

# Developmental Care of Premature Newborns: A Success Story from Evidence-based Research

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**Abstract:** Nursing is useful to the society through the efforts to prevent health problems and through the care, the support and the comfort it provides to the public. In addition, nursing contributes to the advancement of knowledge about experiences of health and illness. Indeed, from the phenomena at the field experience, theoretical work and research in human health play a role in the development of the discipline and the nursing profession. The importance of research for nursing is particularly evident in a context in which evidence-based practice is being promoted, an unavoidable reality in the health field. However, research results do not translate so easily into practice, and it is often argued that there is a gap between the availability of research results and professional practice. Filling this gap cannot depend solely on the world of research and the availability of evidence. It also considers the practice environment and its ability to take into account the available results. This article aims at clarifying the link between the status of discipline, the nursing profession and care in order to establish the need for a better link between knowledge, research and the practice of nursing. It also seeks to briefly recall how knowledge and research contribute to the advancement of a discipline while having the potential and the power to improve practice. More specifically, an example of evidence will highlight how research findings can influence practice and care, outlining briefly how research on investigating the effect of variation in light and noise in neonatal departments in West especially in USA, Canada, Australia, France, etc, have improved the practice of nursing and how nursing theories can contribute not only to the advancement of nursing discipline, but also to the improvement of the provided cares. Levine's conservation model and the theory of promoting pre-term infant health served as a theoretical framework for experimentation to improve the practice of caring for pre-term infants, hence the obligation for nursing staff to pay attention to them and try to integrate them into their interventions.

**Keywords:** Evidence-based Practice, Developmental Care, Nursing Theory, Nursing Research

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## 1. Introduction

Through preventive, curative, promotional and re-adaptive cares, nursing care fulfills its social mandate and thus contributes to improving the living conditions of the population. The provision of care is only a tip of the iceberg since, based on the phenomena observed in practice, theoretical work and research in the field of human health play a role in the development of the discipline and of the profession. The research and use of nursing theory are proving to be of utmost importance in nursing in a context where the reality of pressure towards evidence-based practice is undeniable. However, the gap between research and

practice in nursing is present and similarly the transferability of research results from one context to another or from one person to another reveals the need for a detailed understanding of their implications and adjustments that require a prior assessment of the results by the nurse. The objective of this article is on the one hand to shed light on the existing links between care, the nursing discipline and the nursing profession, on the other hand to recall that the use of theory in the production of research results at the same time helps to add substance to the discipline (knowledge), just as the use of a nursing conceptual model can help to ensure the advancement of the discipline, by locating work around its object. Then, a brief review of the literature will make it

possible to choose a few studies on the variation of light and noise carried out in the West, having led to the conclusion that the reduction of light and noise in premature newborns contributes to their physiological stability. The article also aims to demonstrate that this example of convincing results could inspire neonatal services, particularly that of Cameroon in the fight against neonatal mortality. In the light of Levine's conservation model and the theory of promoting the health of premature infants born from it, a theoretical framework will be sketched for the operationalization of some relevant concepts to further build on the importance of the use of theories in nursing research.

## **2. Link Between Science, Nursing Discipline and Profession**

Nursing is not only a discipline or a science, but also a profession. The discipline brings together knowledge about phenomena present in a person's experiences of health and illness. It is through this discipline-specific knowledge, part of which is the result of a scientific process and offers a set of knowledge organized around certain phenomena, that we can use the expression "nursing science" and that nursing can be recognized as a science. Locating nursing training in academia allows the nursing discipline to benefit from the dual mission of universities, that of disseminating existing knowledge and the other of contributing to the advancement of knowledge in particular through research.

The objective of the profession is to provide quality service to the population. The nursing profession has regulations and standards of practice at the end of training requiring in particular the acquisition of disciplinary knowledge relating to phenomena allowing a better understanding of health and illness experiences. The nursing profession brings together people trained in the discipline and whose scope of practice is delimited by national regulations and monitoring of their application. Standards and regulations serve to protect members of the society in general, they rely on recent research results for updating.

## **3. Care and Professional Practice**

Care is a fundamental notion of the nursing discipline because it is one of the four central concepts (the person, the environment, health and care) which, with relational and non-relational propositions, form the metaparadigm that delimits the boundaries of nursing [1] or its purpose. Every discipline has its object which represents its center of interest. The object of nursing is included in the metaparadigm or is delimited by the metaparadigm. This assumes that theoretical and research work in nursing should focus on those elements included in the subject of the discipline or which fall within the focus of the metaparadigm. These notions are hardly present in the training curricula and not mastered by the nursing staff, which often does not allow them to fully understand the real issues represented by the theory and

research results for a practice based on convincing results and able to ensure the safety of the population, which are the objectives entrusted to them by the society in return for the resources and status accorded to nurses and the professional practice of nursing.

Care, as a concept of the metaparadigm, refers to the actions undertaken by the nurse on behalf of and in relation to living beings as well as the objectives or results of nursing actions [1]. These nurse's interventions take the form of a mutual process between the nurse and the participants in the care, also encompassing the assessment activities. Care is therefore at the heart of nursing practice, which has a triple mission. Nursing practice provides the opportunity to fulfill its social mandate through the provision of preventive, curative, promotional and rehabilitative care; comfort and support care for the population to improve their living conditions. However, for Reed and Shearer [2], the development of nursing knowledge brings scientific research closer to the practice of nursing, where observations and interactions of nurses with people in health situation offer opportunities for development, of test and evaluation of disciplinary knowledge. Since humans are not easily dissociable from their health-related processes and experiences, just as it is not easy to separate the scientist from the clinician [2], it is outstanding that nursing science, knowledge development practices cannot be separated from basic science and applied technological knowledge [2]. In other words, for Reed, nurses can elaborate knowledge and also develop theory from practice, a different vision from the classical vision that allows one to theorize or develop knowledge to put it into practice. Nursing practice should generate nursing knowledge from the observation of phenomena in experiences of health and illness [2]. Nurse practitioners, whatever their level, must be led to theorize from the phenomena they observe in experiences of health and illness [3], because the ability to theorize is a fundamental characteristic of human beings [3-6].

## **4. Theory, Research and Practice**

Introducing nurses to theorizing from phenomena observed by the inductive and abductive method would visibly reduce the shortage of nursing theories and avoid the use of borrowed theories [7]. In addition to natural potentialities, the practice environment favors the development of theory and models of the care process which help to make more explicit the thought strategies used in practice [7], by reducing the gap between research and practice and concomitantly reconciling the discipline of nursing with one's profession. The third mission of professional practice is the transfer of knowledge from science and the application of this knowledge in the healthcare environment. Nurses develop theories and conceptual models, and conduct research whose consistency with practice must be examined. Practice is also the domain of application of the knowledge of the nursing discipline, because the results of research and the theories developed find application in clinical practice, while the

concepts are operationalized there. Professional practice is the area that tests disciplinary knowledge, it is an area of assessment of models and theories. The important role played by nurse practitioners is well established, that is why they must be at the forefront of the profession.

## 5. Nursing Discipline and Its Pitfalls

Disciplines traditionally reflect the real differences that exist between bodies of knowledge per se, and as such become the domain of learning [8]. These authors have used the Oxford Dictionary to define disciplines as branches of instruction or education, a department of learning or knowledge. Thus, institutions responsible for higher education such as Colleges, Schools and Departments are organized into branches of knowledge [8]. Various science faculties exist within departments, including the Faculty of Nursing thus marking its recognition as a science or as a discipline. Should it be recalled that the approval of a branch of knowledge for the status of a discipline requires an object quite specific to this branch which distinguishes it from other disciplines? In nursing, this specific object that distinguishes them from other disciplines is the metaparadigm. Thus, nursing as a discipline is recognizable and different from other disciplines by its metaparadigm. In addition to this center of interest, nursing had to satisfy other requirements to merit the status of a discipline, because, a discipline is a science for Aristotle only if it is able to explain the observed phenomena or to observe from a body of systematic knowledge [9] that Popper [10] names by organized knowledge which, for Lakatos [11] constitutes the hard core on the productive research program. It should be noted that the body of knowledge is the body of knowledge specific to the discipline on which the members of this discipline base their research work and develop their theories. Thus, physics researchers use the theories of their field (physics) to advance physical science, the application of the theories of which is at the origin of technological discoveries. The progress of any scientific discipline depends on the existence and use of its body of knowledge, the increase of this reservoir of knowledge specific to the discipline, the capacity for falsification of theories and hypotheses and the acceptance of the consensus itself. In diversity. The organization of knowledge that specifies the nursing discipline forms the substance of nursing where conceptual nursing models, nursing theories, and domain concepts define the single perspective [1]. The science of the unique differs from multidisciplinary, interdisciplinarity and transdisciplinarity, because in the science of the unique, there is respect for the boundaries delimited within the framework of the metaparadigm, the use of knowledge in itself, the requirement of the productivity of knowledge internal to the discipline, the application of disciplinary knowledge in practice and the dissemination of this knowledge to advance the discipline of nursing.

In addition to disciplinary knowledge, members of a discipline must make use of the methods of science [10] in

their research to achieve and maintain the status of a science or scientific discipline. There are several methods of research, but logic characterizes science by the efforts it provides through the description of phenomena, the verification of facts, control, experimentation and prediction in order to get closer to the truth, because no hypothesis, no theory is taken for true. All assumptions are falsifiable. The more a theory resists falsification tests, the more it corroborates by experience [10], and the better it innovates, informs and contributes to the progress of the discipline [12]. Nursing, as a scientific discipline, is no exception to this rule imposed on all sciences. They must fulfill this mandate to maintain their status as a science. But there are multiple pitfalls hampering the advancement of the discipline. For example, nurses do not use nursing conceptual models or theories in their research. They do not supply the reservoir of knowledge available by developing new conceptual and theoretical frameworks, but on the contrary, they will borrow theories from other fields to resolve the death of theories adapted to current challenges relating to research funding.

## 6. Nursing

Professional competence goes beyond providing health care to individuals, preparing future practitioners, conducting systematic research, to addressing the need of professionals for understanding society [8]. The general characteristic of the nursing profession is that its practice is based on its dynamic system of knowledge development [7]. Nurses must bring their expertise both in the field of research and in that of clinical practice according to the rules of the nursing discipline. In research and clinical practice, the use of nursing theories and the conceptualization of phenomena of interest remain one of the major objectives of the profession as well as the dissemination of nursing knowledge through publications in journals, systematic reviews and in databases. The profession appears as the reflection, the showcase or the mirror of the nursing discipline with the corollary of an evolutionary interdependence [8]. Thus, the discipline embodies the relevant basic knowledge in all areas of professional practice linking the present, past and future [8]. This clearly implies that in clinical practice the motivation to use and generate disciplinary knowledge should remain high for nurses. But this is where the whole issue behind this reflection arises. For example, nurses are beginning to use evidence from other fields to improve their practice without contributing to the advancement of the discipline. However, prior work, as Rolfe [13] asserts, should be required to determine not only the source of knowledge that has been used as evidence for practice, but also to assess the priority of nursing research data which were generated by the application of a scientifically rigorous, objective, controlled, decontextualized and generalizable methodology [2].

Evidence-based practice is defined as the conscientious, explicit and judicious use of the best available data to make decisions about the care of each patient [14]. The goal of such a practice is to contribute to the improvement of the

quality of health care and to beneficial results for the patient [14]. The definition of evidence-based practice and their objectives merit further consideration of the links between this concept and the nursing profession. The credibility of this practice is due to the methodological rigor, to the generalization of the results and to the transferability of the latter from one context to another [14].

Although the hypothetico-deductive method seems more credible, a margin of error on the results of such research still exists so that one could affirm with Popper [10] that the more a theory resists the tests of falsification, the better this theory corroborates in an experience of health or disease. However, the theories and the assumptions resulting from the convincing results are considered as evidence of credibility not to speak the truth. It seems then that the truth of today could be the mistake of tomorrow.

In practice, nurses apply the convincing results of research sometimes inconsistent between the research and the area of practice. Yet we often talk about a gulf that widens the gap between the two. This discrepancy would sometimes result from the lack of use of nursing theory in these data, and the practice that follows could result from inconsistencies between research and practice. Because professional practice reflects discipline, nurses should avoid systematic application of research findings even if it is evidence-based research. A prior evaluation of the data identifying their source and the methodological approach used should be systematically done by nurses to determine whether the evidence has come from such nursing research.

In addition, an evaluation is not often done to determine the conditions of transferability through the possibility of generalization of research results and the conditions for which the decision-making will be beneficial to the client (context). Evidence being an unavoidable reality in this contemporary era, nurses could mobilize so that this type of research contributes not only to improving the quality of care, but also to advancing the discipline of nursing. Nurses can create their own evidence from the conceptualization of the phenomena of interest, then assess the evidence for disciplinary before use.

## 7. Developmental Care to Promote Growth and Prevent Mortality in Premature Infants

Developmental care interventions can help pre-term infants become more familiar with the neonatal intensive care unit environment. Premature newborns are babies born before 37 weeks of amenorrhea who can develop a multitude of problems (hypothermia, hypoglycemia, tachypnea, tachycardia, neonatal hemorrhages, arousal...) because their organs are immature. From this arises the concern that an unfavorable environment in the neonatal intensive care unit may add to these problems and negatively affect the growth of the infant (physiological stability), with a brain that happens to be particularly vulnerable.

Developmental care refers to a range of strategies aimed at reducing the strain on the neonatal intensive care unit. This includes reducing noise and light in a neonatal intensive care unit in Cameroon, a developing country with one of the highest neonatal mortality rates in the world.

Light and noise have been the subject of research in the West and the results of this research have been put into practice in several intensive care units. A review of randomized clinical trials shows that these interventions may have some benefit for evidence-based outcomes in premature infants. If the conditions for transferability of the results are met, these convincing results could be used for the implementation of nursing interventions aimed at reducing noise and light in a neonatal service in Cameroon.

Several disciplines have conducted their research on developmental care (specifically light and noise), the results of which are now evidence. The literature review presents four types of disciplines with literature on developmental care: nursing, medicine, psychology and psychotherapy [15]. The analysis of the concept of developmental care has made it possible to identify several different definitions or understandings [15] where some researchers stand out from others by their use of the developmental synaction model [16, 17]. For these researchers, the premature baby is characterized by a set of subsystems and developmental care is a set of environmental and behavioral strategies to promote the development of the premature newborn.

Some nurses have borrowed Als' synactive model of development [16] to develop a theory, *The Universe of Developmental Care* emphasizing the skin as the junction between the environment and the human being [18]. On the other hand, other nurses have made efforts to conceptualize the developmental care phenomenon [15, 19], using the concept analysis method of Walker and Avant, to identify the definitions and the various uses of the concept of developmental care and outline its main attributes.

### 7.1. Noise Standards and Interventions

The American Academy of Pediatrics (AAP) [20] recommended that staff in neonatal units implement strategies to avoid exceeding a sound level of 45 dB. In more detail, White, Smith and Shepley [21] from their work, recommended that the loudness attributed to the combination of background noise and operational noise (conversations, material handling, and more) in the rooms of newborns does not exceed a sound level  $L_{eq}$  of 45 dB (A). This recommendation is even more pressing in premature infants with immature organ systems. To this end, research has shown that the sources causing these levels of sound intensities are varied, including human and material sources [22, 23].

#### 7.1.1. Wearing Hearing Protection Devices

There are basically two types of hearing protection devices, either earmuffs or earplugs. For example, the use of Minimuffs® earmuffs, frequently used in studies, would reduce the sound intensity by approximately 7 dB (or >50%). Most studies that have looked at the use of these

devices have reported positive results on various parameters, but these results remain sketchy and sometimes contradicted by other studies. For example, Abdeyazdan *et al.* [24] demonstrated that wearing earmuffs reduced motor movements in children and promoted weight gain. For its part, Duran *et al.* [25] showed that wearing earmuffs for 2 days had no effect on physiological parameters, but reduced the child's activity level on the ABSS scale (Anderson Behavioral State Scoring System), including an increase in the time spent in quiet sleep. However, in a similar study, Khalesi *et al.* [26] succeeded in demonstrating both an optimization of physiological parameters (reduction in heart and respiratory rates and increase in oxygen saturation), in addition to a reduction in the ABSS score and an improvement in the quality of sleep, during wearing earmuffs on a day. In contrast, Aita *et al.* [27] reported an increased stress response in premature infants in the intervention group (higher maximum heart rate and lower heart rate variability in this group). However, in this study, the intervention consisted of applying both sound protection (ear muffs), but also visual protection (protective glasses), over a short period of 4 hours. For their part, Sato *et al.* [28], assessed the wearing of earmuffs on sleep, when combined with one-hour rest periods during which the noise level was also reduced by staff, and failed to demonstrate an improvement in sleep by polysomnography. In addition, the study found a decrease in sleep time in children with low gestational age. According to a systematic review by Almadhoob and Ohlsson, [29] on longer-term effects of wearing hearing protection, Abou Turk [30] demonstrated that wearing earplugs in premature infants under 32 weeks at birth or newborns whose birth weight is less than 1500g, allowed an improvement in mental development (measured by the Bayley II scale), this from their first week of life up to 34 weeks of postmenstrual age and the period of 18 to 22 months of corrected age [29]. In our study, the use of these ear protection devices was not accepted in a context where the culture is deeply rooted in mores as in Cameroon, and where nurses in neonatal units were concerned like their counterparts to see earplugs swallowed or aspirated by premature newborns [30].

### 7.1.2. Measurement of Sound Intensities with Feedback

Instinctively, feedback to staff and visitors on the effective sound intensity on the unit could encourage them (staff and visitors) to adopt behaviors that reduce operational sources of noise (conversations, handling of equipment, etc.). One of the approaches studied by some researchers is the use of a sound level meter equipped with an instant feedback device. Essentially, this feedback is in the form of a visual signal indicating whether the sound level is adequate or not. For example, Wang *et al.* [31] evaluated the impact of such a device on noise reduction over a period of 2 months. The devices were placed in the rooms of premature babies, as well as at the central nursing station. A red light indicated a sound intensity of 50 dB or more, a yellow light indicated a sound intensity between 45 and 50 dB, and a green light

indicated a sound intensity of less than 45 dB. The results showed that the intervention resulted in a significant increase in the percentage of time that the noise level at the NICU was below 50 dB in all patient care areas [31], even if the sound level Leq has not been reduced and remains above 45 dB. The authors acknowledged that uncontrollable sources of noise on the unit made it difficult to reach this target. Interestingly, this type of strategy has also been used by Ahamed *et al.* [32] but this time as part of a study evaluating a program made up of multiple interventions implemented in four successive phases. The sound level meter, installed in the rooms of premature babies during phase 3 of the project, indicated in red sound levels above 70 dB, and in yellow, sound levels above 60 dB. Although the implementation of all the interventions in this study resulted in a significant reduction in sound intensity, the specific impact of the device remains difficult to assess, because it is part of a set of interventions., some of which had preceded the implementation of the system.

In a very similar study with four-phase implantation of multiple interventions, Chawla *et al.* [33], first offered feedback on the sound intensities of the previous days to the healthcare team in phase 3 of the project, then in phase 4, they used real-time feedback to using a device similar to that of Wang [31]. We see in this intervention that the authors managed to gradually reduce the sound intensity on the unit until they reached their initial target (3 dB reduction in Leq). However, it is difficult to assess in isolation the specific contribution of feedback on these multi-intervention results. In conclusion, although this type of intervention is arousing interest and can be integrated into noise reduction programs, it requires the application of advanced technology, and by the same token, it seems less adapted in the context of the conduct of this study where time, financial and human resources seem limited.

### 7.1.3. Installation of Acoustic Covers on Incubators

Although placing blankets on incubators is primarily an intervention to reduce light in neonatal units, some researchers believe that incubator blankets could also reduce the noise level that reaches the premature infant in a closed incubator. But this perspective has been criticized for its relevance in reducing sounds with frequencies above 1000 Hertz [34]. Kellam and Bathia [34] propose the use of incubator covers made from sound absorbing material (Sonexwet baffles) such as melamine foam panels, designed to reduce sound frequency  $\geq 1000$  Hertz [34]. To implement this type of intervention, which requires financial resources, in a poor region like Cameroon, financial difficulties could constitute a major obstacle in the purchase of this type of blankets made with sound-absorbing material. However, putting blankets on incubators could solve the problem of excess noise as well as that of excess light. But, unfortunately, the purchase of these devices is a real challenge in the Cameroonian context. In addition to the high cost of these blankets in a context where material and financial resources are very limited, the installation of

acoustic blankets on incubators appears unsuitable in the Cameroonian context. Thus, the interventions to be carried out in such a context must be inexpensive. In addition, equipment that completely covers the incubator would not be accepted in neonatal intensive care units where monitoring of the general condition of the premature newborn remains primarily visual in view of the absence of monitoring equipment.

#### **7.1.4. Educational Strategies and Behavioral Changes, Changes in Infrastructure and the Environment**

Several studies aimed at changing the behavior of staff in neonatal units have been carried out. In most cases, these studies incorporate several interventions at the same time, sometimes including modifications on the infrastructure or the environment of the units. These studies then evoke interventions with multiple strategies for noise reduction [32], a combination of behavioral and environmental modifications [35] or the implementation of noise reduction "programs" [36, 37]. The deployment of these multiple strategies sometimes takes place in successive phases [32, 33]. Overall, these strategies have made it possible to reduce the sound intensity on the units, without however achieving a value lower than the current recommendation of 45 dB (for various reasons, including non-modifiable factors linked to the characteristics of the unit) (infrastructure). Although the interventions are difficult to assess individually in their multifaceted set, the ultimate goal of their implementation being noise reduction in the neonatal intensive care unit. These different strategies and interventions could be appreciated in a context like Cameroon where the renovation and maintenance of infrastructure on the one hand, the establishment of programs on the adoption of behaviors favorable to noise reduction on the other hand are necessary.

Strategies aimed at reducing noise by adopting favorable behaviors include: educating staff through training and awareness sessions, installing posters, distributing brochures or pamphlets, providing feedback (including that on sound intensity at the NICU), the establishment of periods of rest or silence, the identification of a "champion" as the person responsible for reminding staff of the principles and objectives, then training by peer education [32, 33, 35–43]. The components of these interventions are sometimes identified as the *key drivers* which could constitute the effective ingredients of an intervention protocol [32].

Specifically concerning the education sessions, these generally focus on definitions, recommendations, the impact of noise on premature babies and on staff, the contribution of different activities aimed at reducing noise, the results of the measurement of sound intensity on the unit, as well as possible strategies to put in place to reduce the noise. These strategies propose to reduce the tone of voice (library voice), to avoid talking at a long distance, to reserve discussions at a distance from the child (especially during tours), to handle the material delicately, to close radio and put the phone in vibrator mode [33, 41, 43, 44]. With regard to the modifications to the environment, we note, among others: the

installation of sound absorbers (rubber or felt) under the legs of the furniture, the drawers or the doors, the replacement of the metallic material if that it is possible to manage alarms (monitors for example), silent call bells with indicator light and the installation of low flow taps.

Incekar et al. [43] evaluated the effectiveness of a 90-minutes training in 5 topics on noise reduction in a neonatal unit. The training included various teaching strategies (questions and answers, brainstorming, group discussion, posters). The authors report a significant decrease in the Leq sound level of 2 to 7 dB, the greatest decrease being recorded during the change of morning shift. Weich et al. [36] for their part, instituted an educational program in the form of the distribution of pamphlets and the installation of posters on the units, coupled with a presentation intended for health professionals. The information related to a comparison of the unit's sound levels to those recommended, as well as possible strategies to reduce the noise. Even if no sound intensity measurement after the intervention was carried out, the participants demonstrated a month after the intervention an awareness of the noise problem, as well as the acceptability of the means to be put in place to reduce the noise.

For their part, Zamberlan-Amorim et al. [37] evaluated a noise reduction program developed jointly with neonatal team members and families. Nine weekly sessions of exchange and discussion allowed the development of the protocol consisting of strategies suggested by staff and families. These authors report that during the two weeks following the initiation of the protocol, a reduction in the sound level Leq and Lmax of 3.7 and 7.1 dB (A) was observed respectively.

Interestingly, Biabanakigoortani et al. [41] introduced peer training. Five "coaches" from the staff of the unit (nurses or doctors) were selected and trained on the problem of noise and the associated risks. Each coach was then matched with a group of professionals to train over two consecutive weeks through focus groups and face-to-face interactions. The authors report a reduction in Leq from 68.2 to 48.5 dB in rooms for premature babies. Finally, Ramesh et al. [35] instituted a noise reduction program combining behavioral changes coupled with modifications to the unit's environment. After implementation of the protocol, the authors reported reductions in sound intensity of 2.26 to 9.58 dB in all rooms.

Regarding specifically the establishment of periods of rest or silence, Pugliesi et al. [42] evaluated the impact of this intervention (4 periods of 60 minutes per day) on noise reduction and increased sleep time. The results demonstrated during these periods a reduction in sound intensity as well as an increase in sleep duration by polysomnography. For their part, Santos et al. [40] evaluated the impact of the same strategy of 4 periods of rest or silence per day on the loudness of the premature infant. The results demonstrated a significant reduction in Leq of 20 dB (which is exceptional in the studies reported).

Finally, some studies have developed ambitious programs consisting in setting up complex and multiple interventions, by introducing them in different successive phases. For

example, Ahamed *et al.* [32] implemented a four-phase, multi-component intervention over a one-year period using the Plan-Do-Study-Act (PEEA) approach. The researchers identified four *key drivers* from which they selected the specific strategies to be implemented (educate, tackle sources of environmental noise and equipment, modify behavior and culture, and finally, reminders on noise regulation). The authors reported, after one year, a reduction in sound intensity of 7.7 dB during the day and 4.9 dB at night. The specific fact of this complex intervention is that the authors attribute the sustainability of the program to the presence of "champions" introduced in phase 4 and responsible for maintaining a constant dialogue with staff members. In another way, Chawla *et al.* [33] developed a 4-phase noise reduction program, asking staff and visitors about their opinion and perception of the noise problem. This program included, among other things, education sessions, the establishment of rest periods and feedback on the sound intensity measured on the unit.

## 7.2. Standards, Light Impact and Interventions

Empirical evidence shows that premature infants born before the 28<sup>th</sup> week of pregnancy should have a light intensity of less than 20 lux at all times [21]. This author suggests that the baby who is born at 28 weeks gestation or less, should remain in a light intensity of 20 lux at night, daily lighting of 250 to 500 lux, in an ambient light of between 10 and 600 lux according to White *et al.* [21], while avoiding direct illumination towards the eyes of the premature newborn [45]. In conclusion, the particular context of the premature newborn is different in terms of brightness.

### 7.2.1. Impact of Light on Premature Newborns

Regarding high intensity lighting, it can cause significant physiological instability for the premature baby, leading in turn to several damages such as damage to the retina, slowing down of growth and psychomotor development and disorders the circadian rhythm [46–48] of premature newborns already at risk of complications from all their organ systems.

### 7.2.2. Strategies / Interventions Related to Light Reduction

Several randomized studies have focused on the evaluation and comparison of different modes of light management on neonatal units, including cycled light (CL), near darkness (ND), irregularly attenuated light (irregularly dimmed light, DL) and continuous bright light (CBL). Nine of these studies (totaling 544 premature babies) were included in a meta-analysis carried out by Morag and Ohlsson [49], the aim of which was to assess the efficacy and safety of cyclic light, to compare the effects of this light (CL) with those of irregularly attenuated light (DL) or near darkness (ND) on the one hand, and also to assess the effects of CL on those of continuous bright light (CBL) compared to growth in premature infants [46, 50–57]. Generally, the quality of these studies is rated as low due to the small number of participants included and the impossibility of creating blind groups (blinding).

Briefly, six of these studies (n=424) compared cyclic light

(CL) to near darkness (ND). One of the studies failed to demonstrate a significant difference in weight gain at 4 months between the two groups (n=40) [46]. Boo [50] demonstrated that the day / night activity ratio, in the 10 days preceding the discharge, favored the group exposed to cyclic light (n=62). Two other studies (n=189) that assessed the prevalence of retinopathy between the two groups reported no significant difference [51, 56]. However, two studies (n=77) reported a significant reduction in the length of hospital stay in the CL group [51, 52]. Finally, another study (n=37) reported less crying at 11 weeks of corrected age (CA) in the CL group compared to the ND group [52].

In addition, three studies (n=120) compared cyclic light (CL) to continuous bright light (CBL). Two of these studies (n=79) reported a significant decrease in the length of hospital stay in the CL group [54, 57]. One study (n=41) reported a higher mean weight at three months of conceptual age in infants in the CL group and a short arousal time in 24 hours at three months of age [54]. The same study also reported, for the CL group, a decrease in the duration of mechanical ventilation, as well as a decrease in the time required before the initiation of oral feeding. The authors of this meta-analysis conclude that CL reduces the length of hospital stay compared to either CBL or ND. However, and given the low quality of the evidence, further studies will be needed to assess the advantages of LC over ND.

Morag and Ohlsson's [49] meta-analysis occupied a prominent place in our study by measuring variables. During the implementation phase of the pilot study, the day / night cycle could be obtained with little financial expenditure, unlike the purchase of acoustic blankets. The cycle could be achieved by leaving premature newborns in the light of day under conditions that meet the recommended standards and by light management by removing excess light bulbs and / or turning them off [50].

## 8. Promotion of the Integration of Evidence into Professional Practice

Implementation science requires the promotion of evidence [58, 59]. The review of the literature, presented above, made it possible to understand that several interventions relating to the reduction of noise and light in the NICUs have contributed to the flourishing of pre-term infants and to the drastic reduction of neonatal mortality in the West. These interventions are currently spreading to the rest of the world in Latin America, Australia and Asia because they have been proven and their transferability is essential to areas plagued with high neonatal mortality such as Cameroon so that, alongside usual care for the premature newborn, care that reduces stress and improves sleep quality, growth and mental development such as noise and light reduction in NICUs [33, 43, 51, 60–62] occupy their place in the offer of care in the NICUs of Cameroon.

Indeed, complex (multiple) interventions in particular the establishment of a day / night cycle, the reduction of noise

levels by the renovation of the equipment, the establishment and reinforcement of periods of silence at the unit of neonatal intensive care, the implementation of a personalized training program for professionals and visitors as well as the restructuring of the environmental sphere of the NICU [33, 60–62] have been adopted in some countries and have demonstrated their usefulness in improving the quality of care for pre-term infants. Currently, it is essential that these interventions be transferred to Africa, in this case to Cameroon where the neonatal mortality rate is 28 deaths per 1000 live births [63], ranking Cameroon among the countries with neonatal mortality rates the highest in the world [64]. While the nursing research enterprise has a significant body of evidence of valuable interventions that could be applied in clinical practice in high-mortality countries like Cameroon, the results of this research are found to be not translated in some real clinical contexts to meet the pressing clinical needs of patients and populations [59, 65–67].

## 9. Use of Convincing Results in Our Intervention Research

Our research aimed to develop and implement a protocol for nursing interventions with the goal of reducing noise and light in the neonatal intensive care units of the Center Hospitalier d'Essos (CHE) and the Gyneco-Obstetrics and Pediatrics Hospital of Yaoundé (HGOPY) in Cameroon. The aim of this

research was also to evaluate this protocol of nursing interventions on its acceptability and feasibility in this context where financial, human and material resources are very limited.

Because the interventions in our intervention protocol were complex, testing it was a process involving multisectoral participation. This complexity is explained first of all by the need to carry out in the two NICUs, correctional measures relating to physical and environmental aspects such as infrastructure and the development of certain areas. The intervention protocol was implemented and applied more or less in its theoretically defined terms, its frequency, its dose for each intervention by the staff according to the intervention method of Sidani and Braden [68]. A plea was presented to line managers in order to obtain their support and contribution to the implementation of the intervention protocol. An awareness / training session for a large group of participants, of approximately two hours in each unit, with the aim of providing staff (doctors and nurses) with knowledge and skills related to noise reduction and light on premature infants hospitalized in NICUs was performed. Small-group awareness sessions were designed to build participants' knowledge and skills in noise and light reduction at the NICU. These were conducted according to the shift schedule, averaging 1 hour of time per shift out of a total of eight teams of NICU staff. Placards, giant posters were displayed and leaflets disseminated.

**Table 1.** Results obtained on the implementation of correctional measures according to the theoretical domain of the environmental context and resources.

NICU	Problems	Proposed interventions	Results obtained
CHE	Creaking doors	Lubricating the doors	The doors have been greased
	Whistling of incubators	Replacement / repair of whistling incubators	Incubators repaired
	Sound of flowing water near the intensive care unit	Installation of a hydro-economical foamer	Decreased water flow noise
	External noise reaching the resuscitation room	Double glazing on the windows of the intensive care unit	Double glazed windows
	Noise due to pulling chairs on the floor	Felting chair legs	Felted chair legs
	Chat caused by families requesting information from staff	Creation of an information room	No furnished room
	Noise of instruments near the intensive care unit	Moving the instrument trolley	No cart moved
	Excessive light in some rooms	Removal of excess light bulbs	Excess bulbs removed
	Excessive light in some rooms.	Installation of curtains on the windows	Curtains placed on the windows
	Night lighting poorly suited to the required standards	Establishment of a day / night cycle	Intensity of 20 lux from 7 p.m. to 7 a.m. against a daily intensity of 10 to 600 lux installed
NICU	Problems	Proposed interventions	Results obtained
HGOPY	Creaking doors	Lubricating the doors	The doors have been greased
	Snoring of incubators	Replacement / repair of incubators	Incubators repaired
	External noise reaching the resuscitation room	Double glazing on the windows of the intensive care unit	No double glazing on the windows
	Noise of drawers	Felting drawers	Felted drawers
	Noise due to pulling chairs on the floor	Felting chair legs	Felted chair legs
	Chat caused by families requesting information from staff	Creation of an information room	Room set up in front for information
	Alarm noise caused by power cut	Installation of a new relay system (circuit breaker)	New relay system not installed (circuit breaker)
	Ringling noise at the entrance	replacement of the ringtone by an indicator light	Ringtone on entry suppressed, but no indicator light
	Irradiation of phototherapy rays on babies not undergoing this treatment	Creation of a phototherapy room	Start of fitting out a room for phototherapy



NICU	Problems	Proposed interventions	Results obtained
	Excessive light in some rooms.	Window tint in the intensive care unit	Switch placed in the office of the major for the control of the electric light, non-tinted windows, curtains not placed on the windows
	Night lighting poorly suited to recommended standards	Establishment of a day / night cycle	Light intensity of 20 lux from 9 p.m. to 7 a.m. compared to a daily light intensity greater than 600 lux in certain areas of the NICU.

This table shows that despite the will of the participants, some interventions were not carried out such as double glazing, the development of a room for information, the tint of the windows or the installation of curtains to reduce the intensity light at 600 lux at the neonatal unit of HGOPY in order to reduce daytime light at the unit.

**Table 2.** Behaviors implemented and results achieved.

Behaviors to be implemented by staff and / or family	Expected results
Adoption of a "library" voice 1. Non-use of radio, cellphones, etc. 2. Gentle handling of equipment and incubators and silencing of alarms 3. Redevelopment of unit areas 4. Care planning for newborns to let them sleep 5. Establishment of moments of "calm" 6. Alarm management (oxygen indicator) 7. Education of families and visitors 8. Reminders during communication sessions for behavior change (CCC) 9. Introduction of penumbra from 7 p.m. to 7 a.m.	"Library" voice adopted 1. Absence of radios, cellphones placed on vibrator and answer to telephone calls outside the unit 2. Equipment and incubators handled gently and alarms immediately switched off as soon as they are triggered 3. Areas of the unit redeveloped 4. Planned newborn care when newborns are awake 5. Moments of "calm" established at the NICU 6. Well managed oxygen indicator alarms (oxygen indicator buzzer off when triggered) 7. Families and educated visitors 8. Reminders during CCC sessions 9. Twilight from 7 p.m. to 7 a.m., introduced

Table 2 shows that the participants adopted new behaviors in order to reduce noise and light in the units.

Nursing models are currently available and ready to provide a frame of reference for researchers entering the field of developmental care. Levine's model of conservative care would be of particular interest to researchers in the developmental care of pre-term infants. Research based on this model could not only enrich disciplinary knowledge, but also improve clinical practice and coherently align nursing discipline and professional practice to serve as evidence that contributes to the reduction of neonatal mortality worldwide and could be done specifically in Cameroon under good conditions.

## 10. Theoretical Considerations

Implementation science requires strong theoretical nursing frameworks in order to reinvigorate and propel the entire profession towards a new research paradigm, with potentially significant impact on patient care [59, 67, 69]. Committing to the use of nursing theories in translational research is a necessity for advancing research in nursing. Levine's vision of conservation nursing was called upon in this research to explain how the premature newborn can conserve energy in the nursing unit. The moderate spectrum theory of Mefford [70] provided the concepts of operationalization.

### 10.1. Levine's Model of Conservation Care

As Levine points out, the conservative care model takes a holistic and integral view of the person and imparts to intervention research a conception of a process of adaptation that reflects continuous change through which the individual retains his integrity in the realities of its environment [71].

Through this process of care aimed at conservation, Levine's model has enabled our study to develop the mechanisms by which the nurse, as an agent of adaptation or of change, plays a preponderant role in the care environment of the new-born prematurely considered as a holistic being, so that it maintains its energetic balance, its structural, personal and social integrity. Levine's model of conservation provided explanations for the conservation of health as the wholeness or integrity of human beings [72] fitted into a fluid interface between the internal environment which is susceptible to constant change and the external environment in all its conceptual, perceptual and operational dimensions [71]. The model was particularly relevant for a study of premature infants because of the emphasis on the biophysiological dimension of a person and how to understand the influence of the environment on this dimension while seeing the person in his or her own comprehensiveness.

### 10.2. Mefford's Theory of Health Promotion of Preterm Infants

Nursing has long been involved in implementation science and has had an influence on important theoretical and empirical work, particularly in the promotion of research implementation. The framework for promoting action on the implementation of nursing research is widely cited [73, 74]. Although this framework is relevant for some studies, the theory of promoting the health of premature infants was relevant for this study through its process of explaining the phenomenon of noise and light, its impact on the health of premature infants and related interventions.

In our study of premature newborns prey to environmental stimuli, Mefford's intermediate theory was able to describe

and explain the phenomenon of stimuli experienced by the premature infant at the NICU through its four concepts of disruption of the premature infant health, that is the disturbance of energy balance as explained by Peng et al. [48, 75] in their perspective; then the disturbance of structural integrity, the disturbance of personal integrity and finally the disturbance of social integrity. The theoretical model of Mefford [76] also described the process of care as a conservation by the fact of the coherence of the nursing care and the intensity of the latter in order to achieve the completeness (state of health) of the new patients born prematurely on discharge from hospital.

Levine's conservation model and Mefford's theory made it possible to collect data from the first phases of the method and to present the research results according to the four dimensions of the concept of conservation which are energy, structural integrity, personal integrity and social integrity. The Conceptual-Theory-Empirical (CTE) structure made it possible to understand the role of balancing between the reduction in energy consumption and the energy production / contribution, involving the elimination of sources of noise and excess light as well as reducing the intensity of noise and light on other sources in order to reduce excess energy consumption by premature newborns, in order to avoid stress, prolonged wakefulness or lack of sleep, restlessness and various activities at the base of energy expenditure [71]. The consequences of this influence could be observed on the structural, neurological and social aspects of premature newborns. Likewise, the CTE structure has made it possible to articulate social integrity as the maintenance or restoration of the sense of identity, self-confidence and uniqueness of each premature newborn [71]. Finally, Levine's model of conservative care, through Mefford's theory, allowed the explanation of the nursing process as a conservation characterized by a scientific approach that determines care practices and interventions [77] in a context where the interface between the immature internal environment of the premature newborn and the external environment full of stimuli, in particular noise and excess light, poses serious health problems to premature babies. Health itself as wholeness was viewed as a model of adaptive change identified by staff on improving sleep quality and decreasing wakefulness and restlessness in pre-term infants as a holistic individual.

### **10.3. The Reference Framework of the Theoretical Domains of Michie et al. [78]**

Although the theory of promoting the health of preterm infants has provided a useful basis for this research to design interventions to modify behavior, Mefford's theory offers little information on how to ensure that interventions developed will be effectively implemented by staff, hence the importance of behavior change theories. The Theoretical Domains Framework (TDF) developed by Michie et al. [78] suggests ways to go about making these interventions effective. Michie et al. [78] explains the mechanisms of behavior change. Not only did the TDF make it easy to find the theoretical constructs explaining the behaviors and

mechanisms of intervention implementation, it also facilitated the choice of the theories relevant to the intervention implementation phase, and suggested how to do the theoretical evaluation of the behavior of professionals in these neonatal intensive care units. This is a framework that justifies the use of a theoretical approach underlying the implementation of the protocol by the staff in place, while adjusting their usual interventions. The TDF helped to understand the mechanisms of change, including how and in which contexts behaviors can change.

## **11. Conclusion**

At the end of this article, the aim of which was to clarify the link between the status of a discipline, the profession and care, to briefly recall how knowledge and research contribute to the advancement of the discipline, to show how the results of research can influence practice and care; particularly research on developmental care (variation of light and noise) in neonatal services can contribute not only to the advancement of the nursing discipline, but also to reduce neonatal mortality elsewhere in the world and in Cameroon specifically by relying on a nursing model or an intermediate theory, one can realize the immensity of the work in convincing nurses of the importance of using nursing theory. Yet the latter is capital in research and practice.

## **12. Recommendation**

With regard to evidence, nurses are encouraged to conduct nursing research and ensure that the results of this work are recorded in databases. These data can be used in research and in the clinic, and be used as evidence, conclusive results.

## **Conflict of Interest**

There is not any conflict of interest for this paper.

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