)
6.5 Chemical or sterile meningitis (i.e., posterior fossa syndrome, nonsteroidal antiinflammatory drug-induced)	4 (2, 5)
6.6 Autoimmune encephalitis	4 (4, 5)
7.Encephalopathies	
7.1 Eclampsia, including hemolysis, elevated liver enzymes, low platelet count syndrome	5 (5, 5)
7.2 Uremic encephalopathy	5 (4, 5)
7.3 Mitochondrial encephalopathy, lactic acidosis, and stroke like (episodes) and related disorders	4 (2, 5)
7.4 Creutzfeldt-jakob encephalopathy	3 (2, 4)
8.Neuroendocrine disorders	
8.1 Panhypopituitarism	4 (4, 5)

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8.2 Multinle endocrine neoplasia	3 (2, 4)
9. Movement disorders	
9.1 Hemiballismus	2 (1, 4)
9.2 Acute dystonic reactions	3 (1, 4)
9.3 Amyotrophic lateral sclerosis	4 (2, 4)
10. Clinical Syndromes	
10.1 Vegetative state	5 (5, 5)
10.2 Abulia	5 (5, 5)
10.3 Dysautonomia (central fever, hyperventilation, etc)	5 (5, 5)
10.4 Psychiatric emergencies	5 (4, 5)
10.5 Locked-in syndrome	4 (3, 5)
10.6 Cord compression	5 (4, 5)
10.7 Brain death	5 (4, 5)
11. Perioperative neurosurgical care	
11.1 Intracranial pneumatosis	5 (4, 5)
11.2 Postcraniotomy CSF hypovolemia	5 (5, 5)

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	11.3 Postcarotid endarterectomy/stenting hyperperfusion syndrome	5 (4, 5)
	12. Neuro-Oncology	
	12.1 Brain tumors and metastases	5 (5, 5)
	12.2 Spinal cord tumors and metastases	4 (4, 5)
	12.3 Carcinomatous meningitis	3 (2, 4)
	12.4 Paraneoplastic syndromes	4 (2, 4)
	13. Pharmacotherapeutics	5 (4, 5)
B. General medical disease states		
	1. Cardiovascular	
	1.1 Acute aortic and peripheral vascular disorders (i.e., dissection, pseudoaneurysm)	5 (4, 5)
	1.2 Rupture of aneurysm (bleeding and cardiac tamponade)	5 (4, 5)
	1.3 Acute myocarditis	4 (2, 5)
	1.4 Cardiac-cerebralsyndrome	4 (4, 5)
	1.5 Right heart failure	5 (4, 5)
	2. Respiratory	
	2.1 Pulmonary hemorrhage and massive hemoptysis	5 (5, 5)

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2.2 Sleep apnea	4 (2, 5)
2.3 Obesity-hypoventilation syndrome	4 (2, 4)
2.4 Smoke inhalation, airway burns	4 (2, 5)
3. Renal	
3.1 Critically ill patients with chronic renal failure	4 (4, 5)
3.2 Continuous renal replacement therapy	5 (3, 5)
4. Metabolic and endocrine effects of critical illness	
4.1 Thyroid storm	5 (4, 5)
4.2 Adrenal crisis	5 (4, 5)
4.3 Pheochromocytoma	4 (4, 5)
4.4 Disorders of calcium and magnesium balance	5 (3, 5)
4.5 Hypothyroidism	4 (4, 5)
4.6 Low serum T3 syndrome	3 (2, 5)
5. Infectious disease	
5.1 Severe community acquired infection (e.g., severe community-acquired pneumonia)	4 (4, 5)
5.2 HIV/AIDS	4 (3, 5)

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5.3 Atypical pathogens and viral infections	4 (4, 5)
5.4 Fever in critically ill patient	5 (4, 5)
6. Acute hematologic disorders	
6.1 Acute hemolytic disorders including thrombotic microangiopathies	5 (4, 5)
7. Acute GI and genitourinary disorders	
7.1 Acute and fulminant hepatic failure (including drug dosing)	5 (4, 5)
7.2 Ileus and toxic megacolon	4 (3, 5)
7.3 Acute perforations of the gastrointestinal tract	4 (4, 5)
7.4 Acute vascular disorders of the intestine, including mesenteric infarction	4 (3, 5)
7.5 Acute intestinal obstruction, volvulus	4 (3, 5)
7.6 Pancreatitis	4 (4, 5)
7.7 Urinary tract bleeding	4 (3, 5)
7.8 Obstructive uropathy, acute urinary retention	4 (3, 5)
7.9 Intra-abdominal infection and gastrointestinal leakage	5 (4, 5)
8. Immunology and transplantation	
8.1 Immunosuppression, especially the neurotoxicity of these agents	3 (2, 5)

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9.Others	
9.1 Acute illness in pregnancy	5 (4, 5)
9.2 Acute illness in pediatric	4 (3, 5)
9.3 Initial approach to the manages multisystem trauma	5 (4, 5)
9.4.ICU sleep disorders	5 (4, 5)
C. Critical care monitoring practical procedures	
1. General critical care practical procedures and therapeutic interventions	
1.1 Peripheral venous line placement	5 (4, 5)
1.2 Nasogastric tube placement	4 (3, 5)
1.3 Urinary catheterization	4 (3, 5)
1.4 Administration of nitric oxide or prostacyclin	3 (2, 4)
1.5 Fibreoptic laryngoscopy	4 (4, 5)
1.6 Echocardiography	4 (4, 5)
1.7 Pulmonary ultrasonography	4 (4, 5)
1.8 Percutaneous gastrostomy	2 (1, 4)
1.9 Extracorporeal membrane oxygenation and other circulatory support systems	3 (2, 5)

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1.10 Enteral nutrititon nasogastrojejunal tube placement	5 (4, 5)
1.11 Pericardiocentesis	4 (3, 5)
1.12 Sengstaken tube (or equivalent) placement	3 (3, 5)
1.13 Indications for gastroscopy	4 (4, 5)
2. Neurocritical care practical procedures and therapeutic interventions	
2.1 Interpretation of continuous electroencephalogram monitoring	5 (4, 5)
2.2 Jugular venous bulb catheterization	4 (3, 5)
2.3 Plasmapheresis and intravenous immunoglobulin	4 (4, 5)
2.4 Administration of intravenous and intraventricular thrombolysis	4 (3, 5)
2.5 Intrathecal administration of chemotherapy, and radiographic agents	5 (4, 5)
2.6 Nervous system ultrasound	4 (3, 5)
2.7 Interpretation of single photon emission-CT and positron emission tomography	3 (2, 3)
2.8 Positron emission tomography	3 (2, 3)
2.9 Endovascular neurosurgical training (e.g., Guglielmi detachable coil placement, arterial stenting, cerebral angioplasty, intraarterial thrombolysis)	3 (2, 4)
D. Professionalismand system management	

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1. Describes and explains the managerial and administrative responsibilities of the ICM specialist	5 (4, 5)
2. Medical economics: health care reimbursement, budget development	4 (4, 5)
F. Principles of research and certification	
1. Study design	4 (4, 5)
2. Biostatistics	4 (4, 5)
3. Grant funding and protocol writing	4 (4, 4)
4. Manuscript preparation	4 (4, 5)
5. Institutional review boards and health insurance portability and accountability act	4 (3, 5)
G. Scoring systems	
1.General status scoring:	
1.1 Therapeutic Intervention Scoring System	4 (4, 4)
1.2 Multiple organ dysfunction score	4 (3, 5)
2. Organs scoring:	
2.1 Killip class	4 (4, 5)
2.2 NYHA class	5 (4, 5)
2.3 Acute lung injury scoring	4 (4, 5)

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2.4 The Child-Pugh score	4 (4, 4)
2.5 Acute kidney injury scoring (AKIN, RIFLE)	4 (3, 5)
2.6 Acute pancreatitis scoring	4 (4, 5)
3. Sedation, pain and delirium scoring:	
3.1.Ramsay sedation score	4 (2, 5)
3.2 CHADS-2 risk scores in chronic atrial fibrillation	4 (3, 5)
4. Trauma scoring	
4.1 Injury severity score	4 (4, 5)
4.2 Abbrebiated injury scale	4 (4, 5)

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Core competencies in neurocritical care training in China: consensus developed by a national Deiphi consensus survey combined with nominal group technique

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Online Supplementary Appendix 2

Comparaison of core competencies established in the present study with those from other international bodies

Items in our core competencies	Overlap with other sources			
	UCNS	AAN	CoBaTrICE	CCICCM
A. Neurological disease states				
1. Cerebrovascular diseases				
1.1. By the end of neurocritical care training, the trainee should be able to manage infarction and ischemia independently				
1.1.1. Massive hemispheric infarction	√	√		
1.1.2. Basilar artery occlusion and stenosis	√	√		

1.1.3. Carotid artery occlusion and stenosis	√	√		
1.1.4. Delayed cerebral ischemia				
1.2. By the end of neurocritical care training, the trainee should be able to manage intracerebral hemorrhage independently				
1.2.1. Supratentorial	√	√		
1.2.2. Cerebellar	√	√		
1.2.3. Brainstem	√	√		
1.2.4. Intraventricular	√	√		
1.2.5 Subarachnoid hemorrhage aneurysmal and others	√	√		
1.3. By the end of neurocritical care training, the trainee should be able to manage arteriovenous malformations independently	√			
1.4. By the end of neurocritical care training, the trainee should be able to manage carotidcavernous fistulae independently	√			
1.5. By the end of neurocritical care training, the trainee should be able to manage cervical and cerebral arterial dissections under supervision	√			
2. Neurotrauma				
2.1. By the end of neurocritical care training, the trainee should be able to manage				

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traumatic brain injury independently				
2.1.1. Axonal shearing injury	√	√		
2.1.2. Epidural hematoma	√	√		
2.1.3. Subdural hematoma	√	√		
2.1.4. Contusions and lacerations	√	√		
2.1.5. Penetrating craniocerebral injuries	√	√		
2.1.6. Traumatic SAH	√	√		
2.2 By the end of neurocritical care training, the trainee should be able to manage spinal cord injury independently	√	√		√
3. Status epilepticus				
3.1. By the end of neurocritical care training, the trainee should be able to manage convulsive status epilepticus independently	√	√		√
3.2. By the end of neurocritical care training, the trainee should be able to manage nonconvulsive status epilepticus independently	√	√		√
3.3. By the end of neurocritical care training, the trainee should be able to manage myoclonic epilepsy independently	√	√		√
4. Neuromuscular diseases				

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4.1. By the end of neurocritical care training, the trainee should be able to manage myasthenia gravis independently	√	√		
4.2. By the end of neurocritical care training, the trainee should be able to manage GuillainBarré syndrome independently	√	√		
5. Infections				
5.1. By the end of neurocritical care training, the trainee should be able to manage encephalitis (viral, bacterial, parasitic) independently	√	√		√
5.2. By the end of neurocritical care training, the trainee should be able to manage meningitis (viral, bacterial, parasitic) independently	√	√		√
5.3. By the end of neurocritical care training, the trainee should be able to manage brain and spinal epidural abscess under supervision	√			√
6. Toxicmetabolic disorders				
6.1. By the end of neurocritical care training, the trainee should be able to manage drug overdose and withdrawal independently	√		√	√
6.2. By the end of neurocritical care training, the trainee should be able to manage temperaturerelated injuries independently	√			
6.3. By the end of neurocritical care training, the trainee should be able to manage				

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carbon monoxide poisoning and delayed encephalopathy independently				
7. Inflammatory and demyelinating diseases				
7.1. By the end of neurocritical care training, the trainee should be able to manage central pontine myelinolysis independently	√			
7.2. By the end of neurocritical care training, the trainee should be able to manage osmotic demyelination syndrome independently				
8. Encephalopathies				
8.1. By the end of neurocritical care training, the trainee should be able to manage hepatic encephalopathy independently	√			
8.2. By the end of neurocritical care training, the trainee should be able to manage hypoxicischemic encephalopathy independently	√			
8.3. By the end of neurocritical care training, the trainee should be able to manage metabolic encephalopathy independently				
8.4. By the end of neurocritical care training, the trainee should be able to manage hypertensive encephalopathy and posterior reversible encephalopathy syndrome (PRES) independently	√			
9. Neuroendocrine disorders				

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9.1. By the end of neurocritical care training, the trainee should be able to manage pituitary apoplexy independently	√			
9.2. By the end of neurocritical care training, the trainee should be able to manage diabetes insipidus independently	√			
10. Movement disorders				
10.1. By the end of neurocritical care training, the trainee should be able to manage movement disorders (severe dystonia and opisthotonos) independently	√			
11. Clinical syndromes				
11.1. By the end of neurocritical care training, the trainee should be able to teach or supervise others to manages coma	√	√		√
11.2. By the end of neurocritical care training, the trainee should be able to manage herniation syndromes independentl	√		√	√
11.3. By the end of neurocritical care training, the trainee should be able to manage elevated intracranial pressure independently	√		√	√
11.4. By the end of neurocritical care training, the trainee should be able to manage intracranial hypotension/ hypovolemia independently	√		√	
11.5. By the end of neurocritical care training, the trainee should be able to manage	√	√	√	

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hydrocephalus independently				
11.6. By the end of neurocritical care training, the trainee should be able to manage delirium independently	√	√		
12. Perioperative neurosurgical care				
12.1. By the end of neurocritical care training, the trainee should be able to manage postcraniotomy hypertension independently	√			
12.2. By the end of neurocritical care training, the trainee should be able to manage postcraniotomy pain independently	√			
12.3. By the end of neurocritical care training, the trainee should be able to manage wound cerebrospinal fluid (CSF) leaks independently	√			
12.4. By the end of neurocritical care training, the trainee should be able to manage wound infections independently	√			
12.5. By the end of neurocritical care training, the trainee should be able to manage postoperative brain edema independently	√	√		
12.6. By the end of neurocritical care training, the trainee should be able to manage postcraniotomy intracranial hemorrhage independently	√			
12.7. By the end of neurocritical care training, the trainee should be able to assess	√			

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and manage postcervical spine surgery airway independently				
12.8. By the end of neurocritical care training, the trainee should be able to assess and manage highrisk postoperative neurosurgical patient independently	√		√	√
13. By the end of neurocritical care training, the trainee should be able to conduct neurorehabilitation independently	√			
B. General medical disease states				
1. Cardiovascular				
1.1. By the end of neurocritical care training, the trainee should be able to recognize and manage different types of shock independently	√		√	√
1.2. By the end of neurocritical care training, the trainee should be able to recognize and manage myocardial infarction and unstable coronary syndromes independently	√			√
1.3. By the end of neurocritical care training, the trainee should be able to recognize and manage neurogenic cardiac disturbances (electrocardiographic changes, stunned myocardium) independently	√			
1.4. By the end of neurocritical care training, the trainee should be able to assess and manage lifethreatening arrhythmia independently	√		√	√
1.5. By the end of neurocritical care training, the trainee should be able to recognize	√			√

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and manage left ventricular failure and/or acute pulmonary edema independently				
1.6. By the end of neurocritical care training, the trainee should be able to recognize and manage neurogenic pulmonary edema independently	√			
1.7. By the end of neurocritical care training, the trainee should be able to manage hypertension crisis independently	√			√
1.8. By the end of neurocritical care training, the trainee should be able to perform and interpret cardiac output and hemodynamic monitor independently	√	√	√	√
1.9. By the end of neurocritical care training, the trainee should be able to perform electrocardiography and interpretsthe results independently			√	√
2. Respiratory				
2.1. By the end of neurocritical care training, the trainee should be able to assess and manage acute and chronic respiratory failure (type I and type II) independently	√			√
2.2. By the end of neurocritical care training, the trainee should be able to manage chronic obstructive pulmonary disease (COPD) and status asthmaticus under supervision	√			√
2.3. By the end of neurocritical care training, the trainee should be able to recognize (diagnosis and grading) and manage acute respiratory distress syndrome (ARDS)	√		√	√

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independently				
2.4. By the end of neurocritical care training, the trainee should be able to manage aspiration independently	√			
2.5. By the end of neurocritical care training, the trainee should be able to recognize and manage upper airway obstruction independently	√			√
2.6. By the end of neurocritical care training, the trainee should be able to recognize and manage bronchopulmonary infections independently	√			
2.7. By the end of neurocritical care training, the trainee should be able to recognize and manage pleural diseases (empyema, effusion, pneumothorax) independently	√			√
2.8. By the end of neurocritical care training, the trainee should be able to recognize and manage neurogenic breathing patterns (central hyperventilation, CheyneStokes respirations, et cetera) independently	√			
2.9. By the end of neurocritical care training, the trainee should be able to assess and manage thromboembolic disease (including pulmonary embolism) under supervision independently				√
2.10. By the end of neurocritical care training, the trainee should be able to interpret chest radiographs independently	√		√	√

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2.11. By the end of neurocritical care training, the trainee should be able to interpret chest CT image independently				√
2.12. By the end of neurocritical care training, the trainee should be able to perform and interpret end tidal CO_2 monitoring independently	√			
2.13. By the end of neurocritical care training, the trainee should be able to perform and interpret arterial blood gas analysis independently			√	√
2.14. By the end of neurocritical care training, the trainee should be able to manage noninvasive and invasive echanical ventilation independently (indication,rational, complication, and weaning)	√	√	√	√
3. Renal				
3.1. By the end of neurocritical care training, the trainee should be able to assess and manage fluid, electrolytes disorders independently	√		√	√
3.2. By the end of neurocritical care training, the trainee should be able to recognize (diagnosis and grading) and manage acute kidney injury independently	√		√	√
3.3. By the end of neurocritical care training, the trainee should be able to recognize and manage derangements secondary to alterations in osmolality and electrolytes independently	√			

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3.4. By the end of neurocritical care training, the trainee should be able to manage acidbase disorders independently	√	√		√
3.5. By the end of neurocritical care training, the trainee should be able to manage oliguria and polyuria independently	√			
3.6. By the end of neurocritical care training, the trainee should be able to manage rhabdomyolysis under supervision	√			
3.7. By the end of neurocritical care training, the trainee should be able to conduct drug dose adjustment in renal failure independently	√			√
3.8. By the end of neurocritical care training, the trainee should be able to manage cerebral salt wasting independently	√			
3.9. By the end of neurocritical care training, the trainee should be able to manage syndrome of inappropriate antidiuretic hormone (SAIDH) independently	√			
4. Metabolic and endocrine effects of critical illness				
4.1. By the end of neurocritical care training, the trainee should be able to manage diabetes mellitus (ketotic and hyperglycemic hyperosmolar coma, hypoglycemia) independently	√			√
4.2. By the end of neurocritical care training, the trainee should be able to manage	√			

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systemic inflammatory response syndrome (SIRS) independently				
4.3. By the end of neurocritical care training, the trainee should be able to perform enteral/ parenteral nutritional support independently	√	√	√	√
4.4. By the end of neurocritical care training, the trainee should be able to manage pituitary crisis under supervision				
5. Infectious Disease				
5.1. By the end of neurocritical care training, the trainee should be able to comply with infection control measures independently	√		√	√
5.2. By the end of neurocritical care training, the trainee should be able to perform antimicrobial agent selection and determine dose in critically ill patients independently	√		√	√
5.3. By the end of neurocritical care training, the trainee should be able to manage hospital acquired and opportunistic infections in the critically ill patient independently	√	√		√
5.4. By the end of neurocritical care training, the trainee should be able to assess and manage fever in critically ill patient independently	√			√
5.5. By the end of neurocritical care training, the trainee should be able to conduct	√			√

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interpretation of antibiotic concentrations and sensitivities independently				
5.6. By the end of neurocritical care training, the trainee should be able to recognize and manage sepsis, severe sepsis, and septic shock independently			√	√
5.7. By the end of neurocritical care training, the trainee should be able to recognize and manage multidrug resistance bacteria infection independently				
5.8. By the end of neurocritical care training, the trainee should be able to perform antimicrobial agent selection in neurological infections independently				
6. Acute hematologic disorders				
6.1. By the end of neurocritical care training, the trainee should be able to manage disseminated intravascular coagulation under supervision	√			√
6.2. By the end of neurocritical care training, the trainee should be able to conduct anticoagulation and fibrinolytic therapy independently	√	√		√
6.3. By the end of neurocritical care training, the trainee should be able to conduct blood component therapy independently	√		√	√
6.4. By the end of neurocritical care training, the trainee should be able to conduct hemostatic therapy independently	√			
6.5. By the end of neurocritical care training, the trainee should be able to recognize	√			

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and manage hypercoagulable states under supervision				
6.6. By the end of neurocritical care training, the trainee should be able to recognize and manage traumatic coagulopathy independently				√
7. Acute gastrointestinal and genitourinary disorders				
7.1. By the end of neurocritical care training, the trainee should be able to assess and manage gastrointestinal bleeding independently	√			√
7.2. By the end of neurocritical care training, the trainee should be able to prescribe stress ulcer prophylaxis independently				√
7.3. By the end of neurocritical care training, the trainee should be able to assess and manage abdominal compartment syndrome independently	√			√
8. Immunology and transplantation				
8.1. By the end of neurocritical care training, the trainee should be able to interpret principles of transplantation (brain death, organ donation, procurement, maintenance of organ donors, implantation) under supervision	√	√	√	
9. General trauma and burns				
9.1. By the end of neurocritical care training, the trainee should be able to assess and provide initial management of the trauma patient independently	√		√	√

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9.2. By the end of neurocritical care training, the trainee should be able to manage spine and pelvis trauma independently	√			
9.3. By the end of neurocritical care training, the trainee should be able to manage chest and abdominal trauma independently	√			
9.4. By the end of neurocritical care training, the trainee should be able to manage crush syndrome independently				
9.5. By the end of neurocritical care training, the trainee should be able to describe burns and electrical injury independently	√		√	
10. Transport				
10.1 By the end of neurocritical care training, the trainee should be able to teach of supervises patient assessment before transport			√	√
10.2. By the end of neurocritical care training, the trainee should be able to prepare equipment for transport independently				√
10.3. By the end of neurocritical care training, the trainee should be able to perform intrahospital transport independently				√
11. Others				
11.1. By the end of neurocritical care training, the trainee should be able to assess				√

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and manage multiorgan dysfunction syndrome independently				
11.2. By the end of neurocritical care training, the trainee should be able to manage ICU acquired weakness under supervision				
C. **Critical care monitoring practical procedures**				
1. Monitoring				
1.1. By the end of neurocritical care training, the trainee should be able to perform neuromonitoring independently	√			
1.2. By the end of neurocritical care training, the trainee should be able to interpret principles of ECG monitoring independently	√			
1.3. By the end of neurocritical care training, the trainee should be able to perform and interpret invasive hemodynamic monitor independently	√			√
1.4. By the end of neurocritical care training, the trainee should be able to perform and interpret noninvasive hemodynamic monitor independently	√			√
1.5. By the end of neurocritical care training, the trainee should be able to perform and interpret respiratory mechanics monitor under supervision	√			√
1.6. By the end of neurocritical care training, the trainee should be able to perform and interpret metabolic monitoring under supervision (oxygen consumption, carbon	√			

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dioxide production, respiratory quotient)				
1.7. By the end of neurocritical care training, the trainee should be able to conduct multimodality monitoring in NICU independently	√			
2. General critical care practical procedures and therapeutic interventions				
2.1. By the end of neurocritical care training, the trainee should be able to perform arterial catheterisation independently	√	√	√	√
2.2. By the end of neurocritical care training, the trainee should be able to teach or supervise others central venous catheter insertion	√	√	√	√
2.3. By the end of neurocritical care training, the trainee should be able to conduct vasoactive/inotropic medication therapy independently	√		√	√
2.4. By the end of neurocritical care training, the trainee should be able to teach or supervise others to perform cardiopulmonary resuscitation, postresuscitation brain protection, to provide advanced life support for postresuscitation patient	√		√	√
2.5. By the end of neurocritical care training, the trainee should be able to teach or supervise others to perform cardioversion and defibrillation			√	√
2.6. By the end of neurocritical care training, the trainee should be able to perform airway maintenance and ventilation in nonintubated/unconscious patients	√	√	√	√

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independently				
2.7. By the end of neurocritical care training, the trainee should be able to perform tracheal intubation independently	√	√		√
2.8. By the end of neurocritical care training, the trainee should be able to perform difficult and failed airway management independently			√	
2.9. By the end of neurocritical care training, the trainee should be able to perform and interpret intraabdominal pressure monitor independently				√
2.10. By the end of neurocritical care training, the trainee should be able to teach or supervise others to perform tracheal aspiration			√	√
2.11. By the end of neurocritical care training, the trainee should be able to teach or supervise others to perform oxygen therapy			√	√
2.12. By the end of neurocritical care training, the trainee should be able to perform fibreoptic bronchoscopy and bronchoalveolar lavage in the intubated patient under supervision	√		√	
2.13. By the end of neurocritical care training, the trainee should be able to explain and perform recruitment maneuver: principle and practice under supervision				√
2.14. By the end of neurocritical care training, the trainee should be able to perform	√		√	√

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thoracocentesis via a chest drain independently				
2.15. By the end of neurocritical care training, the trainee should be able to perform percutaneous tracheostomy independently	√		√	
2.16. By the end of neurocritical care training, the trainee should be able to performsbedside ultrasound to localize pleural effusion and ascites under supervision				√
2.17. By the end of neurocritical care training, the trainee should be able to assess inferior caval vein by ultrasound under supervision				
2.18. By the end of neurocritical care training, the trainee should be able to perform ultrasound techniques for vascular localisation independently			√	
2.19. By the end of neurocritical care training, the trainee should be able to perform thyrocricocentesis under supervision				
3. Neurocritical care practical procedures and therapeutic interventions				
3.1. By the end of neurocritical care training, the trainee should be able to perform lumbar puncture independently	√	√	√	√
3.2. By the end of neurocritical care training, the trainee should be able to perform shunt and ventricular drain tap for CSF sampling independently	√			
3.3. By the end of neurocritical care training, the trainee should be able to manage	√			

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external ventricular drains independently				
3.4. By the end of neurocritical care training, the trainee should be able to assess and manage pain of neurocritical care patients independently	√	√	√	√
3.5. By the end of neurocritical care training, the trainee should be able to assess sedation and describe principle it independently	√	√		√
3.6. By the end of neurocritical care training, the trainee should be able to interpret and manage of ICP and cerebral perfusion pressure data independently	√	√		
3.7. By the end of neurocritical care training, the trainee should be able to interpret saturation and jugular venous oxygenation and brain tissue oxygen data under supervision	√			
3.8. By the end of neurocritical care training, the trainee should be able to perform systemic moderate hypothermia under supervision	√			
3.9. By the end of neurocritical care training, the trainee should be able to manage fluid and conduct osmotic dehydration treatment independently				
3.10. By the end of neurocritical care training, the trainee should be able to perform and interpret cerebral multimodality monitoring (pH, partial pressure of carbon dioxide [pCO_2], laser Doppler, microdialysis) under supervision	√	√		

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3.11. By the end of neurocritical care training, the trainee should be able to perform lumbar drain insertion independently	√			
3.12. By the end of neurocritical care training, the trainee should be able to manage and insert ICP monitoring independently	√	√		
3.13. By the end of neurocritical care training, the trainee should be able to manage cerebral oximetric or perfusion monitoring under supervision	√	√		
3.14. By the end of neurocritical care training, the trainee should be able to perform brain ventricle puncture under supervision				
3.15. By the end of neurocritical care training, the trainee should be able to interpret CT/MRI of nervous system under supervision	√			
3.16. By the end of neurocritical care training, the trainee should be able to choose neuromuscular blockade and describe indication of it under supervision			√	√
D.Professionalism and system management				
1. By the end of neurocritical care training, the trainee should be able to gather accurate, essential information from all sources, including medical interviews, physical examinations, medical records and Laboratory and radiological results independently	√		√	√

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2. By the end of neurocritical care training, the trainee should be able to integrate clinical findings with laboratory investigations to form a differential diagnosis independently	√		√	√
3. By the end of neurocritical care training, the trainee should be able to involve patients (or their surrogates if applicable) in decisions about care and treatment (including informed consent and endoflife care) independently	√	√	√	√
4. By the end of neurocritical care training, the trainee should be able to promote collaborative practice independently, including multidisciplinary cooperation and effective team working	√		√	
5. By the end of neurocritical care training, the trainee should be able to ensure continuity of care through effective handover of clinical information independently			√	√
6. By the end of neurocritical care training, the trainee should be able to describe implications of chronic and comorbid disease in the acutely ill patient independently			√	√
7. By the end of neurocritical care training, the trainee should be able to seek learning opportunities and integrate new knowledge into clinical practice independently	√		√	√
8. By the end of neurocritical care training, the trainee should be able to apply knowledge to clinical problem solving, clinical decision making, and critical thinking	√		√	

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independently.				
9. By the end of neurocritical care training, the trainee should be able to develop a clinically applicable knowledge of the basic and clinical sciences that underlie the practice of neurointensive care	√			
10. By the end of neurocritical care training, the trainee should be able to provide effective and professional consultation to physicians and health care professionals of other specialty independently	√			
11. By the end of neurocritical care training, the trainee should be able to maintain accurate medical records and documentation independently	√		√	√
12. By the end of neurocritical care training, the trainee should be able to communicate the continuing care requirements of patients at ICU discharge to health care professionals, patients and relatives under supervision			√	
13. By the end of neurocritical care training, the trainee should be able to manage the safe and timely discharge of patients from ICU independently			√	√
14. By the end of neurocritical care training, the trainee should be able to identify and minimise risk of critical incidents and adverse events independently			√	√
15. By the end of neurocritical care training, the trainee should be able to recognize	√			

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and identifys deficiencies in peer performance independently				
16. By the end of neurocritical care training, the trainee should be able to identify environmental hazards and promote safety for patients and staff independently			√	√
17. By the end of neurocritical care training, the trainee should be able to communicate effectively with patients, relatives and members of the healthcare team independently	√		√	√
18. By the end of neurocritical care training, the trainee should be able to respect privacy, dignity, confidentiality, and legal constraints on the use of patient data	√		√	√
19. By the end of neurocritical care training, the trainee should be able to demonstrate sensitivity and responsiveness to gender, age, culture, religion, sexual preference, socioeconomic status, beliefs, behaviors and an awareness of their impact on decision making	√		√	
20. By the end of neurocritical care training, the trainee should be able to demonstrate respect, compassion, integrity, and altruism in relationships with patients, families, and colleagues	√			
E. Ethical and legal aspects of critical care medicine				
1. By the end of neurocritical care training, the trainee should be able to evaluate	√	√	√	

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death and dying, and perform brainstem death testing under supervision				
2. By the end of neurocritical care training, the trainee should be able to manage palliative care of the critically ill patient, forgo lifesustaining treatment and order not to resuscitate under supervision	√		√	
3. By the end of neurocritical care training, the trainee should be able to apply and describe practice to minimizes the physical and psychosocial consequences of critical illness for patients and families under supervision			√	√
4. By the end of neurocritical care training, the trainee should be able to formulate clinical decisions with respect for ethical and legal principles independently	√		√	√
5. By the end of neurocritical care training, the trainee should be able to adhere to principles of confidentiality, scientific/academic integrity, and informed consent independently	√			
F. Principles of research and certification				
1. By the end of neurocritical care training, the trainee should be able to perform presentation independently	√			
2. Certification				
2.1 By the end of neurocritical care training, the trainee should acquire the				√

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certification of basic life support				
2.2 By the end of neurocritical care training, the trainee should acquire the certification of advanced cardiac life support				√
G. Scoring systems				
1. General status scoring				
1.1. By the end of neurocritical care training, the trainee should be able to describe and assess patient with acute physiology and chronic health evaluation II score independently				√
1.2. By the end of neurocritical care training, the trainee should be able to describe and assess patient with simplified acute physiology score II score independently				√
2. Organs scoring				
2.1. By the end of neurocritical care training, the trainee should be able to describe and assess patient with acute kidney injury scoring (KDIGO) independently				
2.2. By the end of neurocritical care training, the trainee should be able to describe and assess patient with sequential organ failure assessment score independently				√
3. Sedation, pain and delirium scoring				
3.1. By the end of neurocritical care training, the trainee should be able to teach and				

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supervise others to perform CriticalCare Pain Observation Tool independently				
3.2. By the end of neurocritical care training, the trainee should be able to describe and assess patient with Richmond AgitationSedation Scale independently				
3.3. By the end of neurocritical care training, the trainee should be able to describe and assess patient with the confusion assessment method for the diagnosis of delirium in the ICU independently				
3.4. By the end of neurocritical care training, the trainee should be able to describe and assess patient with selfrating anxiety scale independently				
4. Neural system scoring				
4.1 By the end of neurocritical care training, the trainee should be able to teach and supervise others to perform Glasgow Coma Scale				
4.2 By the end of neurocritical care training, the trainee should be able to describe and assess patient with National Institute of Health Stroke Scale independently				

UCNS: United Council for Neurologic Subspecialties, ***AAN***: American Academy of Neurology, ***CCICCM***: Chinese College of Intensive and Critical Care Medicine, ***CoBaTrICE:*** Competencybased Training Programme in ICM for Europe

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5&6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5&6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Online appendix 1
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-8
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8
		(*e*) Describe any sensitivity analyses	8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	Figure 1

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Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	9
Outcome data	15*	Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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