‘Determination of the feasibility of a multicomponent intervention program to prevent delirium in the intensive care unit: A modified RAND Delphi study’

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**Abstract**

*Background*: Delirium is common in Intensive Care Unit (ICU) patients and associated with poor outcome. In non-ICU patients a multicomponent intervention program with non-pharmacological interventions has shown to reduce delirium. Currently, there is insufficient evidence regarding the effects of such a program in ICU patients. We developed a draft program based on a review. As most studies were conducted in non-ICU patients, the feasibility of the program in ICU patients needs to be assessed before investigating its effectiveness.

*Objectives*: To determine experts’ opinion and to achieve group consensus on the feasibility and completeness of the multicomponent intervention program for ICU patients.

*Methods*: A modified RAND/UCLA appropriateness Method Delphi study was used. A total of 38 experts were selected following purposive sampling. Round one informed the experts about the draft program and asked for their opinion about its feasibility and completeness. In round two the experts were asked to reconsider their opinion based on changes made, and to rank the interventions in order of importance. The feasibility was scored using a 9-point Likert scale. A disagreement index (DI) and panel median were calculated to determine the level of agreement.

*Results*: During Delphi round one 100% of the questionnaires was completed, during round two 79%. After two rounds the experts agreed on the feasibility of the interventions targeting sleep deprivation (panel median 7.00, DI 0.26), immobility (panel median 8.00, DI 0.22), visual and hearing impairment (panel median 8.00, DI 0.19), and cognitive impairment (panel median 8.00, DI 0.23), except for cognitive training (panel median 5.00, DI 0.52).

*Conclusions*: During this study a feasible multicomponent intervention program to prevent ICU delirium was developed based on expert consensus. As no consensus was reached on cognitive training, a pilot study is planned to determine the feasibility of cognitive training in the ICU.

**1. INTRODUCTION**

Delirium is a common acute brain disorder in Intensive Care Unit (ICU) patients associated with serious short- and long-term consequences, including a higher rate of mortality, re-intubations, and ICU readmissions, longer ICU and hospital length of stay, longer duration of ventilation, increased risk for use of physical restraints and long-term cognitive problems.1-6 In addition, delirium is a financial burden due to increased ICU and hospital costs.7 These negative consequences emphasize the need for strategies to prevent delirium.8

As multiple risk factors are associated with delirium in critically ill adults,9-11 it is plausible that delirium prevention strategies should target multiple risk factors.12, 13 Non-pharmacologic approaches that target modifiable risk factors to prevent delirium appear promising.12, 14-19 In non-ICU patients it has been shown that a multicomponent non-pharmacological intervention (MCI) program targeting several delirium risk factors can significantly reduce delirium incidence and duration.15, 18 Studies in ICU patients that focus on specific parts of the program also showed beneficial effects.14, 16, 17, 20, 21 However, there is currently insufficient evidence for the effects of a MCI program in ICU patients due to weaknesses in study design, sample size or problems with data collection.13, 22 Therefore, further research is needed into the effects of a MCI program on delirium in ICU patients.

In preparation of a randomized controlled trial to study the effects of a MCI program on delirium in ICU patients, a draft MCI program was developed based on a review of existing literature which mainly included studies in non-ICU patients. The draft MCI program, consisting of nursing and physical therapy interventions, focuses on the modifiable delirium risk factors cognitive impairment, sleep deprivation, immobility, and visual and hearing impairment. In view of the fact that the draft MCI program contains several interventions with interacting components, the MCI program is considered to be a complex intervention according to the MRC framework.23, 24

Since it is uncertain whether the draft MCI program is feasible in an ICU setting, the aim of this current study is to determine experts’ opinion and to achieve group consensus on the feasibility and completeness of the draft MCI program for ICU patients. Assessing the feasibility of a complex intervention is an important element in the development and evaluation of an intervention according to the MRC framework.23, 24[\_ENREF\_23\_ENREF\_23](#_ENREF_23)

**2. METHODS**

A modified RAND/UCLA appropriateness Method (RAM) Delphi study was used.25 This method was chosen since it allows to include experts from diverse regions and expertise, without the need to meet physically. As a result the experts stay anonymous for each other, eliminating the influence of dominant persons during the consensus forming.26, 27 Multiple stages from RAM were used, including a literature review and individual feasibility rating and ranking of the interventions. A panel meeting was not part of this study for reasons of feasibility and logistics, like travel time and irregular shifts.

A literature review was conducted to develop a draft of the MCI program in the form of an intervention protocol. The review mostly included studies conducted in non-ICU patients, supplemented with studies conducted in ICU patients. The latter category only consisted of studies focusing on single interventions from the MCI program. Each intervention aimed at cognitive impairment, sleep deprivation, immobility, and visual and hearing impairment was included if it was considered feasible to be carried out by an ICU nurse. Interventions aimed at dehydration and feeding were not included as these items are incorporated in daily clinical ICU practice already. See Appendix A for the references used.

Feasibility of the individual interventions was scored using a 9-point Likert scale. This Delphi study consisted of two rounds and an anonymous expert panel. After the last round the experts received a final report with the results and conclusions of the Delphi study.

*2.1 Participants*

Purposive sampling was conducted based on predetermined selection criteria,28 to recruit experts who were representative for the clinical ICU practice in the Netherlands in which the MCI program will be tested in the future, and who have the appropriate knowledge about delirium and nursing interventions.29, 30 Inclusion criteria for panel members were: membership of a delirium working group in their ICU and/or having special interest in the subject delirium; registered critical care nurse, intensivist or physical therapist working in a representative ICU from both academic and general hospitals, or work as a delirium researcher; appropriate knowledge about nursing interventions. One independent contact person per hospital, which guaranteed voluntary participation, recruited experts for the panel according to the inclusion criteria.29 The participating hospitals in this Delphi study have ICUs equipped for surgical, medical, neurology/neurosurgical, or trauma ICU patients. Three experts, including a registered critical care nurse, an intensivist and a physical therapist, from each of the eleven Dutch hospitals that expressed an interest in participating in the planned randomized controlled trial, and from one non-participating hospital were invited to participate in the Delphi study. Also two senior nurse scientists from the field of delirium research were invited to participate as an expert.

*2.2 Data collection*

Data were collected using LimeSurvey, an online Software survey tool.31 Each of the experts received a private invitation to the questionnaire by email. Each Delphi round started with an information letter concerning the aim and content of that specific round, the estimated time investment, and a deadline for completion. The experts were able to save answers and complete the questionnaire at a later time if necessary. To optimize the response rate, the experts received a maximum of two reminders per round about the deadline for completion. In the first round, an information paragraph per delirium risk factor was presented to the participants. The experts were asked to give their opinion about the completeness of the interventions per risk factor and to explain their answer and include suggestions for modifications and/or improvements. Per intervention the expert was asked to indicate her/his opinion about the feasibility of that specific intervention on a 9-point Likert scale. The experts were asked to explain their answers and the reason why they chose their answer. All information from the experts’ explanations about both the completeness and feasibility was used in the decision making process on the modification of the interventions. The interventions that scored ‘feasible’ in round one and did not need any modifications were accepted and not presented as a question to the experts again in round two. The second round started with a general summary and explanation about the results and analysis of Delphi round one. Subsequently an information paragraph per delirium risk factor was described. This paragraph included the modified or newly added interventions based on the first Delphi round. The experts were asked to rank the interventions that were part of that risk factor in order of importance for delirium prevention, with the most important intervention on the first place, followed by the intervention that was second important and so on. Per intervention the experts received the following information: the intervention as presented in the draft MCI program, the overall group results of the feasibility rating during Delphi round one and the modified or new intervention. The experts were asked to reconsider their opinion based on this information 29, 30 and to rate the feasibility of the modified or new intervention. Similar to Delphi round one the experts were asked to explain their answers.

*2.3 Ethical considerations*

This study was evaluated by the medical research ethics committee XX region, the Netherlands (No.2014/1487). Participants' consent was assumed by return of the completed questionnaire. This study was conducted according to the principles of the Declaration of Helsinki (64th WMA General Assembly, Fortaleza, Brazil, October 2013) and in accordance with the Medical Research Involving Human Subjects Act. Handling of the data complied with the Dutch Personal Data Protection Act.

*2.4 Data analysis*

For each intervention a disagreement index (DI) and panel median was calculated to determine the level of agreement.25 A panel median of 1-3 without disagreement indicates ‘not feasible’, a panel median of 4-6 or any median with disagreement indicates ‘uncertain’, and a panel median of 7-9 without disagreement indicates ‘feasible’.25 Disagreement means a lack of consensus; ratings of the experts are spread over the entire 9-point Likert scale. To detect disagreement, the interpercentile range (IPR: 0.3-0.7) and the IPR adjusted for symmetry (IPRAS) was calculated. An IPR lower than the IPRAS indicates disagreement. After calculating the ratio, a DI <1 indicates agreement.25

After each of the two Delphi rounds, one researcher (XX) read and assessed all the explanations of the experts for the need to be used to modify or newly add any interventions. Afterwards two researchers discussed the results (XX, XX) and decided which modifications the interventions needed. In case of disagreement or questions two other researchers (XX, XX) were consulted to make a final decision.

The ranking by the experts in order of importance was rated as follows. Per delirium risk factor the maximum achievable number of points for an intervention rated on rank one was identical to the number of interventions that were part of that specific risk factor. The number of points for an intervention rated on rank two was identical to the number of interventions minus one and so on, until one point for an intervention ranked on the lowest possible rank for that risk factor. For each intervention that was part of that risk factor we counted how many experts rated that specific intervention, and this number was multiplied by the maximum achievable number of points per rank. These points achieved per possible rank were added up, resulting in a total score per intervention. These scores ultimately resulted in the ranking of the interventions per risk factor.

This ranking was used as additional information in the process of determining whether or not to exclude an intervention based on the level of agreement. If there was no consensus on the feasibility of an intervention, and the ranking of that intervention was low, this was a reason to exclude that intervention from the MCI program.

*2.5 Validity and reliability*

A high response rate is important for the validity of the results.29 Sumsion (1998) suggested a response rate of 70% for each round in order to maintain rigor of the Delphi technique.32 To reach commitment in the study and to optimize the ownership of the panel, we chose to invite experts from the ICUs that expressed an interest in participating in the planned randomized controlled trial in order to ultimately increase the response rate.30 Also, the experts were informed exactly about the content, aim and the time investment for the study, and reminders about the deadline of completion were sent.29, 30 A Delphi study usually consists of two to four rounds.29, 30 The number of Delphi rounds was predetermined to two, to prevent exhaustion and reduction of the response rate of the experts, so as to ultimately limit attrition bias.30, 33

**3. RESULTS**

In total, 38 experts participated in the Delphi study. (Table 1.) During the first Delphi round 100% (N=38) of the questionnaires was completed, and during the second round 79% (N=30). After two rounds the expert group agreed on the feasibility of the interventions targeting sleep deprivation (panel median 7.00, DI 0.26), immobility (panel median 8.00, DI 0.22), visual and hearing impairment (panel median 8.00, DI 0.19), and cognitive impairment (panel median 8.00, DI 0.23). Despite the modifications based on Delphi round one, the score of the expert group for cognitive training remained ‘uncertain’ (panel median 5.00, DI 0.52). (Table 2.) Every risk factor includes interventions related to direct patient care such as ‘explain to the patient who you are to improve the patient’s orientation’, and indirect unit based interventions such as ‘noise reduction strategies or use of flyers to highlight the importance of sleep’. See Appendix A for the complete interventions of the MCI program.

*3.1 Delphi round one*

All interventions scored a DI <1.00, indicating agreement. In total, thirteen interventions scored ‘uncertain’ based on the median, 28 interventions scored ‘feasible’ and none of the interventions scored ‘not feasible’. (Table 2.)

Of the interventions that were part of the risk factor ‘visual and hearing impairment’, five were modified based on the experts’ opinions about completeness and feasibility. Also eight new interventions were added. Seven of the interventions that were part of the risk factor ‘sleep deprivation’ were modified based on the experts’ explanations and three new interventions were added. Of the interventions that were part of the risk factor ‘cognitive impairment’, five were modified based on the experts’ explanations and two new interventions were added. All eleven cognitive training interventions were modified based on the experts’ explanations. And of the interventions that were part of the risk factor ‘immobility’ four were modified based on the experts’ explanations. Also two interventions were newly added. The modifications consisted of (textual) changes to the intervention itself and adding notes to the intervention to make it more clear and complete. (See Figure 1 for an example.)Nine interventions were not modified at all.

*3.2 Delphi round two*

All interventions scored a DI <1.00, indicating agreement. In total, thirteen interventions scored ‘uncertain’ based on the median, 34 interventions scored ‘feasible’ and none of the interventions scored ‘not feasible’. (Table 2.) No interventions needed a modification or needed to be newly added, based on the experts’ explanations and answers during Delphi round two. See Table 3 for the ranking of the interventions. Two interventions ‘Resolve any reversible cause’and ‘Provide continuity nurses’were removed from the intervention program based on their panel median (‘uncertain’) and the ranking of the interventions. (Table 2 and 3.) During both Delphi rounds the cognitive training interventions scored ‘uncertain’. Reasons for scoring cognitive training as ‘uncertain’ or ‘not feasible’ were: too difficult, complex and burdening for ICU patients, dependent on the capabilities of individual patient, and too labor-intensive for ICU nurses. See Appendix A for the intervention program after Delphi round two.

**4. DISCUSSION**

In this modified RAND/UCLA appropriateness Method Delphi study, a multidisciplinary expert panel agreed on the feasibility of a multicomponent non-pharmacological intervention (MCI) program aimed at preventing delirium in ICU patients. During the preset two Delphi rounds the expert group reached consensus on the feasibility and completeness of the interventions targeting sleep deprivation, immobility, visual and hearing impairment, and cognitive impairment, but not on cognitive training. Although the Delphi technique proved to be an appropriate design for the aim of our study, during both Delphi rounds the cognitive training interventions scored ‘uncertain’ meaning no consensus was reached on their feasibility. We believe that adding an extra Delphi round would not have resulted in consensus on the feasibility of cognitive training, as the ‘uncertain’ score for cognitive training was most likely due to unfamiliarity of the experts with performing cognitive training in their clinical practice. Because of the necessity of consensus before adding an intervention to the final MCI program, an additional prospective cohort pilot study is planned to determine the feasibility of cognitive training in ICU patients.34 During this pilot study ICU patients, ICU nurses and delirium researchers will test the cognitive training interventions in clinical practice which allows a proper decision to be made about whether or not to include cognitive training in the MCI program. Former pilot studies suggest that cognitive training combined with physical therapy is feasible and safe for the rehabilitation of ICU patients.35, 36

In view of the high delirium incidence and the serious consequences related to delirium,1-5 the use of a MCI program in ICU patients is promising and relevant for the daily clinical ICU practice.14, 16, 17, 20, 21, 37 Currently, there is in insufficient evidence regarding the effectiveness of a MCI program in ICU patients.13, 22 Because a more rigorous design is needed to prove effectiveness, we have planned a stepped wedge cluster randomized controlled trial, called the UNDERPIN-ICU study (nUrsiNg DEliRium Preventive INterventions in the Intensive Care Unit), which aims to determine the effect of the MCI program on delirium in ICU patients, to ultimately increase the number of delirium free days in the ICU.

To facilitate delirium prevention, the identification of ICU patients at high risk for delirium is important, since these are the most fragile patients who require the maximum preventive efforts.38 Patients’ risk for delirium in the ICU can be predicted using a delirium prediction model, allowing early delirium prevention in high risk patients.39-41 As many delirium risk factors are present in the ICU,42 prevention strategies target multiple modifiable delirium risk factors. Recent studies 13, 22 aimed at reducing ICU delirium by the implementation of a non-pharmacological protocol targeted mostly the same risk factors as our MCI program. Despite the fact that dehydration and feeding were targeted by the MCI program studied in non-ICU patients,15, 18 they are not targeted by our MCI program, nor by the intervention protocol of two recent ICU delirium prevention studies conducted in ICU patients,13, 22 as these items are incorporated in daily clinical ICU practice. In contrast to recent ICU delirium prevention studies,13, 22 our Delphi study provides a clear insight into how the intervention program was developed, on which specific sources the interventions were based, and an exact description of the interventions including clarifying notes. (Appendix A.) This is important for future studies into the effects of a MCI program on delirium in ICU patients and ultimately the use of the MCI program in clinical practice, as it allows for transparency and implementation of the interventions.

*4.1 Strengths and limitations*

For this study we used the research guidelines of Hasson et al. for performing and reporting the Delphi technique.29 An important strength of this study is the high response rate of the expert panel during the different Delphi rounds, which positively influences the validity of the results.29, 32 A frequent issue in Delphi studies aimed at achieving group consensus is the question what level of agreement equals consensus.30 In order to avoid having to choose an arbitrary cut off we used the RAM, as this method provides clear rules for determining the level of agreement.25 Furthermore, to ultimately limit attrition bias, the maximum number of Delphi rounds was predetermined.30, 33 In addition, to improve the interpretation of the results of a previous Delphi round by the experts, we returned the results accompanied by an explanation on for example the meaning of a group median and DI.30

However, our results should be interpreted considering some limitations. First, we used purposive sampling which most likely resulted in selection bias.28 We did this to include a representative sample for the clinical ICU practice in which the MCI program will be implemented during the future UNDERPIN-ICU study. This was important for the sense of ownership to stimulate the response rate during the Delphi study.30 Second, in regard to the generalizability of the results it should be taken into account that our sample was limited to one country. However, we did select a heterogeneous and representative sample of experts from ICUs from both academic and general hospitals spread all over the Netherlands. In addition, we based the final MCI program on the expertise of ICU nurses, intensivists, physical therapists as well as delirium researchers, to make sure the MCI program included all important interventions.

**5. CONCLUSION**

In this study a feasible multicomponent non-pharmacological intervention (MCI) program aimed at preventing delirium in the ICU was developed based on expert consensus. The use of a literature review provided a sound scientific base for the draft MCI program, and during the Delphi rounds the MCI program was tailored to be tested in ICU patients. This Delphi study represents an essential step towards future research consisting of a stepped wedge cluster randomized controlled trial, the UNDERPIN-ICU study, to determine the effects of the MCI program on ICU delirium.

**Conflict of interests**

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**Table 1: Participants characteristics**

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| **Characteristics** | **Delphi round 1** | **Delphi round 2** |
| Response rate, N (%) | 38 (100) | 30 (79) |
| Age, years (mean ± SD) | 42 ± 7.7 | 41 ± 7.7 |
| Male, N (%) | 18 (47.4) | 13 (43.3) |
| Education, N (%)  Higher professional education  Academic level | 23 (60.5)  15 (39.5) | 19 (63.3)  11 (36.7) |
| Profession, N (%)  ICU nurse  Physical therapist  Intensivist  Delirium researcher | 12 (31.6)  12 (31.6)  12 (31.6)  2 (5.2) | 9 (30.0)  11 (36.7)  9 (30.0)  1 (3.3) |

**Table 2: Panel median and disagreement index (DI)**

|  |  |  |
| --- | --- | --- |
| **Risk factor**  **Interventions as part of the risk factor** | **Round 1**  **Panel median**# **(DI)** | **Round 2**  **Panel median**# **(DI)** |
| Visual and hearing impairment  Ensure use of visual aids when awake  Provide adapted material  Ensure hearing aids are functioning  Ensure use of hearing aids when awake  Resolve any reversible cause  Use special communication techniques  *Ensure note of impairment is in patient’s file*  *Ensure visual aids are clean*  *Approach patient from good vision side*  *Prevent dehydration cornea*  *Extra attention verbal communication*  *Ask family to bring hearing aids,*  *batteries and instructions*  *Speak clear, limit background noise*  *Approach patient from good hearing side* | 8.00 (0.35)\*  8.00 (0.08)  7.00 (0.37)  8.00 (0.13)  8.00 (0.16)  6.00 (0.97)  8.00 (0.37)  -  -  -  -  -  -  -  - | 8.00 (0.19)\*  8.00 (0.22)  7.00 (0.22)  -  8.00 (0.08)  5.00 (0.32)  8.00 (0.16)  9.00 (0.08)  9.00 (0.13)  7.00 (0.28)  9.00 (0.08)  8.00 (0.13)  8.00 (0.13)  7.00 (0.37)  7.00 (0.37) |
| Sleep deprivation  Noise reduction strategies  Avoiding procedures during sleep time  Reduction of ICU lights  Using earplugs  Providing relaxation music  Ask family what patient does at home to  promote sleep  Discouraging daytime sleep  Strive to use sedation as less as possible  Encouraging (early) mobilization  *Be cautious with use of sleep medication*  *Use flyers to highlight importance sleep*  *Provide clear day structure* | 7.00 (0.31)\*  6.50 (0.30)  6.50 (0.30)  8.00 (0.13)  7.00 (0.50)  7.00 (0.37)  7.00 (0.65)  7.00 (0.22)  8.00 (0.16)  8.00 (0.16)  -  -  - | 7.00 (0.26)\*  7.00 (0.22)  7.00 (0.16)  8.00 (0.16)  8.00 (0.16)  7.00 (0.12)  7.00 (0.60)  -  8.00 (0.09)  -  7.00 (0.48)  8.00 (0.37)  8.00 (0.28) |
| Cognitive impairment (orientation protocol)  Place information board for patient  Provision of clock and calendar in room  Presence of familiar object in room  Facilitation of regular visiting hours  Discuss with family which name to use to  call the patient  Provide appropriate lightning  Ensure appropriate use of glasses  Ensure patient is provided with information  Stimulate patient’s orientation  Explain who you are  *Provide continuity of nurses*  *Compile poster with information about patient* | 8.00 (0.16)\*  8.00 (0.16)  9.00 (0.13)  8.00 (0.00)  8.00 (0.29)  9.00 (0.13)  7.00 (0.37)  8.00 (0.08)  8.00 (0.16)  8.50 (0.13)  8.00 (0.16)  -  - | 8.00 (0.23)\*  8.00 (0.28)  -  -  -  -  7.00 (0.65)  -  8.00 (0.16)  8.00 (0.16)  8.00 (0.00)  6.00 (0.52)  7.00 (0.37) |
| Cognitive impairment (cognitive training)  Digit span  Digit game  Memory task  Symbol searching  Digit cancellation task  Blocks task  First and second names  Executive functioning  Bells test  Picture guess  Difference searching | 6.00 (0.58)\*  6.00 (0.52)  7.00 (0.35)  7.00 (0.45)  6.00 (0.49)  6.00 (0.85)  6.00 (0.52)  6.00 (0.84)  6.00 (0.32)  5.00 (0.85)  4.00 (0.52)  6.00 (0.65) | 5.00 (0.52)\*  6.00 (0.45)  6.00 (0.22)  6.00 (0.52)  6.00 (0.45)  5.00 (0.85)  5.00 (0.51)  5.00 (0.32)  6.00 (0.45)  5.00 (0.85)  5.00 (0.60)  5.00 (0.45) |
| Immobility  Optimize patients’ sedation  Physical therapy at least once daily  Physical therapy dependent on tolerance  Initiation, encouraging and reminding  patients to mobilize  Promote and facilitate mobilization  *Reduce pain and fear as hampering factor*  *Set and register clear goals per patient* | 8.00 (0.28)\*  8.00 (0.16)  8.00 (0.29)  8.00 (0.00)  8.00 (0.29)  6.00 (0.65)  -  - | 8.00 (0.22)\*  8.00 (0.16)  -  8.00 (0.16)  7.00 (0.37)  7.00 (0.37)  8.00 (0.05)  7.00 (0.16) |

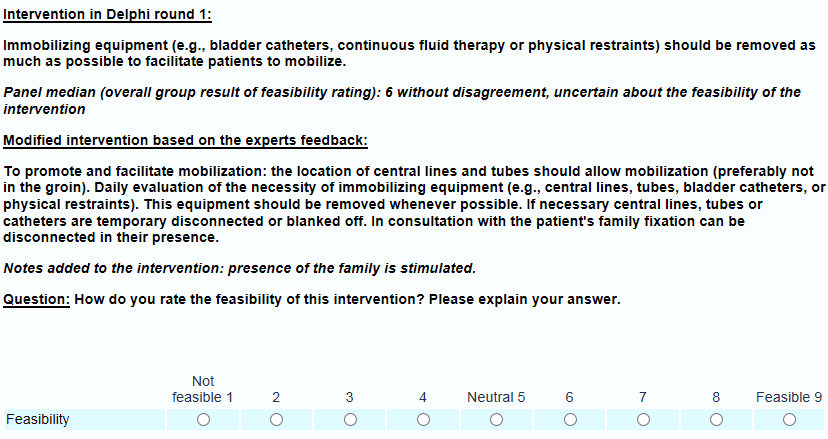
#A panel median of 1-3 indicates ‘not feasible’, a panel median of 4-6 or any median with disagreement indicates ‘uncertain’, and a panel median of 7-9 indicates ‘feasible’. DI <1 indicates agreement.

\*The panel median and DI per delirium risk factor.

*Italic interventions* are new interventions added based on the results of Delphi round 1 and therefore only the panel median (DI) of Delphi round 2 is available. The interventions without panel median (DI) in Delphi round 2 are those that did not require modifications and scored ‘feasible’ in round one. These interventions were accepted and not presented as a question to the experts again.

**Table 3: Ranking of the interventions**

|  |  |
| --- | --- |
| **Risk factor**  **Ranking interventions** | **Total score** |
| Visual and hearing impairment   1. Ensure use of visual aids when awake 2. Ask family to bring hearing aids, batteries and instructions 3. Ensure note of impairment is in patient’s file 4. Ensure use of hearing aids when awake 5. Ensure hearing aids are functioning 6. Prevent dehydration cornea 7. Ensure visual aids are clean 8. Speak clear, limit background noise 9. Approach patient from good vision side 10. Use special communication techniques 11. Approach patient from good hearing side 12. Extra attention verbal communication 13. Provide adapted material 14. Resolve any reversible cause | 222  201  190  185  171  155  140  131  125  118  114  102  78  47 |
| Sleep deprivation   1. Reduction of ICU lights 2. Noise reduction strategies (including avoiding procedures during sleep time) 3. Provide clear day structure 4. Encouraging (early) mobilization 5. Discouraging daytime sleep 6. Strive to use sedation as less as possible 7. Using earplugs 8. Be cautious with use of sleep medication 9. Ask family what patient does at home to promote sleep 10. Use flyers to highlight importance sleep 11. Providing relaxation music | 175  172  135  124  118  114  98  88  84  72  71 |
| Cognitive impairment (orientation protocol)   1. Explain who you are 2. Provision of clock and calendar in room 3. Stimulate patient’s orientation 4. Provide appropriate lightning 5. Ensure patient is provided with information 6. Place information board for patient 7. Provide continuity nurses 8. Ensure appropriate use of glasses 9. Discuss with family which name to use to call the patient 10. Facilitation of regular visiting hours 11. Presence of familiar object in room 12. Compile poster with information about patient | 197  161  138  135  121  116  114  111  110  99  97  85 |
| Cognitive impairment (cognitive training)   1. Digit span 2. Memory task 3. Symbol searching 4. Digit game 5. First and second names 6. Executive functioning 7. Picture guess 8. Digit cancellation task 9. Difference searching 10. Blocks task 11. Bells test | 142  135  128  121  119  113  113  108  94  92  87 |
| Immobility   1. Optimize patients’ sedation 2. Reduce pain and fear as hampering factor 3. Physical therapy dependent on tolerance 4. Physical therapy at least once daily 5. Set and register clear goals per patient 6. Promote and facilitate mobilization 7. Initiation, encouraging and reminding patients to mobilize | 159  149  143  139  91  85  70 |



**Figure 1: Example questionnaire item in Delphi round two\***

**\***This is an example of an intervention targeting immobility that was modified based on the explanations of the experts during Delphi round one.

**APPENDIX A: Intervention program after Delphi round two**

The UNDERPIN-ICU program (nUrsiNg DEliRium Preventive INterventions in the Intensive Care Unit), consisting of nursing and physical therapy interventions, will focus on the modifiable delirium risk factors cognitive impairment, sleep deprivation, immobility, and visual and hearing impairment.

1 Visual and hearing impairment

This protocol aims to prevent or treat sensory deprivation and ultimately the loss of orientation. The intervention will consist of:

Ensure there is a clear note in the patients’ file in case of visual and/or hearing impairment and what types of visual or hearing aids the patient is using.

*Notes added to the intervention: whenever an electronic patient data management system is available a reminder should be built in to make sure visual and hearing impairment is discussed during the admission interview and the patient’s family is asked to bring any visual or hearing aids including an instruction on how to use them to the ICU.*

Visual protocol:

1. Ensure that the patients use their visual aids whenever they are awake.

*Notes added to the intervention: e.g. use glasses or magnifier, in case a patients wants to use contact lenses the patient should be able to insert and remove the lenses by themselves. Pay attention to pressure spots due to glasses during repositioning.*1-6

1. Ensure that visual aids are clean before use.
2. Approach the patient from the side at which he or she has good vision.
3. Provide material adapted to visually impaired patients, like large-print books, electronic books (iPad) or fluorescent tape on call bell.1-6
4. Prevent dehydration of the cornea during sedation.
5. Pay extra attention to verbal communication about the execution of (nursing) activities and the patient’s surroundings, in case a patient is severely visually impaired.

Hearing protocol:

1. Ask the patient’s family to bring the patient’s hearing aids, including enough batteries and an instruction on how to use them, to the ICU.
2. Ensure that the hearing aids are fully functional before use.
3. Ensure that the patients use their hearing aids whenever they are awake, remove the hearing aids in consultation with the patient during the night or moments of rest.

*Notes added to the intervention: pay attention to pressure spots due to the hearing aids during repositioning.*1-6

1. Speak clear and limit background noise.
2. Approach the patient from the side at which he or she has good hearing.
3. Use special communication techniques, like easy (hand)gestures, writing, pictures/symbols, letter cards or new communication devices like an iPad.1-6

2 Sleep deprivation

*Aim:* to minimize/avoid sleep deprivation.

1. Unit-wide noise-reduction strategies 1, 2, 4-12:
   1. Quiet hallways, closed doors, no loud talking, provide colleagues with noise feedback. Vibrating beepers or telephones. Use of headphone when a patient listens to music or is watching television. Decrease alarm volume, expansion of alarm boundaries of the mechanical ventilator or monitor within safe levels.

*Notes added to the intervention: close doors of the patient’s room or other rooms like the staff room or utility room depending on the building and possibilities of the ICU.*

* 1. Avoid nursing and medical procedures during sleep time, taking into account the patient’s medical condition.

*Notes added to the intervention: use a schedule to make adjustments to allow sleep. These adjustments include a rescheduling of medication rounds (adjustment of the default time for medication gifts), blood draws, scheduling vital signs measurement (minimize use of non invasive blood pressure measurements) and bundling of necessary nursing activities.*

1. Reduce ICU lights to a minimum when it is time to sleep, unless necessary.2, 7, 9-12

*Notes added to the intervention: automatically dim (turn off) the lights in (communal) rooms after a certain time. Use of a flashlight by nurses during the nightshift. Dim monitor screens and turn the machines out of the patient’s sight. Fend light by the use of curtains, luxaflex or lamellae.*

1. After consultation with the patient, apply earplugs (unless contra indicated), from start of the night shift until the end of the night shift.11, 13
2. Provide relaxation music when it is time to sleep, pay attention to noise disturbance.1, 11

*Notes added to the intervention: ask the patient’s family for help and advice regarding the patient’s music preference and if necessary to bring any devices.*

1. Ask the patient/family what the patient does at home to promote sleep and whenever permissible provide this to the patient.12

*Notes added to the intervention: for example, read to the patient (by nurse, family or audio book), or when the patient has particular sleep objects, such as a certain pillow provide these. Keep hygiene rules in mind. You can ask this question during the admission interview.*

1. Be cautious with the use of sleep medication, use a ward protocol in case you use sleep mediation.

*Notes added to the intervention: the ward protocol provides information regarding the choice of sleep medication, for example do not use sedation like midazolam or propofol, and the time of administration.*

1. Highlight the importance of good sleep in your ward by the use of flyers that ask attention for the reduction of light and noise during the night.
2. Provide a clear day structure by compiling a personal day program for the patient.
3. Discourage daytime sleep, by improving the sleep-wake cycle using bright light during the day.4, 8, 11, 14, 15

*Notes added to the intervention: whenever necessary a short rest moment can be planned in a personal day program.*

1. Whenever fitting the patient’s individual treatment plan: strive to use sedation as less as possible. In case of sedation, perform a daily wake-up (reduce or stop sedation once a day) and pursue a Richmond Agitation-Sedation Scale (RASS) score of > -3 en < +2. Pursue a RASS of 0 in patients without sedation.9, 10

*Notes added to the intervention: in case the patient is having a RASS score outside the target levels: evaluate the cause and if possible take care of it. Use the ward protocol for this.*

1. Encourage (early) mobilization.11

3 Cognitive impairment

*Aim:* aims to (re)orientate patients with regard to time, place and person to prevent or minimize decline.

Orientation protocol:

1. Place a board with the name of the patient’s nurse, intensivist and a day schedule in the patient’s sight.1

*Notes added to the intervention: the day schedule is compiled using key words and symbols for activities like mobilization, sleeping, visiting hours.*

1. Provide a clock and calendar in the patient’s room in the patient’s sight.1, 3, 5-7, 16

*Notes added to the intervention: it is important to keep track of whether the clock is working and the time and date are correct.*

1. In consultation with the patient’s family, take care of the presence of familiar objects in the patient’s room like own pillows, pictures or family photographs.3, 8, 16 Let the patient watch television, listen to preferred music or read the paper or a magazine.7, 17, 18

*Notes added to the intervention: if necessary let the family bring visual or auditory media from home (labelled with a name). It is important to follow the hygiene rules and have availability of WIFI.*

1. Facilitate regular visits from family and friends. Give the family a letter to explain preventive measures like reorientation and the presence of family or friends.3, 6

*Notes added to the intervention: provide wide visiting hours. Important is to inform the family about the care, treatment and rest moments of the patient and when the specific consultation meetings with healthcare staff are planned. Make clear arrangements about who may visit the patient and how many and how long visitors are allowed. Translate the letter into different languages.*

1. Discuss with patient’s next of kin how to call the patient (use of the first or last name).7

*Notes added to the intervention: this subject might be part of the admission interview and should be documented in the patient’s file and on the board in his room (see intervention A).*

1. To get to know the patient his/her family and nurse compile a poster containing information about the patient’s preferred calling name, which devices the patient is using to support vision/hearing, what the patient does at home to promote sleep, favourite music, television programs, books, and hobbies, and other things important to the patient.
2. Orient the patient’s bed so they can perceive daylight/darkness 8 and provide appropriate lighting fitting the time of the day.5 Place patients with a long ICU length of stay in the rooms with most daylight.

*Notes added to the intervention: during the day time bright light, in the course of the evening dim the light and during the night as dark as possible. Decisive in the possibilities to be able to execute this intervention is the construction of the ICU.*

1. Ensure appropriate use of glasses(contact lenses) and hearing aids.16
2. Ensure daily during the day shift that the patient is provided with simple and short information about the ward, hospital (i.e., hospital name, ICU length of stay), reason for hospitalization, and their illness progression (e.g. concerning diagnostic and therapeutic measures).1, 7, 8

*Notes added to the intervention: it is important to provide uniform information (registered in the patient’s file). The nurse should also ask the patient what he or she already knows. Based on their own discretion nurses can repeat the information.*

At least every shift:

1. Stimulate the patient’s orientation as part of the daily routine by asking or explaining them what day is it and where they are.1, 7, 8
2. Health care professionals explain to the patient who they are, and what their role is, answer the patient’s questions and discuss the patient’s concerns whenever necessary.2, 5, 6

Preliminary cognition training protocol:

*Aim:* to minimize/avoid cognitive decline*.*

Cognitive training will be described in the article describing the pilot of cognitive training.19

* Digit span: to train attention and short term memory
* Digit game: to train selective attention and (verbal) working memory
* Memory task: to train attention, working memory and long term memory
* Symbol searching: to train speed of information processing using visual perception and selective attention
* Digit cancellation task: to train selective attention and visual perception
* Blocks task: to train selective attention and (visual) working memory
* First and second names: to train speed of daily life memory
* Executive functioning: to train working memory and attention
* Bells test: to train selective attention
* Picture guess: to train reasoning and working memory
* Difference searching: to train selective attention and working memory

**4 Immobility**

*Aim:* to improve patients’ functional mobility in the ICU and to stimulate patients’ cognition.

1. With the exception of contra indications: optimize ICU patients’ sedation (pursue RASS 0) to permit (active) physical therapy, while retaining their comfort.20

*Notes added to the intervention: for this stimulation of the day- and night rhythm is important.*

1. Reduce pain and fear as a hampering factor for mobilization, by taking care of adequate analgesia and proper guidance of the patient.
2. Physical therapy or mobilization supported by nurses should be performed at least once daily.6, 16, 20, 21.

*Notes added to the intervention: whenever possible more often.*

1. With the exception of contra indications: patients who are unresponsive due to coma (RASS -3/-4/-5), who are at risk for contractures, will receive passive motion exercises for all their limbs.21 In addition, their position in bed should be changed every three to four hours to prevent the occurrence of pressure ulcers.6 When patients are able to interact (RASS > -3 and < +2), physical therapy can consist of active (independent) exercises while the patient is lying on his back. When the patient tolerates these exercises the therapy can be extended to bed mobility activities, including upright sitting, sitting balance activities and exercising on a cycle movement device. These activities can be followed by participation in activities of daily living and exercises that encourage increased independence with functional tasks (e.g. sit-to-stand transfers from bed to chair), and finally pre-gait exercises and walking (if necessary with mechanical ventilation). Progression of activities should depend on patient tolerance and stability.21, 22
2. Whenever feasible, nurses and instructed family should initiate, encourage and remind patients to mobilize early or do motion exercises multiple times a day.1, 4, 5, 8-10 In addition, nurses stimulate active involvement during daily care activities.

*Notes added to the intervention: the physical therapist plays a stimulating and informing role in this.*

1. To promote and facilitate mobilization: the location of central lines and tubes should allow mobilization (preferably not in the groin). Daily evaluation of the necessity of immobilizing equipment (e.g., central lines, tubes, bladder catheters, or physical restraints). This equipment should be removed whenever possible.1, 6 If necessary central lines, tubes or catheters are temporarily disconnected or blanked off. In consultation with the patient’s family fixation can be disconnected in their presence.

*Notes added to the intervention: presence of family is stimulated.*

1. Per patient clear goals targeting mobilization are set and registered in the patient’s medical record. In addition, multi disciplinary consultation takes place to take care of the right timing of physical therapy regarding sedation and the day program.

*Notes added to the intervention: it should be known what mobilization is allowed and/or if the patient needs any devices for security reasons like a collar, corset or plaster helmet. Whenever possible the patient is informed about this and receives the necessary instructions.*

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