Feasibility of a light intervention study on alertness and sleep

of nightshift working nurses

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English abstract

Title: feasibility of a light intervention study on alertness and sleep of nightshift working nurses.

Background: nightshifts are common for nurses when working in direct patient care. Working during the night causes a deterioration in circadian rhythm, which causes a decreased alertness and increased fatigue. This increases risks of errors during nightshifts and could cause health problems as sleepiness. Among various tips to adjust the rhythm, light exposure in general works to adjust the rhythm, but especially the blueish component seems to generate a stronger effect.

Aim: the effect of blue light should be tested in an intervention study, the first step is to determine the methodology. Therefore this study aims to test the feasibility of a light intervention on alertness and sleep of nightshift working nurses. **Method:** feasibility was tested on three areas: acceptability, demand and practicality. A survey among 676 nurses in the Netherlands explored the first two areas and a small scale field study was used to assess the practicality mostly. **Results:** nurses apply several methods to adjust their rhythm to the nightshift, therefore the light glasses could become part of their routine. Most nurses however are not familiar with the effects of a light intervention. The glasses have been tested positively and do not interfere with daily work activities.

Conclusion: although applying a light intervention is not known among nurses that work nightshifts, using light glasses might be a suitable intervention for better adjustment.

Recommendations: there is a lot of variation between the current work situation and the preferred. When testing the intervention in future research the views of nurses should also be taken into account because they could affect the outcomes.

Keywords: Nightshift, nurses, circadian_rhythm, light_feasibility_study, survey

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Nederlandse samenvatting

Titel: feasibility van een licht interventie studie op alertheid en slaap onder verpleegkundigen die nachtdiensten werken. **Achtergrond:** nachtdiensten werken is onvermijdelijk in de directe patiëntenzorg. Het zorgt echter wel voor een verandering van het circadiane ritme, wat verminderde alertheid en vermoeidheid veroorzaakt. Dit veroorzaakt een toename van het risico op fouten tijdens de nachtdienst en heeft invloed op de gezondheid van zorgmedewekers, zoals slapenloosheid. Er zijn verschillende tips om het ritme aan te passen. Lichtblootstelling werkt als interventie, maar het blauwe lichtspectrum lijkt nog effectiever te zijn. **Doel:** om het effect van blauw licht te testen in een interventie, moet allereest de methode bepaald worden. Het doel van deze studie is daarom het testen van de toepasbaarheid van een lichtinterventie op alertheid en slaap onder verpleegkundigen die nachtdiensten werken. **Methode**: feasibility is getest op drie gebieden: aannemelijkheid, vraag naar en uitvoerbaarheid. Met een survey onder 676 verpleegkundigen in Nederland zijn de eerste twee gebieden bekeken. Een veldstudie is gebruikt om, voornamelijk, de uitvoerbaarheid te toetsen. **Resultaten:** verpleegkundigen gebruiken verschillende methoden om zich aan te passen aan de nachtdienst, dus het gebruik van een lichtbril zou onderdeel kunnen worden van deze methoden. De meeste verpleegkundigen zijn niet bekend met de effecten van een lichtinterventie. De lichtbril is getest in de praktijk en kan gebruikt worden tijdens de werkzaamheden. **Conclusie:** ondanks dat het toepassen van licht niet bekend is onder verpleegkundige die nachtdiensten werken kan het gebruik van een lichtbril wel een passende interventie zijn om het circadiane ritme aan te passen. **Aanbevelingen:** er is veel variatie tussen de huidige werksituatie en de voorkeuren van verpleegkundigen. Wanneer de interventie in de toekomst getest wordt, is het belangrijk om deze voorkeuren van verpleegkundigen mee te nemen, omdat ze invloed kunnen hebben op de uitkomsten.
Trefwoorden: Nachtdienst, verpleegkundigen, circadiane_ritme, licht_feasibility_studie, survey

Introduction

The light/dark cycle, that is based on sunlight, is the foremost regulator of circadian rhythms[1]. In current society people are required to be awake on times that are in conflict with this rhythm[2]. Nurses working in direct patient care are exposed to rotating shifts. The schedules of shift work vary across countries and institutions with regard to length, rotation in schedule and number of (consecutive) shifts[3]. In the Netherlands shifts are divided between morning-, evening-, and nightshifts, a so called three shift system[4].

Shift work disturbs internal circadian rhythms[5–9]. Working during the night effects sleep, causing sleep deprivation and fatigue[8,10,11]. This influences alertness/attention during the nightshifts contributes to risk of errors [3,12], such as medication administration mistakes[13]. Therefore, shift work has a negative effect on patient safety[7] as well as the general health of nurses[14]. In order to improve performance at night and sleep during day, adaption of circadian rhythms to night work is essential[12].

Several tips to improve sleep and the circadian rhythm have been written for shift workers[15]. The Dutch organization "Stichting Arbeidsmarkt Ziekenhuizen" (StAZ), published a project that investigated reducing effects of specific interventions for nightshift workers[16]. Their conclusion: food could reduce fatigue during nightshifts by 26%[16]. Nightshift workers should:

- avoid alcohol and drinks high in caffeine six hours before going to bed;
- avoid eating heavy meals three hours before going to bed;
- eat high-protein, but light meals while at work and when waking up after the night shift [15].

Reducing disturbing noises in bedrooms and staying in a dark environment after the night shift are other recommendations[15].

Evidently, the most influential external solution to adjust the rhythm is light.[7,17] In several studies, light exposure was tested to adapt the circadian rhythm to shift work[17–22], to improve alertness[23,24], as a remedy against sleepiness[22], to diminish eye fatigue[25] and to improve sleep[19].

As stated, the circadian rhythm is sensitive to light, especially to the blueish part of the lightspectrum[7]. This blue light suppresses production of melatonin, postpones preparation for sleep and triggers alertness. Several studies have tested blue light as an intervention against sleepiness and to improve alertness. It is important to expose the person for a specified duration to blue light, this however affects flexibility of nurses. In an intervention study[26], participants were constantly exposed by ambient blue light, testing alertness and performance of nightshift workers. In a pilot

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study among sawmill shift workers, participants were exposed to blue-green light pulses to a maximum of 90 minutes each time, followed by 30 minutes ambient light exposure[27]. However these two procedures were tested in a laboratory and are not possible in a care setting, due to the night rest patients need. In a study among nurses, light in the breakroom was designed as bright light exposure[28]. Bright light exposure was applied for four 20 min time periods, before starting work and every two hours during the nightshift. Researchers applied this approach to not affect patients and interfere as little as possible with normal work activities. Another conventional method of light exposure in various studies is sitting in front of a light therapy device for a specified time period[29,30].

Exposure to blue light can also be achieved by wearing glasses with blue light. Internal clocks can be altered by using glasses for only half an hour[31]. The manufacturers claim that by wearing these glasses you can get an energy boost, it improves sleep, stimulates peak performances and avoids jet lags(or the feeling of). By applying these glasses in daily practice of nurses the work environment will be undisturbed and patient care is not negatively affected.

Aim

The general aim is to define the protocol and measurement set-up of an intervention study, with the objective to determine the impact of light exposure with the use of the Propeaq Premium light glasses on alertness and sleep quality of nightshift working nurses.
Therefore this study aims to test the feasibility of a light intervention on alertness and sleep of nightshift working nurses. To achieve this aim, the views of nurses regarding nightshifts will be explored as well as measures nurses already or would use to adapt to nightshifts. The feasibility of the Propeaq Premium light glasses will also be tested.

Method

Design and population

A cross-sectional study was performed to test the feasibility of a light intervention among nurses. Data is collected at one specific point in time and therefore this study is cross-sectional.

This study was reported according to STROBE statement, a guideline for reporting observational studies to improve the reproducibility of the study.[33] The domain of the study contains nurses working nightshifts in direct patient care.

Outcomes

Main outcome of this study is feasibility, to determine if the intended intervention should be efficacy tested[34]. Areas that were focused on are: acceptability, demand and practicality[34]. See figure 1 for an overview of variables per outcome.

This study consists of two parts, a survey and a field study. The survey tested acceptability and demand, acceptability and practicality were tested in the field study. Both methods of the study are described below.

Survey

The first part of this study explored the current context by carrying out a web-based survey, by using SurveyMonkey software[35]. This survey was designed to explore views of nurses regarding nightshifts and investigate what measures nurses already take or would use to adapt to nightshifts.

Participants and recruitment

Study population of the survey were nurses working nightshifts in hospitals, nursing homes and mental health institutions in the Netherlands. Nurses of two organizations, a University Medical Center(UMC) and a nursing home were invited personally, via email and asked for their participation. To increase the generalizability and the number of participants, an email was send to the general contact addresses of 467 other healthcare organizations. They were asked to spread the attached survey link among their nurses. A total of 710 nurses of 107 different institutions responded and 676 surveys were completed and used for analysis. Data was collected from April 12th until May 4th 2018. For all institutions the link was available for two weeks. Response rates of the UMC and nursing home were collected, respectively 51% and 53% of the nurses completed the survey.

Data collection

The questionnaire was developed during an iterative process of researcher and supervisor. In

order to improve the validity of the questionnaire, a group of independent health care workers provided feedback for improvement on the questionnaire.[36] Key characteristics were collected regarding: gender, age, education and questions about work. The questionnaire contained questions based on literature about tips that improve alertness or decrease sleepiness/fatigue. It ends with questions about preferences and experiences concerning working nightshifts. All questions with a 7-point likert scale range from 0 up to 6 and start "negative" and end "positive"(e.g. totally disagree – totally agree). Appendix 1 contains the survey.

Data analysis

In order to describe the sample, descriptive statistics (frequencies, mean/median scores and standard deviations) were calculated. Analysis were performed with IBM SPSS Statistics version 23.0 for Windows(IBM, New York, United States). All statistics were 2-tailed significant if $P<0.05$. Incomplete cases were excluded for analysis. Comparisons between nursing home nurses and hospital nurses were made with an independent sample t-test. The criteria for this test were met because the sample size of both groups were above thirty[37].

A linear regression was performed to test for a causal relation between two continuous variables, age and hours of sleep. To test for correlations between categorical variables they should be linear correlated and have at least 30 cases[37]. The first criterion was tested with scatterplots and linearity could not be assumed, therefore Spearman's Rho was used. The following variables were tested for correlation: number of nightshifts a month and influence on the nurse, preferred/current count of consecutive nightshifts and the influence on schedules.

Field research

The second part of this study investigated the feasibility of Propeaq premium light glasses[31] with a quantitative questionnaire.

Participants and recruitment

The device was tested by ten nurses, of which two were male. The mean(SD) age of the nurses was 31.3(11.879).

The nurses were personally approached by the researcher via email and asked to participate. In a personal meeting nurses were asked to read instructions of the devices. Glasses were worn for half an hour during the appointment, without light turned on. After testing the device, the questionnaire was taken verbally by the researcher to ensure all questions were answered and understood.

Data collection

Data was collected between March 7th and April 6th 2018. To measure practicality of the glasses, a questionnaire was developed with closed-end questions. Development of the questionnaire was based on a list of practical concerns written by the researcher and supervisor beforehand. The components of the questions were clarity of the instructions, applicability in practice, comfort of wearing the glasses and probability of using them when it effects alertness and/or sleep and with and without compensation of the employer. Appendix 2 contains the questionnaire.

Data analysis

Descriptive statistics were used to analyze the questionnaire, resulting in frequencies of all responses.

Ethical issues

Ethical permission was not required because the Dutch Medical Research Involving Human Subjects Act(WMO) was not applicable. This study was performed according to the principles of the Declaration of Helsinki(7th version; October 2013)[38] and Good Clinical Practice[39]. Data was collected and stored following the General Data Protection Regulation[40]. The nurses participated voluntary to the survey, this was seen as permission for collection of their data and the nurses participating in the field study gave written consent. The data were not traceable due to participant codes. The data was only available for researcher and daily supervisor and will not be used for other purposes than research.

Results

Key characteristics of the participating nurses in the survey are presented in table 1.

-Insert table 1-

Survey

Acceptability

The current context regarding nightshifts showed that 80.9% of the nurses were positive about their work schedule and 58.6% scored a four or higher when asked about the amount of influence they have on their schedule. In total 35.2% wouldn't change anything regarding their schedule, but 21% would like to change something about the nightshifts. Thirty percent of these nurses would like to quit working nightshifts completely.

During the night more than 90% of the nurses are most alert between 23:00-03:00 and least alert between 03:00-07:00. The median*(IQR)* scores for influence of nightshifts on physical health, sleep

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quality/duration, social- and personal life were 4*(2,5)*. The scores on mental health and work performance were respectively 3*(1,4)* and 2*(1,4)*.

The mean(SD) hours nurses sleep is 6.37(1.492) and whether this amount is appropriate was scored with a median*(IQR)* of three*(1,5)*. The nurses recovery within 48h had a median*(IQR)* of four*(3,5)*.

As preparation for nightshifts, adjusting sleep pattern isn't applied by 13% of the nurses. Exposure to light is only "always" executed by 9.6% and 46.8% never administers this. During the nightshift, powernaps are applied in 21.3% of the nurses and 12.6% doesn't take a powernap, although they want to. Half of the nurses use energy drinks during the night, these drinks include coffee and soda's. After the nightshift, 22% of the nurses use sleep medication of which 3.6% "always" uses medication. Alcohol isn't used by 90.4% of the nurses, however almost 5% stated they use alcohol sometimes.

Demand

When asked whether light exposure improves alertness during nightshifts and sleep afterwards, 46.5% of the nurses answers this positively, however 43.5% answered the question neutral. The majority (60.7%) would not take a seat in front of a light therapy device and an even larger percentage (91.6%) would not wear light emitting glasses during nightshifts. A total of 109(16%) nurses explained their decision. Eight percent concluded light exposure is not necessary, although 53.7% stated they don't know how the glasses work, but are willing to try it. The median*(IQR)* scores of preferences regarding light and sound in the room they spend most time during the night were respectively 3*(1,3)* and 3*(3,5)*. See table 2 for all results.

-Insert table 2-

Statistical calculations

See table 3 for all results and p-values.

Differences

The nursing home nurses had more work experience, worked more nightshifts a month and were significantly older. The hospital nurses however work more hours per week and there were no differences in average hours of sleep after nightshifts.

Satisfaction about the schedule, influence on the schedule, appropriate hours of sleep, preferences regarding sound and the thoughts about a light intervention effecting alertness were not different for both groups. Whether nurses like to work nightshifts and work nightshifts mostly solo the nursing home nurses scored significantly higher. The influence of nightshifts on physical and

mental health, sleep quality, social life, work performances and personal life were al significantly different on a P=.000 level and sleep duration on P=.011. The hospital nurses scored the influence on these factors higher. The nursing home nurses recover on average more within 48h and prefer more light during the nightshift.

Linear regression
Between age and the total hours of sleep, a weak correlation coefficient was found and only 1.7% of the sleep hours of nurses could be explained by age.

Correlations
Between the amount of consecutive nights and the preference of consecutive nightshifts a significant correlation coefficient of 0.323 was found. This implicates that there is a relation between the current and preferred consecutive nightshifts. But in the ideal situation the correlation would be one, or at least close to one.
The amount of influence and the current and preferred number of consecutive nightshifts were not significant. The number of nightshifts a month and the influence on social life had a correlation coefficient of -.082 which is weak, but it was significant. Correlations of the other influences were not significant.

-Insert table 3-

Field study

Acceptability
Median*(IQR)* score for the probability of using the glasses if: the glasses improve alertness is 5*(4,5.25)*, if they improve sleep is 5*(4.75,5.25)*, if they have to be purchased by the employee 1*(0,1.75)* and if they are purchased by the employer 5*(4.75,6)*.

Practicality
The opinion about comfort of wearing the glasses during work differs, only two nurses thought the glasses were comfortable and a little comfortable. The instructions of the glasses were found clear by al nurses. Seven of the nurses concluded wearing the glasses was possible during work, the other three already wear glasses and therefore it is not possible to wear other glasses.
See table 4 for all results.

-Insert table 4-

Feasibility
Summarized the acceptability for a light intervention could be found in the decreased alertness

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during the second part of the night. The general amount of sleep and the label whether this amount was sufficient could also be improved with a light intervention. Nurses apply several methods to adapt their rhythm, so applying a light intervention could become part of their routine. The nurses would use the glasses if it improves alertness and sleep and when it is purchased by the employer.

Regarding demand, the nurses are not willing to use the light therapy lamp and especially not the light glasses. However in the explanation some nurses gave, they state they are willing to try it because they don't know the effect of light.

The practicality of the glasses is overall positive. They can be worn while working and do not interfere with the patient contact. The comfort of wearing the device is not ideal, this might need improvement.

Discussion

This study aimed to test the feasibility of a light intervention on alertness and sleep of nightshift working nurses by performing a survey and a field study. The nurses apply several methods to adapt to the nightshift, thus a light intervention could become another method, however in general nurses don't know that light could have a positive effect and respond negatively on using a device like the light glasses. The practicality of the glasses was tested positively, they can be worn during work and are easy to use.

In this study the mean hours of sleep when working nightshifts was 6.37±1.492. A cross-sectional study among nurses of Grundy at all (2009) found a mostly corresponding number of 6.47±2.29 hours of sleep[41]. Although this number could be divided between the hours of sleep for day workers 8.27±1.24 and night workers 4.78±1.67. All participants normally do work day and nightshifts, therefore the sample is similar. The difference between the hours found in this study and of the nightshift workers in the other cross-sectional study could be explained by the subjective measurement used. Nurses in the current study were asked how many hours they normally sleep when working nightshifts, while the hours of sleep of nurses in the study of Grundy et all (2009) were collected directly after their sleep. Therefore recall bias could have influenced the outcomes. The linear regression between age and the hours of sleep showed a weak correlation. This is contradictory with findings of Gamble at all (2011) in a exploring study about the contribution of phenotypes and genotypes to adaption in shift working nurses. They concluded that older nightshift nurses slept significantly shorter than younger nightshift nurses(P<.01)[42]. Recall bias could also have been an explanation for this, although the results of the other study were likewise collected with a survey and the researchers were not clear about when these data were gathered.
To adapt to nightshifts, most nurses adjust their sleeping pattern according to the current study. Adaption was also studied in the research of Gamble et all (2011) and a conclusion was drawn that adaption did not just depend on how much nurses slept, but also when they slept considering their work episode[42]. The study distinguished five sleep schedules, from staying in the night mode to not sleeping for 24h. The present study did not collect data on how nurses adjusted their sleeping pattern, which might be more effective when done in a substantiated way.

This study contains several strengths and limitations. A strength of this study is that the survey was tested first, to increase validity. To improve possibility for reproduction, the STROBE statement was used as a guideline for reporting. The sample size could not be estimated because the number of nurses working nightshifts is unknown in the Netherlands, however this study did reach a grand sample of 676 completed surveys within two weeks. Nonetheless, the first limitation is the

short time period the survey was available and the process of recruitment. Due to deadlines the survey data had to be collected fast and the recruitment of nurses could not be personalized. Some of the healthcare organizations responded negatively on the request because of the short period. A second limitation with regard to generalizability of this study is found in low responses of mental health care nurses in comparison with the nursing home and hospital nurses.

Conclusion

Applying a light intervention as a method to adjust the rhythm is unknown among nurses that work nightshifts. Using light glasses might be a suitable intervention for better adjustment. The practicality was tested positively and the glasses could be worn while working in direct patient care.

Recommendations

How nurses think about nightshifts and what they apply to adjust is outlined in this study. There is a large variation in preferences between the nurses. In order to prevent influence of these preferences in a future intervention study, these differences have to be taken into account. Also the amount of light exposure needs to be determined. Because of the different preferences regarding light, this also might vary among nurses.

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References

1.   Bracci M, Ciarapica V, Copertaro A, Barbaresi M, Manzella N, Tomasetti M, et al. Peripheral skin temperature and circadian biological clock in shift nurses after a day off. Int J Mol Sci. 2016;17.

2.   Serkh K, Forger DB. Optimal Schedules of Light Exposure for Rapidly Correcting Circadian Misalignment. PLoS Comput Biol. 2014;10.

3.   Tanaka K, Takahashi M, Hiro H, Kakinuma M, Tanaka M, Kamata N, et al. Differences in Medical Error Risk among Nurses Wokring Two- and Three-shift Systems at Teaching Hospitals: A Six-month Prospective Study. 2Industrial Heal. 2010;48:357–64.

4.   van Amelsvoort LGPM, Jansen NWH, Swaen GMH, van den Brandt PA, Kant Ij. Direction of shift rotation among three-shift workers in relation to psychological health and work-family conflict. Scand J Work Environ Heal. 2004;30:149–56.

5.   Bjorvatn B, Waage S. Bright light improves sleep and psychological health in shift working nurses. J Clin Sleep Med. 2013;9:647–8.

6.   Postnova S, Robinson PA, Postnov DD. Adaptation to Shift Work: Physiologically Based Modeling of the Effects of Lighting and Shifts' Start Time. PLoS One. 2013;8.

7.   Berger AM, Hobbs BB. Impact of Shift Work on the Health and Safety of Nurses and Patients. 2005;10:465–72.

8.   Asaoka S, Aritake S, Komada Y, Ozaki A, Odagiri Y, Inoue S, et al. Factors associated with shift work disorder in nurses working with rapid-rotation schedules in Japan: The nurses' sleep health project. Chronobiol Int. 2013;30:628–36.

9.   Loef B, van Baarle D, van der Beek AJ, van Kerkhof LW, van de Langenberg D, Proper KI. Klokwerk + study protocol: An observational study to the effects of night–shift work on body weight and infection susceptibility and the mechanisms underlying these health effects. BMC Public Health. 2016;16:692.

10.   Fallis WM, McMillan DE, Edwards MP. Napping during night shift: Practices, preferences, and perceptions of critical care and emergency department nurses. Crit Care Nurse. 2011;31:1–12.

11.   Korompeli A, Chara T, Chysoula L, Sourtzi P. Sleep disturbance in nursing personnel. Nurs Forum. 2013;48:45–53.

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12. Boudreau P, Dumont GA, Boivin DB. Circadian Adaptation to Night Shift Work Influences Sleep, Performance, Mood and the Autonomic Modulation of the Heart. PLoS One. 2013;8.

13. Suzuki K, Ohida T, Kaneita Y, Yokoyama E, Uchiyama M. Daytime sleepiness, sleep habits and occupational accidents among hospital nurses. J Adv Nurs. 2005;52:445–53.

14. Books C, Coody LC, Kauffman R, Abraham S. Night Shift Work and Its Health Effects on Nurses. Health Care Manag (Frederick). 2017;36:1.

15. Morin CM, Espie CA. Insomnia: A clinical guide to assessment and treatment. New York: Kluwer Academic; 2003. 190 p.

16. CIRCADIAN.Netherlands. Project optimalisatie nachtarbeid ziekenhuizen. Een studie naar de mitigerende effecten van nachtarbeid ondersteunende interventies. Amsterdam; 2011.

17. Kozaki T, Kubokawa A, Taketomi R, Hatae K. Light-induced melatonin suppression at night after exposure to different wavelength composition of morning light. Neurosci Lett. 2016;616:1–4.

18. Horowitz TS, Cade BE, Wolfe JM, Czeisler CA. Efficacy of bright light and sleep/darkness scheduling in alleviating circadian maladaptation to night work. Am J Physiol Endocrinol Metab. 2001;281:E384-91.

19. Lowden A, Akerstedt T, Wibom R. Suppression of sleepiness and melatonin by bright light exposure during breaks in night work. J Sleep Res. 2004;13:37–43.

20. Smith MR, Fogg LF, Eastman CI. A compromise circadian phase position for permanent night work improves mood, fatigue, and performance. Sleep. 2009;32:1481–9.

21. Smith MR, Eastman CI. Night shift performance is improved by a compromise circadian phase position: study 3. Circadian phase after 7 night shifts with an intervening weekend off. Sleep. 2008;31:1639–45.

22. Sadeghniiat-Haghighi K, Yazdi Z, Jahanihashemi H, Aminian O. The effect of bright light on sleepiness among rapid-rotating 12-hour shift workers. Scand J Work Environ Heal. 2011;37:77–9.

23. Correa Angel, Barba A, Padilla F. Light effects on behavioural performance depend on the individual state of vigilance. PLoS One. 2016;11:1–13.

24. Zamanian Z, Kakooei H, Ayattollahi SMT, Deghani M. Effect of bright light on shift work

A.D.Beishuizen | 5657571 | Feasibility of a light intervention study on alertness and sleep among nightshift working nurses | 29/06/2018

nurses in hospitals. Pakistan J Biol Sci. 2010;13:431–6.

25. Azmoon H, Dehghan H, Akbari J, Souri S. The Relationship between Thermal Comfort and Light Intensity with Sleep Quality and Eye Tiredness in Shift Work Nurses. J Environ Public Health. 2013;2013:1–5.

26. Sletten TL, Ftouni S, Nicholas CL, Magee M, Grunstein RR, Ferguson S, et al. Randomised controlled trial of the efficacy of a blue-enrichded light intervention to improve alertness and performance in night shift workers. Occup Environ Med. 2017;74.

27. Sasseville A, Hébert M. Using blue-green light at night and blue-blockers during the day to improves adaptation to night work: A pilot study. Prog Neuro-Psychopharmacology Biol Psychiatry. 2010;34:1236–42.

28. Costa G, Ghirlanda G, Minors DS, Waterhouse JM. Effect of bright light on tolerance to night work. Scand J Work Environ Heal. 1993;19:414–20.

29. Baehr EK, Fogg LF, Eastman CI. Intermittent bright light and exercise to entrain human circadian rhythms to night work. Am J Physiol. 1999;277:R1598-604.

30. Bjorvatn B, Stangenes K, Øyane N, Forberg K, Lowden A, Holsten F, et al. Randomized placebo-controlled field study of the effects of bright light and melatonin in adaptation to night work. Scand J Work Environ Heal. 2007;33:204–14.

31. ChronoEyewear. Propeaq premium light glasses [Internet]. 2017 [cited 2018 Mar 5]. Available from: https://www.propeaq.com/en/no-jet-lag-2/

33. Elm E Von, Altman DG, Egger M, Pocock SJ, Peter C, Gøtzsche P, et al. guidelines for reporting observational studies Strengthening the reporting of observational studies in epidemiology (STROBE) statement : guidelines for reporting observational studies. Br Med J. 2007;335(October):19–22.

34. Bowen DJ, Kreuter M, Spring B, Linnan L, Weiner D, Bakken S, et al. NIH Public Access. Am J Prev Med. 2010;36:452–7.

35. SurveyMonkey [Internet]. [cited 2018 Mar 15]. Available from: https://nl.surveymonkey.com/

36. Portney LG, Watkins MP. Foundations of Clinical Research Applications to practice. Third edit. Essex: Pearson Education Limited; 2014. 842 p.

37. Vocht A de. Basishandboek SPSS 22. Eerste dru. Utrecht: Bijleveld Press; 2014. 256 p.

A.D.Beishuizen | 5657571 | Feasibility of a light intervention study on alertness and sleep among nightshift working nurses | 29/06/2018

38. Adopted, Assembly, Helsinki. Wma Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects. 1964;(June 1964):21–2.

39. ICH. Integrated addendum to ICH E6(R1): Guideline for Good Clinical Practice E6(R2). ICH Guidel. 2016;6(November):66.

40. Autoriteit Persoonsgegevens [Internet]. 2018 [cited 2018 May 23]. Available from: https://autoriteitpersoonsgegevens.nl/nl

41. Grundy A, Sanchez M, Richardson H, Tranmer J, Borugian M, Graham CH, et al. Light Intensity Exposure, Sleep Duration, Physical Activity, and Biomarkers of Melatonin Among Rotating Shift Nurses. Chronobiol Int. 2009;26:1443–61.

42. Gamble KL, Motsinger-Reif AA, Hida A, Borsetti HM, Servick S V., Ciarleglio CM, et al. Shift work in nurses: Contribution of phenotypes and genotypes to adaptation. PLoS One. 2011;6.

Tables and figures

Table 1 – Key characteristics **N = 676**

Variables	
Female, n *(%)*	614 *(90.8)*
Age (years) M ± SD	39.51 ± (12.694)
CAO[a], n *(%)*	
VVT[b]	351 *(51.9)*
GGZ[c]	22 *(3.3)*
Hospital	303 *(44.8)*
Results province, n (%)	
Drenthe	5 *(0.7)*
Flevoland	32 *(4.7)*
Friesland	60 *(8.9)*
Gelderland	75 *(11.1)*
Groningen	7 *(1)*
Limburg	75 *(11.1)*
Noord-Brabant	114 *(16.9)*
Noord-Holland	24 *(3.6)*
Overijssel	31 *(4.6)*
Utrecht	78 *(11.5)*
Zeeland	75 *(11.1)*
Zuid-Holland	99 *(14.6)*
Missing	1 *(0.2)*
Educational level, n *(%)*	
MBO[d] L[e] 3	161 *(23.8)*
MBO L 4	271 *(40.1)*
HBO[f] Bachelor	159 *(23.5)*
HBO Master	17 *(2.5)*
WO Bachelor[g]	3 *(0.4)*
WO Master	2 *(0.3)*
Other	63 *(9.3)*
Ward, n (%)	
General hospital ward	151 *(22.3)*
Specialized hospital ward	41 *(6.1)*
Women/child ward	44 *(6.6)*
Psychiatric ward	7 *(1)*
Nursing home ward	153 *(22.6)*
Domiciliary care	35 *(5.2)*
Other	245 *(36.2)*
Experience (years) M ± SD	18.48 ± 12.385
Work hours M ± SD	27.86 ± 6.688
Nights / month, M ± SD	5.83 ± 3.965
Set schedule, n *(%)*	
No	536 *(79.3)*
Forward rotating schedule, n *(%)*	
No	419 *(62)*

Mean ± standard deviation
[a] CAO, collective employment agreement | [b] VVT, nursing homes and domiciliary care | [c] GGZ, mental healthcare | [d] MBO, senior secondary vocational education and training | [e] L, education level | [f] HBO, associate degree | [g] WO Bachelor, undergraduate | [h] WO Master, postgraduate

Table 2 – Results survey

Variabeles

Satisfaction schedule[a], median (IQR)	5 (4,6)	
Influence schedule[b], median (IQR)	4 (2,5)	
Like working nightshifts[c], median (IQR)	4 (3,6)	
Least – most alert, n (%)		
23:00-01:00h	6 (0.9)	438 (64.8)
01:00-03:00h	21 (3.1)	196 (29)
03:00-05:00h	422 (62.4)	16 (2.4)
05:00-07:00h	227 (33.6)	26 (3.8)
Influence on[d], median (IQR)		
Physical health	4 (2,5)	
Mental health	3 (1,4)	
Sleep quality	4 (2,5)	
Sleep duration	4 (2,5)	
Social life	4 (2,5)	
Work performance	2 (1,4)	
Personal life	4 (2,5)	
Hours of sleep, M ± SD	6.37 ± 1.492	
Appropriate hours of sleep[c], median (IQR)	3 (1,5)	
Recovery within 48h[c], median (IQR)	4 (3,5)	
Measures adaption nightshift[e], median (IQR)		
Previous		
Alter sleep pattern	2 (1,3)	
Alter eating pattern	4 (2,5)	
Alter light exposure	4 (3,5)	
During		
Apply powernap	5 (5,5)	
Use energy drinks	5 (3,5)	
Eat low calorie meals	3 (3,5)	
Apply extra light	3 (2,5)	
Apply extra sound	4 (3,5)	
After		
Use sleep medication	5 (5,5)	
Sleep in a dark bedroom	1 (1,1)	
Sleep in a quiet bedroom	2 (1,5)	
Use alcohol	5 (5,5)	
Sleep directly after the shift	2 (1,3)	
Stay in bed for 7 hours	3 (2,4)	
Light exposure improves alertness & sleep[c], median (IQR)	3 (3,5)	
Preference light[f]	3 (3,5)	
Preference sound[f]	3 (1,3)	
Use light therapy lamp, n (%)		
No, certainly not	410 (60.7)	
Yes, if	180 (26.6)	
Yes, always	86 (12.7)	
Use light glasses[g], n (%)		
Yes	57 (8.4)	
No, this is not possible during my work	103 (15.2)	
No, I already wear glasses	211 (31.2)	
No, I don't think the glasses have any use	181 (26.8)	
No, I think the glasses look weird	100 (14.8)	
Different, namely	107 (15.8)	

Mean ± standard deviation

[a] 7-point likert scale from 0: unsatisfied, trough 3: not unsatisfied/not satisfied up to 6: satisfied | [b] 7-point likert scale from 0: no influence at all up to 6: I complete my schedule by myself | [c] 7-point likert scale from 0: totally disagree trough 3: do

not disagree/ do not agree up to 6: totally agree | [d] 7-point likert scale from 0: no influence at all up to 6: a lot of influence | [e] 6-point scale with: 1: always, 2: almost always, 3: sometimes, 4: almost never, 5: never, 6: never, but I want to | [f] 7-point scale with: 0: extra low on light/sound up to 6: extra high on light/sound | [g] Multiple answers possible.

Table 3 – Results statistical tests

	Nursing home M±SD	Hospital M±SD	P-value
Differences			
Experience	19.45±12.392	17.35±12.351	.031
Work hours	26.34±7.069	29.79±5.629	.000
Nights/month	6.70±4.542	4.72±2.782	.000
Sleep hours	6.25±1.548	6.46±1.382	.079
Age	41.24±12.997	37.50±12.137	.000
Satisfaction of schedule	4.69±1.518	4.62±1.268	.000
Influence on schedule	3.52±1.690	3.48±1.476	.000
Like nightshifts	4.19±2.109	3.31±2.027	.000
Work independent	4.28±1.721	3.28±1.976	.016
Influence			
Physical health	2.97±1.896	3.65±1.632	.000
Mental health	2.21±1.952	3.16±1.815	.000
Sleep quality	3.30±1.989	3.98±1.811	.000
Sleep duration	3.48±1.997	3.84±1.866	.016
Social life	3.41±2.036	3.94±1.671	.000
Work performance	1.79±1.670	2.57±1.690	.000
Personal life	3.02±2.002	3.60±1696	.000
Hours' sleep adequate	3.10±2.050	2.93±1.986	.288
Recovery 48h	4.14±1.638	3.61±1.683	.000
Light preference	3.62±1.579	3.18±1.632	.001
Sound preference	2.42±1.572	2.26±1.426	.169
Improves alertness & sleep	3.73±1.440	3.69±1.292	.734
	Correlation coeff(R^2)		
Regression			
Age versus hours of sleep	0.131(.017)		
	Spearmans' Rho	**P-Value**	
Correlation			
Current – preferred consecutive	0.323	.000	
Influence schedule – current consecutive	0.051	.184	
Influence schedule - consecutive	0.041	.281	
Nights/month – Influence			
Physical health	-.050	.194	
Mental health	-.065	.093	
Sleep quality	.023	.547	
Sleep duration	.015	.698	
Social life	-.082	.034	
Work performance	-.068	.077	
Personal life	-.041	.282	

Table 4 – Results field study, Propeaq premium light glasses

Variables	n (%)
Instruction clear	
Yes	10 (100)
Comfort during work	
Very uncomfortable	-
Uncomfortable	5 (50)
A little uncomfortable	1 (10)
Not uncomfortable / not comfortable	2 (20)
A little comfortable	1 (10)
Comfortable	1 (10)
Very comfortable	-
Wearing possible during work	
Yes	7 (70)
Wear red glasses	
Yes	7 (70)
Change glasses	
Yes	9 (90)
Wearing if it improves alertness	
Very unlikely	-
Unlikely	-
A little unlikely	-
Not unlikely / not likely	-
A little likely	3 (30)
Likely	5 (50)
Very likely	2 (20)
Wearing if it improves sleep	
Very unlikely	-
Unlikely	-
A little unlikely	-
Not unlikely / not likely	1 (10)
A little likely	1 (10)
Likely	6 (60)
Very likely	2 (20)
Wear when purchase self	
Very unlikely	4 (40)
Unlikely	4 (40)
A little unlikely	1 (10)
Not unlikely / not likely	-
A little likely	-
Likely	-
Very likely	1 (10)
Wear when purchase by employer	
Very unlikely	-
Unlikely	-
A little unlikely	-
Not unlikely / not likely	-
A little likely	2 (20)
Likely	5 (50)
Very likely	3 (30)

Figure 1 – Outcomes on areas of feasibility

Survey		Question nr	Subject
Acceptability	Satisfaction	14, 15, 16 & 24	Satisfaction schedule, influence on schedule, changes schedule, like nightshifts
	Perceived appropriateness	17, 18, 19, 20, 21, 26, 27, 28, 29, 30, 31, 32, 34, 35 & 36	Alertness during night, measures to adapt, influence nightshift, hours of sleep, appropriate hours, recovery time
Demand	Expressed interest	37, 38, 39, 40 & 41	Preference light and sound, use of lamp or glasses, effect of light on alertness and sleep
Field study			
Acceptability	Intent to continue use	Propeaq: 6, 7, 8 & 9	Use if it improves alertness or sleep, use if purchased self, use if purchased employer
Practicality	Positive + negative effects on target population	Propeaq: 2	Comfort glasses and comfort strap
	Ability to carry out	Propeaq: 1 & 3	Instructions, questions clear, able to answer during work and spare time, legibility of questions

Appendix 1   Questionnaire SurveyMonkey

Welcome to the survey about working nightshifts

My name is Annerieke Beishuizen and I'm working as a nurse in a nursing home. At this moment I am writing my masterthesis for the study nursing science of the Utrecht University. This masterthesis is a study exploring the corrent context of healthcare professionals working nightshifts in direct patient care.

Nightshifts are inavitable when working in direct patient care. To gain isight in what healthcare professionals apply to adjust to the nightshifts, this survey was developed. Asnwering all questions will take +/- 15 minutes.

Your answers will be anonimously and particpation is voluntary.

If you have any questions, please contact: a.d.beishuizen@students.uu.nl

Best whishes,

Annerieke

* 1. What is your gender

○ Male

○ Female

* 2. What is your date of birth? (dd/mm/yyyy)

Date [   ]

* 3. What is your current CAO?

○ VVT

○ GGZ

○ Hospital

* 4. What is your highest educational level?

○ MBO niv 3   ○ HBO Master

○ MBO niv 4   ○ WO Bachelor

○ HBO Bachelor   ○ WO Master

○ Anders namelijk:

[   ]

* 5. What is the name of your healthcare institution?

[   ]

* 6. On which ward do you work?

[⬍]

[   ]

* 7. How many years of experience do you have in healthcare?

0   50

○————————————————— [   ]

* 8. How many hours, on average, do you work every week?

* 9. How many nightshifts on average do you work per month?

| 0 | 30 |

* 10. Do you work day, evening and nightshifts according to a set schedule?

○ Yes

○ No

* 11. How many consecutive nightshifts do you work?

○ 1   ○ 5

○ 2   ○ 6

○ 3   ○ 7

○ 4

○ Changing between [..] - [..] nights

* 12. What is your preference regarding consecutive nightshifts?

○ 1   ○ 5

○ 2   ○ 6

○ 3   ○ 7

○ 4

○ Different namely:

* 13. Are the schedules completed according to a forward rotating system?

○ Yes

○ No, different namely:

* 14. How satisfied are you with your schedule?

Unsatisfied			Not unsatisfied / not satisfied			Satisfied
○	○	○	○	○	○	○

* 15. If you were able to change someting to you schedule, what would it be?

[   ]

* 16. To what extend do you have influence on your schedule?

I have no influence on my schedule						I finish my schedule by myself
○	○	○	○	○	○	○

* 17. Between what time period during the nightshift do you feal least alert?

○ 23:00-01:00

○ 01:00-03:00

○ 03:00-05:00

○ 05:00-07:00

* 18. Between what time period during the nightshift do you feal most alert?

○ 23:00-01:00

○ 01:00-03:00

○ 03:00-05:00

○ 05:00-07:00

* 19. To what degree do you apply the following measures as preperation for your nightshift?

Frequency

Altered sleep pattern	[▲▼]
Altered eating pattern	[▲▼]
Appying light exposure	[▲▼]

Different namely (incl frequency: always-never):

[   ]

* 20. To what degree do you apply the following measures during your nightshift?

Frequency

Apply powernap (max 20 min sleep)	[▲▼]
Use energy drinks	[▲▼]
Eat meals low in calories	[▲▼]
Stay in extra light environments	[▲▼]
Stay in environments with extra sound	[▲▼]

Different namely (incl. frequency: always-never):

[   ]

* 21. To what degree do you apply the following measures after your nightshift?

Frequency

Use of sleepmedication	[▲▼]
Sleep in dark bedroom	[▲▼]
Sleep in quiet bedroom	[▲▼]
Use alcohol	[▲▼]
Immediately sleep after getting home	[▲▼]
Stay in bed for at least 7 hours	[▲▼]

Different namely (incl. frequency: always-never):

[   ]

* 22. When do you use energy drinks (coffee, coca cola, red-bull etc)

☐ Never   ☐ Just before going to bed

☐ During the nightshift   ☐ During a day- or evening shift

☐ Directley after the nightshift   ☐ Whole day long

* 23. Between which of the following time frames do you generally eat during the nightshift?

☐ 23:00-00:00   ☐ 04:00-05:00

☐ 00:00-01:00   ☐ 05:00-06:00

☐ 01:00-02:00   ☐ 06:00-07:00

☐ 02:00-03:00   ☐ 07:00-08:00

☐ 03:00-04:00   ☐ Not

☐ Different namely:

[   ]

* 24. I like working nightshifts

Totally disagree | Do not disagree /
do not agree | Totally agree

○ ○ ○ ○ ○ ○ ○

* 25. Generally I perform my work during the nightshift by myself

Never | Sometimes | Always

○ ○ ○ ○ ○ ○ ○

* 26. Working nightshifts influences my physical health

No influence at all | A lot of influence

○ ○ ○ ○ ○ ○ ○

* 27. Working nightshifts influences my mental health

No influence at al | A lot of influence

○ ○ ○ ○ ○ ○ ○

* 28. Working nightshifts influences my sleep quality

No influence at all | A lot of influence

○ ○ ○ ○ ○ ○ ○

* 29. Working nightshifts influences my sleep duration

No influence at all | A lot of influence

○ ○ ○ ○ ○ ○ ○

* 30. Working nightshifts influences my social life

No influence at all | A lot of influence

○ ○ ○ ○ ○ ○ ○

* 31. Working nightshifts influences my work performances

No influence at all | A lot of influence

○ ○ ○ ○ ○ ○ ○

* 32. Working nightshifts influences my personal life

No influence at all   A lot of influence

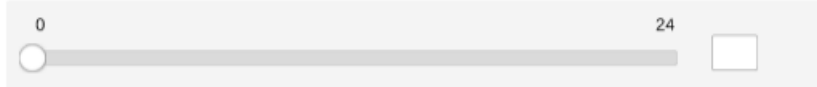   ◯   ◯   ◯   ◯   ◯   ◯   ◯

* 33. Can you decide your bedtime by yourself?

☐ Yes

☐ No, I have to take my partner into account

☐ No, I have to take my child(ren) into account

☐ No, I have to take my pet(s) into account

☐ Different namely:

[   ]

* 34. How many hours do you generally sleep after a nightshift?

0   24

◯━━━━━━━━━━━━━━━━━━━━━━━━ [   ]

* 35. The total amount of hours I sleep after a nightshift is adequate

| | | Do not disagree / do not agree | | | | Totally agree |
Totally disagree

  ◯   ◯   ◯   ◯   ◯   ◯   ◯

* 36. I usually recover within 48h after my nightshift

Never   Sometimes   Always

  ◯   ◯   ◯   ◯   ◯   ◯   ◯

* 37. I prefer that the environment that I spend the most time during the nightshift is:

Extra low on light   Extra high on light

  ◯   ◯   ◯   ◯   ◯   ◯   ◯

I don't care, because:

[   ]

* 38. I prefer that the environment that I spend the most time during the nightshift is:

Extra low on
sound

○ ○ ○ ○ ○ ○ ○

Extra high on
sound

I don't care, because:

_____

* 39. I think light exposure would improve alertness during the nightshift and sleep after the nightshift

Totally disagree

Do not disagree /
do not agree

Totally agree

○ ○ ○ ○ ○ ○ ○

This is an example of a light therapy device, press OK to proceed.

* 40. I would use a light therapy device during my nightshift

○ No, certanly not

○ Yes, always

○ Yes, if:

_____

This is an example of light glasses, press OK to proceed.

* 41. I would wear light glasses during my nightshift

- [ ] Yes
- [ ] No, this is not possible during my work
- [ ] No, I already wear glasses
- [ ] No, I don't think the glasses have any use
- [ ] No, I think the glasses look weird
- [ ] Different namely:

[   ]

Appendix 2

Instruction Propeaq premium light glasses

Thank you for participating in this research!

You received the Propeaq premium light glasses from the researcher. These glasses can be used for various health purposes.

The researcher would like to know what your opinion is regarding the ease of use of the glasses. Therefore several questions are opposed on the following page of this document, on which we would like your answer.

First read the instruction of the glasses below. After reading you are allowed to wear the glasses, without the lights turned on. Than please answer the questions on the following pages.

Instruction

On the inside of frame of the glasses you find a round button. By pressing this button, the glasses are turned on. The small blue lights indicate the remaining battery power. To activate the blue light of the glasses, you need to press the same round button twice, shortly. During the nightshift the glasses need to be worn twice, for half an hour, between 01:00-03:00h. You are free to decide on what time point you would like to wear the glasses. When you leave work after the nightshift, the transparent glass of the glasses need to be replaced by the red glasses. To remove these, apply light pressure on the glass close to the paws of the glasses. After this, the red glass can be placed back from the inside. The glasses with red glass need to be worn until the lights in the bedroom are turned off.

After reading the instruction above, would you wear the glasses during the nightshift?

☐ Yes

☐ No (end of participation), because

Gender		(Male/female)
Age		(Years)

Questionnaire Propeaq premium light glasses

1. <u>Was it clear how to use the glasses after reading the instructions?</u>

☐ Yes

☐ No

2. <u>How comfortable were the glasses during your work?</u>

☐ Very uncomfortable

☐ Uncomfortable

☐ A little uncomfortable

☐ Not uncomfortable/not comfortable

☐ A little comfortable

☐ Comfortable

☐ Very comfortable

3. <u>Is it possible to wear the glasses during the nightshift?</u>

☐ Yes

☐ No, because

| |
| |

4. <u>Would you wear the glasses with red glass after a nightshift, as described in the instruction?</u>

☐ Yes

☐ No, because:

| |
| |

5. <u>You can try to replace the transparent glass for the read glass now. Can you change the glasses?</u>

☐ Yes

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☐ No, because:

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┌─────────────────────────────────────────────────────────────┐
│                                                             │
│                                                             │
└─────────────────────────────────────────────────────────────┘
```

6. <u>If the glasses would improve your alertness during the nightshift, how likely would u use the glasses?</u>

☐ Very unlikely

☐ Unlikely

☐ A little unlikely

☐ Not unlikely/not likely

☐ A little likely

☐ Likely

☐ Very likely

7. If the glasses improve your sleep after the nightshift, how likely would you use the glasses?

☐ Very unlikely

☐ Unlikely

☐ A little unlikely

☐ Not unlikely/not likely

☐ A little likely

☐ Likely

☐ Very likely

8. The glasses are for sale for a price of € 299,-
How likely, if the glasses do effect alertness and sleep positively, would you buy these glasses?

- ☐ Very unlikely
- ☐ Unlikely
- ☐ A little unlikely
- ☐ Not unlikely/not likely
- ☐ A little likely
- ☐ Likely
- ☐ Very likely

9. If your employee would buy the glasses, how likely would you use the glasses?

- ☐ Very unlikely
- ☐ Unlikely
- ☐ A little unlikely
- ☐ Not unlikely/not likely
- ☐ A little likely
- ☐ Likely
- ☐ Very likely

10. Do you have other additions or comments?

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Thank you for your participation!

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