Development and validation of an abbreviated questionnaire to easily measure cognitive failure in Intensive Care Unit survivors: a multicenter study

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**ABSTRACT**

**OBJECTIVES:** To develop and validate an abbreviated version of the Cognitive Failure Questionnaire (CFQ) that can be used by patients as part of self assessment to measure functional cognitive outcome in Intensive Care Unit (ICU) survivors.

**DESIGN:** A retrospective multicenter observational study.

**SETTING:** The ICUs of two Dutch university hospitals.

**PATIENTS:** Adult ICU survivors.

**INTERVENTIONS:** None.

**MEASUREMENTS AND MAIN RESULTS:** Cognitive functioning was evaluated between 12 and 24 months after ICU discharge using the full 25 item CFQ (CFQ-25). Incomplete CFQ-25 questionnaires were excluded from analysis.

Forward selection in a linear regression model was used in hospital A, to assess which of the 25 CFQ items should be included to prevent a significant loss of correlation between an abbreviated and the full CFQ-25. Subsequently, the performance of an abbreviated CFQ was determined in hospital B using Pearson’s correlation. A Bland Altman plot was used to examine whether the reduced-item outcome scores of an abbreviated CFQ were a replacement for the full CFQ-25 outcome scores.

Among 1934 ICU survivors 1737 were included, 819 in hospital A, 918 in hospital B. The Pearson’s correlation between the abbreviated 14 item CFQ and the CFQ-25 was 0.99. The mean of the difference scores was -0.26 and 95% of the difference scores fell within +5 and -5.5 on a 100-point maximum score.

**CONCLUSIONS:** It is feasible to use the abbreviated CFQ-14 to measure self-reported cognitive failure in ICU survivors as this questionnaire has a similar performance as the full CFQ-25.

**KEY WORDS**

Cognitive Dysfunction; Cognitive Failure Questionnaire; Critical Illness; Intensive Care Unit; Neuropsychological Tests; post-intensive care syndrome

**INTRODUCTION**

Recent advances in the treatment in the Intensive Care Unit (ICU) have resulted in substantially reduced mortality rates after critical illness.(1, 2) As a consequence, there has been a shift in emphasis from preventing immediate mortality to reducing long-term impact of critical illness in survivors.(3) Indeed, it has been shown that ICU survivors often develop physical, mental, and cognitive impairments following ICU discharge.(4, 5) These impairments are associated with a reduced health related quality of life (HRQOL), functional status and daily functioning of ICU survivors, and together have been coined as the post-intensive care syndrome (PICS).(2, 6) PICS has far reaching consequences for both ICU survivors and their families.(2, 7) In particular long-term cognitive impairment is a growing public health problem,(8) as it occurs in 4 to 62% of the ICU survivors (9) and poses a great burden on the economy.(10) Moreover, cognitive impairment is associated with depression, increased dependence and poor social functioning.(11) Both the frequent occurrence and deleterious consequences of cognitive impairment following critical illness require further recognition and action of both clinicians and researchers.(11) To date survivors’ perception of their cognitive function, which could help to understand the functional implications of cognitive impairment, received limited study. Improved identification of survivors’ perception of cognitive impairment is an essential step towards meeting the needs of ICU survivors and their families.

Post-ICU cognitive impairment affects a person’s attention, processing speed, memory, as well as executive function.(11) Consequently, everyday cognitive failure negatively impacts daily routine and HRQOL. Seemingly simple tasks that a person normally should be able to perform without errors, suddenly become complicated.(12, 13) To assess a person’s likelihood of committing such errors in everyday life, multiple self-report measures are available.(13) The Cognitive Failures Questionnaire (CFQ) designed by Broadbent et al. (1982) is the most frequently used and most comprehensive measure in terms of covered domains of daily life failures.(13, 14) This self-administered questionnaire consists of 25 items that cover failures of perception, memory, and motor function (14) and therefore is the designated questionnaire to identify ICU survivors’ perception of their cognitive function.

Given the multifaceted nature of PICS, several questionnaires are needed to study relevant issues related to physical, cognitive, and mental health impairments to enable a thorough measurement of the presence and consequences of PICS. In earlier studies in ICU survivors non-response was considered a problem with around 70% returned CFQ-25 despite sending reminders and/or follow-up phone calls.(15, 16) We hypothesize that introducing an optimal short form of the full 25 item CFQ (CFQ-25) for ICU survivors will possibly less burden the survivors as well as increase the response rates and efficiency. With that the aim of our study was to develop and validate an abbreviated version of the CFQ-25 that can be used by patients as part of self assessment to measure functional cognitive outcome in ICU survivors.

**MATERIALS and METHODS**

**Design and Study population**

This study was a retrospective study using the data of two prospective cohort studies aimed at examining the impact of delirium during ICU stay on long-term outcome and self-reported cognitive problems in survivors of critical illness carried out in two university hospitals in the Netherlands.(15, 16)

In the original studies (15, 16) all consecutive adults admitted to the mixed medical-surgical ICUs were included between January 2008 and February 2009 in Hospital A, and January 2011 and July 2014 in hospital B. In the original study (15) patients from hospital A were excluded if they had been admitted to the ICU for <1 day; were unable to be reliably assessed for delirium due to: sustained coma in the ICU, inability to understand Dutch, severe pre-existing mental disability such as retarded metal development or Alzheimer’s disease, serious receptive aphasia, or serious auditory or visual disorders; and if the delirium screening was not complete during their ICU stay. In the original study (16) patients from hospital B were excluded if they had been admitted to the ICU for <2 days, were transferred from an ICU of another hospital, or if they were suffering from an acute neurological illness such as stroke or subarachnoid hemorrhage or another condition that could hamper delirium assessment. In this current study patients were excluded from analysis when they had an incomplete CFQ-25.

This study was conducted in accordance with the applicable rules as described in the principles of the Declaration of Helsinki (64th WMA General Assembly, Fortaleza, Brazil, October 2013) and the Medical Research Involving Human Subjects Act (WMO).

The Medical ethical research committee (MREC) Arnhem-Nijmegen region, the Netherlands (CMO Region Arnhem-Nijmegen number 2010-008) and the local MREC from the University Medical Center Utrecht, the Netherlands (Institutional Review Board numbers 10-006, 10-056, 12-421) reviewed this study and waived the need for approval.

**Data collection**

After 12 to 24 months after ICU discharge, ICU survivors’ perceived cognitive functioning was evaluated using the validated Dutch translation of the CFQ-25.(17) This translated questionnaire has shown satisfactory psychometric qualities based on both a high test-retest stability and internal consistency.(17) We used the CFQ dimension structure of Wallace et al. (2002), comprising the four dimensions memory, distractibility, social blunders, and names.(15, 18, 19) On each of the 25 items the ICU survivors scored the frequency with which that type of cognitive failure occurred to them during the last 6 months, on a 5-point Likert scale ranging from “never” (0) to “very often” (4).(12) The most applied way to measure persons’ cognitive functioning based on their proneness to everyday cognitive mistakes, is to sum up the ratings of the 25 individual items of the CFQ, yielding a score from 0-100, with a higher score indicating more self-reported cognitive failure.(20)

Collected demographic variables were age, gender, admission type, acute admission, and Acute Chronic Health Evaluation II and IV (APACHE II and APACHE IV) were collected as measures for illness severity in the first 24 hours after ICU admission.(21, 22) Also data on ICU and hospital length of stay and delirium based on the Confusion Assessment Method for the ICU (CAM-ICU) were collected.(23, 24)

**Statistical analysis**

We firstly developed the abbreviated CFQ and subsequently we validated the abbreviated CFQ.

*Development of the abbreviated CFQ*

In the development phase, using data from hospital A, we used forward selection in a linear regression model to assess which of the 25 CFQ items should be included to prevent a significant loss of correlation between the abbreviated CFQ and the CFQ-25. Criteria to determine the optimal model for the abbreviated CFQ were: a minimal number of CFQ items with the maximum R Square possible and a proportional coverage of the items on the dimensions memory, distractibility, social blunders, and names.(18) This was operationalized as follows, we performed linear regression on the data with forward selection in SPSS. This resulted in 25 models, starting with 1 CFQ item up to 25 CFQ items which showed an increase in R Square as we added CFQ items to the model. We determined the point at which the R square was maximal with a minimal number of CFQ items possible, in other words, the point when the increase of R Square stabilized after including an extra CFQ item to the model. At this point we studied the number of included items and their coverage of the dimension structure. This analysis ultimately resulted in an abbreviated version of the CFQ for ICU survivors with the minimal number of items, that can replace the CFQ-25.

*Validation of the abbreviated CFQ*

Subsequently, in the validation phase the data of hospital B was used. First the performance of the abbreviated CFQ was assessed using Pearson’s correlation. Second, to examine whether the reduced-item outcome scores, i.e. the predicted scores, of the abbreviated CFQ were replaceable for the CFQ-25 outcome scores, and thus whether there was agreement between the abbreviated CFQ and the CFQ-25, we used a Bland Altman plot.

Differences between hospital A and B in demographic variables, illness severity, ICU and hospital length of stay, and delirium were calculated using T-test, Chi-square or Mann-Whitney U test depending on distribution and measurement level.

Data were analyzed using IBM® SPSS® Statistics version 22 for windows. Statistical significance was defined as p<0.05 and the null hypotheses were tested against two-sided alternatives.

**RESULTS**

Two cohorts were used. In hospital A 819 of the 914 ICU survivors (90%) had a complete CFQ-25. Their mean (SD) age was 63 (14) years, and 608 (67%) were male. The median length of ICU stay (LOS ICU) was 1 day [Interquartile range (IQR); 1-2]. 171 (19%) of the survivors were delirious during ICU admission. In hospital B 918 of the 1020 ICU survivors (90%) had a complete CFQ-25. These survivors had significantly different characteristics, including age, sex and APACHE scores. (Table 1) ICU survivors with incomplete CFQ-25 questionnaires also had comparable characteristics. In total, among 1934 ICU survivors, 1737 (90%) had a complete CFQ-25 available for analysis.

**Development of the abbreviated CFQ**

Following forward selection in a linear regression model, the predefined criteria that we used to determine the optimal model for the abbreviated CFQ comprising a minimal number of CFQ items, a maximum R Square and proportional coverage of the items on the dimensions memory, distractibility, social blunders, and names (18) were most optimal in the model with 14 CFQ items. The R Square of this model was 0.973, and the included questionnaire items were in order of forward selection 17, 21, 3, 9, 14, 6, 22, 10, 16, 12, 15, 7, 24, and 2. (Table 2, Table 3 and Appendix 1) The next step in forward selection would have resulted in a 15 item model with the identical CFQ items as the 14 item model plus questionnaire item 18 which belonged to dimension memory. Inclusion of item 18 would have resulted in an overrepresentation of the dimension memory compared to the other dimensions, especially blunders.(18) In addition, the increase of R square to 0.978 was not considered to be clinically relevant.

**Validation of the abbreviated CFQ**

The abbreviated CFQ-14 and the CFQ-25 were significantly correlated, R= 0.986 (p<0.0001). The mean (SD) score of the ICU survivors on the CFQ-25 was 22.8 (16.1) and the mean (SD) on the CFQ-14 23.0 (15.9).

The mean (SD) of the difference scores between the CFQ-25 and the CFQ-14 was -0.257 (2.67) which is surrounding zero. Of the difference scores 95% were falling within plus 5 and minus 5.5 on a 100-point maximum score. Meaning the CFQ-25 outcome scores are replaceable by the CFQ-14 outcome scores and as such the CFQ-14 can be used to assess self-reported cognitive failures in an ICU population. (Figure 1)

**DISCUSSION**

We describe the development and validation of an abbreviated self-reporting Cognitive Failure Questionnaire (CFQ-14) to assess cognitive failure in ICU survivors. This abbreviated version reproduces more than 98% of the variance of the original 25 item CFQ (CFQ-25) and the outcome scores are highly correlated with the original CFQ-25 outcome scores. Furthermore, the CFQ-25 outcome scores are replaceable by the CFQ-14 outcome scores. This means the abbreviated CFQ-14 is comparable to the CFQ-25 and can be used to examine ICU survivors’ perception of their cognitive functioning more efficiently than the full CFQ-25.

Given the major negative consequences of cognitive impairment following ICU admission,(2, 7) further recognition is warranted.(11) Routine screening for cognitive failure in ICU survivors could help to understand the functional implications of cognitive impairment and ultimately to early recognize PICS. Identification of cognitive failure is essential and clinically relevant as it provides clinicians with important functional information necessary for the support of the ICU survivors during their recovery. It also could provide valuable information regarding the ICU survivors’ HRQOL, which may be used by both clinicians and researchers to improve ICU patients’ outcome by the development and/or use of preventive measures.(25, 26) In line with the DSM-V the ultimate strategy to detect cognitive impairment is a combination of self-reported cognitive failure and objective neuropsychological tests.(27) The performance of neuropsychological tests, however, is very laborious and expensive. The CFQ-25 (14) is a realistic and already used strategy to screen large numbers of ICU survivors for self-reported cognitive failure,(15, 16, 28) however, the number of questions to answer and response rates are regarded a limitation. A shorter version likely improves the compliance of survivors to fill out the complete questionnaire and might result in a higher response rate.

As we consider the length of the CFQ-25 a weakness, we selected out a subset of CFQ items to develop an optimal short version and validated it in another sample of ICU survivors. Similar to multiple studies that were also aimed at the reduction of the number of questionnaire items in various questionnaire subjects and patient populations,(29-31) we used a linear regression model to select out the optimal subset of CFQ items. Another conventional approach for data reduction of questionnaires is principal component analysis.(32) However, we wanted to develop a measure that results in a total score comparable to the total score of original CFQ-25, because it allows for a direct comparison of the results between studies using the CFQ-14 for measuring cognitive failure, and studies using the CFQ-25. Since principal component analysis is less appropriate for this purpose we did not choose for this method.

The patient’s cognitive status before ICU admission is important in the identification of post-ICU cognitive failure. Due to critical illness and its consequences, a part of the ICU patients are unable to fill out a questionnaire at ICU admission; for these patients their next of kin are asked to complete the questionnaire. Earlier research showed that the ratings of respondents on the full 25 item CFQ significantly correlate to the ratings of their spouses.(14) This might be similar for our abbreviated version of the CFQ for ICU survivors, however, before using the CFQ-14 at ICU admission, by ICU patients or their next of kin, it should be validated for that purpose first.

Several risk factors for cognitive impairment in ICU survivors are known, including acute stress and acute disease, older age, and delirium.(11) Multiple studies reported an association between delirium duration and worse long-term cognitive outcomes.(8, 15, 16) Delirium frequently occurs in ICU patients.(33) In addition, the age of the world population is increasing. As age is an important risk factor for delirium,(34) the number of people with cognitive impairment is expected to grow, warranting low-threshold monitoring of cognitive function in ICU survivors. Due to its length and low burden, the short 14 item CFQ can easily be used in daily practice to measure self-reported cognitive failure following ICU admission providing valuable information about ICU survivors cognitive function. For example in outpatient clinics that are focused on intensive care follow-up. However, the specific test-performance of the CFQ-14, including perceived burden, response rate and completion time, still needs to be determined and compared to the original CFQ-25.

An important strength of this study is its large sample size. Our sample consisted of mixed (neuro) surgical, medical, trauma, and neurological patients, from two different ICUs with different characteristics of study population which contributes to the generalizability of the results. However, as in both cohorts trauma and neurocritical care patients are underrepresented, one should be cautious regarding generalization of our results towards this specific population. Future research should include a subgroup analysis to further study the applicability of the CFQ-14 in these specific patients.

However, several limitations of this study need to be addressed as well. First, although the short 14 item CFQ is a valid questionnaire to examine the experience of cognitive failures of ICU survivors, it is unclear whether or not self-evaluated subjective cognitive failure is related to objectively measured cognitive function. Previous studies, in various patient categories, on this subject have shown inconsistent results.(35, 36) Therefore it is important to study this relation in future research. Despite this knowledge gap, the self-evaluated CFQ-14 provides valuable information about ICU survivors’ perceived cognitive functioning which can be used to better recognize PICS and as an alert for the necessity of preventive measures or for further cognitive examination. Second, the CFQ is a self-reporting questionnaire and therefore one should take into account that under- or overestimation of cognitive failure may be an issue. Involvement of the ICU survivor’s next of kin in the survivors’ cognitive evaluation may be a solution to prevent this under- or over estimation.(28)

In conclusion, we developed and validated an abbreviated 14 item version of the CFQ which showed similar performance as the full 25 item questionnaire. It is feasible to use this CFQ-14 to measure self-reported cognitive failure in ICU survivors, possibly yielding increased response rates and efficiency.

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**Figure 1: Bland Altman plot of the CFQ-25 and the CFQ-14**

Validation phase: derived from hospital B data only.

**Table 1: Characteristics of the study population**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Hospital A****N= 819** | **Hospital B****N=918** | **P** |
| Age in years, mean (SD) | 62 (14) | 58 (16) | <0.001 |
| Male, N (%) | 563 (69) | 571 (62) | <0.05 |
| Admission type, N (%)Surgical Medical TraumaNeurological/-surgical | 597 (73)115 (14)38 (5)69 (8) | 470 (51)310 (34)0138 (15) | <0.001 |
| Acute admission, N (%)APACHE II score, mean (SD) | 341 (42)14 (5) | 619 (67)18 (7) | <0.001<0.001 |
| APACHE IV score, mean (SD) | 52 (20) | 62 (26) | <0.001 |
| CAM-ICU positive, N (%) | 143 (18) | 380 (49) | <0.001 |
| ICU Length of stay in days, median [IQR]Hospital Length of stay in days, median [IQR] | 1 [1-2]7 [5-13] | 5 [3-9]21 [13-36] | <0.001<0.001 |

**Table 2: Correlations with 25-item CFQ and formula 14-item CFQ model**

|  |  |  |
| --- | --- | --- |
| **Model** | **R** | **R square** |
| 1 | 0.748 | 0.560 |
| 5 | 0.942 | 0.886 |
| 10 | 0.974 | 0.949 |
| 11 | 0.978 | 0.957 |
| 12 | 0.981 | 0.963 |
| 13 | 0.984 | 0.969 |
| 14 | 0.987 | 0.973 |
| 15 | 0.989 | 0.978 |
| 16 | 0.990 | 0.980 |

Formula 14-item CFQ model# = (0.483 + (1.488 \* CFQ\_17) + (2.184 \* CFQ\_21) + (1.779 \* CFQ\_3) + (1.647 \* CFQ\_9) + (1.790 \* CFQ\_14) + (1.484 \* CFQ\_6) + (1.701 \* CFQ\_22) + (1.670 \* CFQ\_10) + (2.001 \* CFQ\_16) + (1.971 \* CFQ\_12) + (1.541 \* CFQ\_15) + (1.367 \* CFQ\_7) + (1.362 \* CFQ\_24) + (1.485 \* CFQ\_2)).

# Items in order of forward selection

**Table 3: CFQ item distribution of both the CFQ-25 and CFQ-14 on the dimension structure of Wallace et al. 2002 (18)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CFQ dimension structure of Wallace et al. 2002** | **Distribution of the CFQ-25 items˜** | **Proportion\***  | **Distribution of the CFQ-14 items˜** | **Proportion** |
| (1) Memory | 3, ***6***, ***12***, 13, ***16***, ***17***, 18, 23 | 8/26=31 | ***6, 12, 16, 17*** | 4/14=29 |
| (2) Distractibility | 1, ***2***,***3***, 4, ***15***, 19, ***21***, ***22***, 25 | 9/26=35 | ***2, 3, 15, 21, 22*** | 5/14=36 |
| (3) Blunders | 5, 8, ***9***, ***10***, 11, ***14***, ***24*** | 7/26=27 | ***9, 10, 14, 24*** | 4/14=29 |
| (4) Names | ***7***en 20 | 2/26=8 | ***7*** | 1/14=7 |

˜The items of the 14-item model are displayed in fat italic

\*The number of CFQ items is 26, because item 3 is distributed over dimension 1 and 2 (18)

The 15-item model would include the items of the 14-item model plus item 18

**Appendix 1#: Cognitive Failures Questionnaire**

1. Do you read something and find you haven't been thinking about it and must read it again?
2. *Do you find you forget why you went from one part of the house to the other?*
3. *Do you fail to notice signposts on the road?*
4. Do you find you confuse right and left when giving directions?
5. Do you bump into people?
6. *Do you find you forget whether you've turned off a light or a fire or locked the door?*
7. *Do you fail to listen to people's names when you are meeting them?*
8. Do you say something and realize afterwards that it might be taken as insulting?
9. *Do you fail to hear people speaking to you when you are doing something else?*
10. *Do you lose your temper and regret it?*
11. Do you leave important letters unanswered for days?
12. *Do you find you forget which way to turn on a road you know well but rarely use?*
13. Do you fail to see what you want in a supermarket (although it's there)?
14. *Do you find yourself suddenly wondering whether you've used a word correctly?*
15. *Do you have trouble making up your mind?*
16. *Do you find you forget appointments?*
17. *Do you forget where you put something like a newspaper or a book?*
18. Do you find you accidentally throw away the thing you want and keep what you meant to throw away -- as in the example of throwing away the matchbox and putting the used match in your pocket?
19. Do you daydream when you ought to be listening to something?
20. Do you find you forget people's names?
21. *Do you start doing one thing at home and get distracted into doing something else (unintentionally)?*
22. *Do you find you can't quite remember something although it's "on the tip of your tongue"?*
23. Do you find you forget what you came to the shops to buy?
24. *Do you drop things?*
25. Do you find you can't think of anything to say?

#Items included in the 14-item CFQ are displayed in italic