

Routine procedures in NICUs: factors influencing pain assessment and ranking by pain intensity

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Summary

Background: Pain associated with routine procedures in NICUs is often inadequately managed. Barriers to more appropriate pain management are nurses' and physicians' knowledge and the challenges of collaborative decision-making. Few studies describe the differing perceptions of procedural pain intensity among nurses and physicians in NICUs which could complicate common decision-making. This study set out to explore the factors influencing pain intensity assessment and to gain insight into a possible pain intensity classification of routine procedures in the NICU.

Method: A survey was conducted among 431 neonatal health care professionals from 4 tertiary level NICUs. Each routine procedure was assessed on a 10-point visual analogue scale (VAS) assuming absence of analgesia.

Results: Multiple ANCOVA models showed that nurses rated 19 of the 27 procedures as significantly more painful than did physicians

($p < 0.05$). We found no differences in pain assessment based on professional experience, gender or age. Of the 27 procedures listed, 70% were rated as painful and 44% were judged very painful. Ranking and classification of the pain intensity of routine procedures were drawn up. The general ranking of the median across all procedures shows that "insertion of a thoracic drain" is assessed as the most painful procedure.

Conclusions: The majority of routine procedures in an NICU are considered to be painful. Nurses generally rate procedures as more painful than do physicians. This difference in assessment deserves exploration in regard to its impact on collaborative decision-making in neonate pain management.

Key words: neonates; procedural pain; classification of pain intensity; factors influencing pain assessment

Introduction

In the last decade the nature and frequency of neonatal procedural pain has been actively explored [1–6]. Pain assessment tools have been developed and validated [7–13] and pain relieving interventions systematically evaluated [14–19]. Today there is sufficient evidence that repetitive pain is harmful in newborns, with possible short [20–24] and long term consequences [24–28]. De-

spite advances in neonatal pain management and increased awareness among health care providers of the consequences of early neonatal pain exposure, there is evidence that such pain is not adequately managed [2, 29–31]. This suggests that the importance attached to neonatal pain management by researchers seems not to be reflected in practice.

Factors influencing pain management

There is evidence that in general pain is not appropriately managed in acute care institutions [32, 33]. Pain management is affected by individual factors such as knowledge, personal beliefs and the ability to cooperate in inter-disciplinary decision-making [34–36], and by the growing techni-

cal skills and rapidly changing situations typical of intensive care units [37]. Also, administration of analgesics may be guided by social prejudices: in one study physicians working in emergency facilities in the US prescribed an analgesic treatment only half as often for patients of Hispanic Ameri-

can origin as for non-Hispanic patients, while Afro-American patients were given 66% fewer analgesics than white people [38].

Critically ill patients who are unable to communicate effectively (ventilated adults, geriatric patients or neonates) run the greatest risk of suffering pain [39]. Underestimation and inadequate treatment of pain conditions in neonates has to some extent already been studied [3, 40, 41]. A survey of three neonatology departments in Great Britain confirmed that 53% of all nurses fail to use a tool for pain assessment to objectivise pain [41]. Despite the fact that a pain assessment tool was already incorporated into the nursing flow sheet throughout the hospital, only 27% of nurses acknowledged that they used it, while 33% indicated that they were using no tools to assess pain [42]. Simons et al. [2] showed that preemptive analgesic therapy was provided to fewer than 35% of neonates studied, while in an NICU 40% of neonates received no analgesic therapy. Studying a sample of 1068 neonates, Johnston et al. [5] found that less than 2% received preemptive analgesia for procedural pain.

It is generally assumed that education and practical experience enhance accuracy of decision-making in appropriate pain management. However, studies report conflicting results: while Corcoran [43] and Tanner et al. [44] found that nursing experts performed better than nursing novices, other authors have reported that knowledge and experience do not influence assessment of pain intensity [40]. In a study of 695 nurses on three different experience levels, Hamers et al. [45] were unable to confirm the influence of expertise on pain assessment. Instead, influential factors in nurses' decision-making, such as medical diagnosis, the child's facial expressions and

age, together with the nurses' knowledge, attitude deficits and workload, were explored [46, 47]. Margolius et al. [48] examined nurses' beliefs about pain in children and perceptions of the adequacy of pain management. They showed that those nurses who provided the most direct care harboured most misconceptions about effective pain management. Nothing in current research shows whether nurses' and physicians' beliefs affect their willingness to prevent or to treat pain.

Accuracy in nurses' decision-making appears to depend on differences in judgements regarding particular nursing situations [49]. Saläterra [50] found that in the paediatric field nurses' knowledge was inconsistent with current research. These results could not be confirmed by Porter et al. [51], whose study indicated that most neonatal clinicians believed infants experience pain equal to or greater than that experienced by adults. But the study reported differences between nurses' and physicians' assessment of procedural pain. These results are consistent with a recent study on this topic, which confirms that nurses generally assess procedures as being more painful than do physicians [2]. No studies could be found on possible differences in pain assessment between neonatal units. Moreover, no German or Swiss data are available concerning the assessment of pain intensity for routine procedures, and possible influential factors, in an NICU.

Aims of the study

The study set out to gain insight into factors influencing pain intensity assessment of routine procedures in NICUs. A further aim was to draw up a ranking and classification of pain intensity of routine procedures.

Method

Study design and sample

With approval from Canton Bern ethics committee a descriptive-exploratory study was carried out. A survey involving 431 neonatal health care professionals from 4 purposively sampled tertiary level NICUs in Switzerland (3 units) and Germany (1 unit) was conducted from April to June 2005, including all staff present during this period. The NICUs were comparable in function and the basic educational level of their staff.

Procedure and statistics

A list of 27 routine procedures was drawn up on the basis of a literature search focusing on results of similar studies [2, 5, 6]. The list was then supplemented by expert opinion in Switzerland (clinical nursing specialists and medical heads of neonatology units). To distinguish painful from non-painful procedures, "diaper change", "cranial sonography" and "x-ray", which had been previously classified as non-painful by the studies mentioned, were included as well. To investigate subjective pain intensity assessment, each procedure was assessed on a 10-point visual analogue scale (VAS), assuming that no anal-

gesia was given during the procedure. Following advice from the head of the Bern University Hospital pain research team, the cut-off for painful procedures was set at ≥ 4 points. The list designed for this study was tested in February 2005 in a pilot study including 9 nurses and 6 physicians from one unit under investigation. No refinement of the list was required. The results of the pilot study were included in the final study. Descriptive statistics and multiple ANCOVA models were fitted. The ANCOVA models used the VAS score of each procedure as a dependent variable and "profession", "age", "gender", "professional experience" and "unit" as independent variables. A final ANCOVA included the VAS scores averaged over all 27 procedures as dependent variable. Averaging VAS scores was allowed, as an unrotated principal component analysis showed a first component which was in a scree plot clearly separated from the other components, which explained 43% of the variance, and on which all variables loaded more than 0.47, indicating that the VAS scores of all 27 procedures shared much common information. The statistical programs SPSS 13 and SAS 9 were used for descriptive and inferential statistics.

Results

Demographic features of the study sample

A total of 431 questionnaires were distributed and 321 were completed. All grades of nursing staff and nursing management participated. The response rate was 74% but varied between 68% and 85% among hospitals. The demographic features of the nurses and physicians are shown in table 1. The total number of respondents answering questions on demographic data is not always the same as the total number asked, because some respondents failed to answer all questions.

The demographic data show that the vast majority (89%) of the respondent health care professionals are female and belong to the nursing profession (99%); men comprised only 11% of the sample. Among respondents in the nursing profession, only 1% were male. The largest group of female health care providers in the nursing profession were aged 20–30 (44%), while the majority of physicians belonged to the 31–40 age group (61%). Regarding professional experience, it is noticeable that in both professional groups people with 0–3 years' experience are predominant (31% for nurses / 50% for physicians). In the non-respondent group (n = 110) 56% were nurses and 44% physicians.

	Nurses		Physicians		Total	
	N	%	N	%	N	%
Gender						
Female	256	99%	30	49%	286	89%
Male	3	1%	31	51%	34	11%
Total	259	100%	61	100%	320	100%
Neonatology unit						
Neonatology Bern	103	40%	20	32%	123	38%
Neonatology USZ Zürich	41	16%	16	26%	57	18%
Neonatology Children's University Clinic Zürich	86	33%	16	26%	102	32%
Neonatology Köln	29	11%	10	16%	39	12%
Total	259	100%	62	100%	321	100%
Age						
20–30 years	113	44%	11	18%	124	39%
31–40 years	96	38%	37	61%	133	42%
41–50 years	35	14%	9	15%	44	14%
>51 years	10	4%	4	7%	14	4%
Total	254	100%	61	100%	315	100%
Professional experience						
0–3 years	78	31%	31	50%	109	35%
>3–5 years	42	17%	9	15%	51	16%
>5–10 years	64	25%	10	16%	74	24%
>10 years	68	27%	12	19%	80	25%
Total	252	100%	62	100%	314	100%

Table 1
Demographic features of the study sample.

Median pain score of all rated procedures

Parallel to pain management in adults, where ≥ 4 points on the VAS is usually the cut-off value for pain and therefore indicates the need for intervention, this survey also set the cut-off for a pain-associated intervention at ≥ 4 points. Figure 1 shows that the “insertion of a thoracic drain” is classified as the most painful intervention with a median pain score of 9 on the VAS. This intervention is followed by “intubation” and by “lumbar puncture” (median pain score of 8). The “heelstick” and “endotracheal suctioning” procedures, which are done several times a day, show a median pain score of 6 and are therefore ranked as very painful procedures also. 8 procedures were assessed as not being painful, with a median of less than 4 points, of which “diaper change” (median pain score 0) is clearly assessed as not painful at all.

Figure 1 shows that some procedures were assessed with scores along the whole range of possible points. Respondents' scores varied from 0–10 points on the VAS for 5 procedures (e.g. for “endotracheal suctioning” or for “extubation”).

Categories were created in order to classify painful and non-painful procedures according to

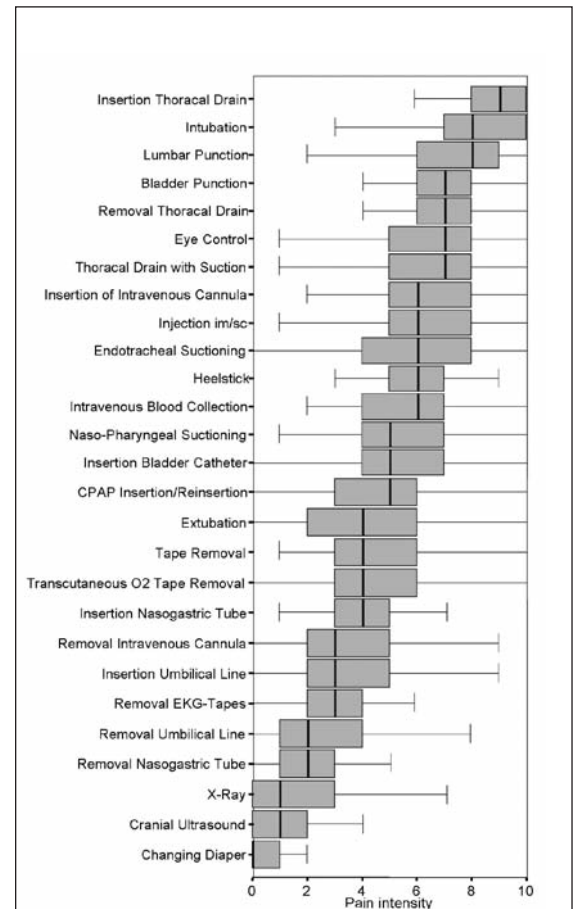


Figure 1
Ranking by median of procedures' pain intensity. (Values: boxes are inter-quartile ranges, the midpoints are medians and whiskers are ranges without outliers)

Table 2
Categorisation of
procedures by me-
dian of pain intensity.

Categorisation	Procedure	Min	25%	Median	75%	Max.
Very painful	Insertion of a thoracic drain	0	8	9	10	10
	Intubation	0	7	8	10	10
	Lumbar puncture	1	6	8	9	10
	Bladder puncture	0	6	7	8	10
	Removal of a thoracic drain	0	5	7	8	10
	Eye control	0	5	7	8	10
	Thoracic drain with suction	1	5	7	8	10
	Insertion of a peripheral line	2	5	6	8	10
	Injections im/sc	1	5	6	8	10
	Endotracheal suctioning	0	4	6	8	10
	Heel stick	1	5	6	7	10
Painful	Venipuncture	2	4	6	7	10
	Nasopharyngeal suctioning	1	4	5	7	10
	Insertion of a bladder catheter	0	4	5	7	10
	Insertion/reinsertion CPAP	0	3	5	6	10
	Extubation	0	2	4	6	10
	Removal of a tape	1	3	4	6	10
	Removal of transcutaneous O ₂ tape	0	2	4	5	10
Not painful	Insertion of a nasogastric tube	0	3	4	5	10
	Removal intravenous cannula	0	2	3	5	10
	Insertion of an umbilical line	0	2	3	5	10
	Removal of ECG tapes	0	2	3	4	10
	Removal of an umbilical line	0	1	2	4	9
	Removal of a nasogastric tube	0	1	2	3	9
	X-ray	0	0	1	3	8
	Cranial ultrasound	0	0	1	2	9
Changing diaper	0	0	0	1	8	

The categorisation is:
very painful: 6–10
(Median); painful: 4–5
(Median); not painful:
0–3 (Median)

the median values (see table 2). Using this classification, pain can be divided into three dimensions: 1) “very painful” (median pain score 6–10), 2) “painful” (median pain score 4–5) and 3) “non-painful” (median pain score 0–3). The classification shows that 70% (n = 19) of procedures in neonatology are considered to be painful and 44% (n = 12) are regarded as very painful with scores of ≥ 6 points. Some of these procedures may be carried out daily, while other procedures are usually performed once. Finally, 26% (n = 8) of the procedures are accorded fewer than 4 points and are therefore considered non-painful.

Comparison of assessment between nurses and physicians

The results show that profession significantly influences assessment of subjective pain intensity

($p = <0.05$). Nurses generally rated the procedures as more painful than physicians (table 3; table 4). Of all 27 procedures, 19 show a higher, to a statistically significant degree, assessment by nurses. In some of these procedures there are discrepancies between the dimensions “painful” (≥ 4 points on the VAS) and “non-painful” (<4 points on the VAS) assessed by the two professions. While “insertion/reinsertion of CPAP” (median 3 points), “extubation” (median 3 points), “tape removal” (median 3 points), “transcutaneous O₂ tape removal” (median 3 points), “insertion of a peripheral line” (median 2 points) and “insertion of an umbilical line” (median 2 points) are considered not painful by physicians (<4 median points on the VAS), nurses consider all these procedures painful (≥ 4 median points on the VAS).

Influence of gender, age, professional experience and units

Although the four hospitals involved in the study are comparable regarding their function as tertiary level NICUs, and regarding the basic education level of the staff, a significant difference in the rating of pain intensity between units could be

discerned (table 4). A post hoc Tukey test highlighted the difference between the Bernese unit and both units in Zürich. Table 3 also shows that gender, age and professional experience were not significant.

Discussion

This study yielded some predominant findings. We found that there is a significant difference between nurses and physicians in the subjective pain intensity assessment of procedural pain. Nurses generally rated all the procedures as more painful. Gender, age and professional experience have no apparent influence on the assessment of pain intensity. Further, in accordance with the cut-off for pain experience in adult care of ≥ 4 points on a VAS, we found that the majority (70% / n = 19) of the routine procedures in a

NICU were assessed as painful and 44% of those (n = 11) were classified as very painful with a median pain value of ≥ 6 points. These meaningful results need to be discussed as to their influence in the daily clinical setting.

The finding that nurses tend to rate procedures as more painful than physicians confirms similar studies done in recent years [2, 51]. Thus, profession must be considered an influential factor in pain assessment. The nurses' generally higher classification of pain intensity may be explained by their continuous observation of the neonate, which extends over hours and days. Discrepancies with familiar behaviour patterns of well-being can therefore be identified and, more specifically, may be interpreted as pain. The difference in assessment between physicians and nurses merits exploration in terms of its impact on collaborative decision-making in the context of pain management in neonates. Although the application of a validated instrument for neonatal pain assessment offers a possible disentanglement of subjective opinions and is therefore urgently recommended to objectivise pain, it needs to be stated that despite all the developments of recent years in establishing valid pain assessment tools, many conceptual and measurement issues remain. Thus, the influence of contextual factors on the expression of pain (gestational age, states of illness and of consciousness, number of procedural pain exposures) has not yet been comprehensively explained.

As already confirmed by others [45], professional experience had no influence on subjective pain assessment. Obviously, experience alone is not enough to optimise the complexity of pain assessment in neonates. It seems more likely that knowledge of pain and specialised training of professionals would have an influence on its management. As shown by Barnason et al. [52] and by Rond et al. [53], specialised training in pain knowledge is effective in improving pain management in adult acute care situations and in increasing patient satisfaction with the pain relief methods applied.

Although the four surveyed NICUs have similar functions to fulfil as tertiary level NICUs and

Table 3

Differences in the assessment of pain intensity between nurses and physicians.

	Nurses Median (IQR)	Physicians Median (IQR)	P-value
Insertion thoracal drain	10 (1)	8 (2)	<.0001 *
Intubation	9 (3)	7 (2)	0.0042 *
Lumbar puncture	8 (2)	6 (2)	<.0001 *
Bladder puncture	7.5 (3)	6 (2)	0.0001 *
Removal thoracal drain	7 (3)	6 (3)	<.0001 *
Eye control	7 (4)	6 (3)	<.0001 *
Thoracal drain with suction	7 (3)	5 (4)	0.0006 *
Insertion of intravenous cannula	7 (3)	5 (3)	0.0018 *
Injection im/sc	6 (3)	6 (3)	0.6650
Endotracheal suctioning	6 (4)	5 (5)	<.0001 *
Heelstick	6 (2)	6 (3)	0.0962
Nasopharyngeal suctioning	6 (4)	5 (4)	<.0001 *
Intravenous blood collection	6 (3)	5 (2)	0.0066 *
Insertion bladder catheter	5.5 (3)	4 (2)	0.0171 *
CPAP (re-)insertion	5 (3)	3 (3)	0.0031 *
Extubation	5 (3)	3 (2)	<.0001 *
Tape removal	4 (3)	3 (3)	0.0100 *
Transcutaneous O ₂ tape removal	4 (3)	3 (2)	0.0733
Insertion nasogastric tube	4 (2)	4 (2)	0.9255
Removal intravenous cannula	4 (2)	2 (2)	0.0030 *
Insertion umbilical line	4 (4)	2 (3)	0.0060 *
Removal ECG tapes	3 (2)	2 (2)	0.0558
Removal umbilical line	3 (2)	1 (2)	0.0070 *
Removal nasogastric tube	2 (2)	2 (2)	0.2669
X-ray	2 (2)	1 (2)	0.0474 *
Cranial ultrasound	1 (2)	0 (1)	0.2652
Changing diaper	0 (1)	0 (1)	0.4250

Table 4

Differences in pain intensity assessment (multivariate analysis).

Parameter	DF	Estimate	Wald	95% confidence limits	Chi-square	P-value
Intercept	1	6.066	5.449	6.683	371.52	<.0001
Neonatology unit	USZ Zürich vs Bern (reference)	-0.436	-0.815	-0.056	5.08	0.02
	KISPI Zürich vs Bern (reference)	-0.589	-0.905	-0.273	13.35	0.0003
	Klinikum Köln vs Bern (reference)	-0.160	-0.606	0.285	0.49	0.48
Profession	1	-0.995	-1.449	-0.542	18.53	<.0001
Gender	1	0.098	-0.466	0.663	0.12	0.73
Age	1	0.017	-0.208	0.242	0.02	0.88
Professional experience	1	0.057	-0.097	0.212	0.54	0.46

were comparable as to basic education level, the mean score for all procedures shows a significant difference between hospitals and especially between units in Switzerland. This difference deserves more attention. One possible explanation is that in the NICU with the highest mean score a great deal of attention has been paid to neonatal pain management over the last 10 years, and this could have influenced staff's general rating. Nevertheless, this remains a hypothetical conclusion since the intensity of professionals' training was not under question in the present study.

The present study proposes a classification of pain intensity of routine procedures in an NICU into three categories (non-painful, painful, very painful). According to this classification 70% of the procedures ($n = 19$) were assessed as painful and 44% ($n = 11$) as very painful, with a median pain value of ≥ 6 points. This large number of procedures classified as painful is surprising, and could indicate that health care providers of the participant NICUs are aware of the pain intensity of procedures and seem hardly likely to underestimate them. However, it must be stated that physicians assessed some procedures as not painful (< 4 points on the VAS), while nurses assessed the same procedures with ≥ 4 points on the VAS and therefore as painful. These major discrepancies concern the procedures "insertion/reinsertion of CPAP", "extubation", "tape removal" and "insertion of an umbilical line". However, we cannot conclude that physicians underestimate these procedures, but rather that they have a different perception of the particular procedures' pain intensity.

The result of a general awareness of the pain intensity of procedures is in line with the study of Porter et al. [50], which confirms that there has been a change in attitudes to and assessment of pain among health care providers of NICUs over

the last decade. Underestimation or misjudgment of pain, as described in previous studies [41, 49], was not confirmed by this survey.

This study further confirms that the three procedures "insertion of thoracic drain", "intubation" and "lumbar puncture" are assessed as the most painful manipulations in neonates, a result also described in the study of Simons et al. [2]. In a study of 120 preterm neonates we found that the procedure "insertion of a thoracic drain" is performed at a frequency of 0.1% among all the procedures during the first 14 days of life, while "intubation" is performed more frequently (0.5%), and "lumbar puncture" is very seldom done (0.01%) [Cignacco et al. 2007, manuscript submitted]. The most frequent painful procedures in the sample mentioned were "CPAP prongs insertion and removal" (24%), "pharyngeal suctioning" (11%) and "endotracheal suctioning" (8%). All three procedures are ranked as painful or very painful by the classification in the present study. As expected, the procedures "diaper change", "cranial ultrasound" and "x-ray" were classified as "not painful", with an average pain value of < 4 points in the present study. These procedures make up about one-third of all measures (30%).

The indicated pain intensity of procedures needs to be discussed bearing in mind that neonates are generally exposed to a large number of interventions, which may include 14–26 procedures a day [Cignacco et al. 2007, manuscript submitted]. Furthermore, neonates of a NICU are exposed to different sources of stress such as light, noise and manipulations, which may contribute to hypersensitivity of the central nervous system. As a result, even non-painful procedures may generate neuronal overstimulation expressed as an increase in pain perception [54, 55]. It is also important to remember that few neonates receive preemptive analgesia for procedural pain [2, 5].

Critical appraisal of the study

The fact that in the present study the pain intensity of five procedures shows a broad range of scores from "no pain" (= 0 points) to "unbearable pain" (= 10 points) calls for critical discussion. It may be explained by existing clinical guidelines, which in some of the NICUs surveyed do not permit certain procedures without analgesia. This probably had a substantial influence on the subjective pain intensity assessment of some health care providers. The study has limitations concern-

ing sampling, which, for conclusive testing of the delineated hypotheses, should be improved by stratification, e.g., according to educational training of pain management skills and by selection of procedures for which there is no consensus concerning the need for preemptive analgesia among participant hospitals. Further, the non-respondent rate of 26% means that the results described can only be generalised within limits.

Conclusions

Our findings confirm that most routine procedures in an NICU are considered painful, stating a general difference in pain intensity assessment between nurses and physicians. This difference deserves exploration in terms of its impact on collaborative decision-making. It would be of interest for further research to explore whether nurses' and physicians' beliefs and perceptions affect their willingness to prevent or treat pain. The use of a validated instrument for pain assessment in neonates offers to disentangle subjective opinions and therefore is urgently recommended as a means of objectivising pain. Further, the proposed classification into three pain dimensions can be used as basis for defining pain management for single procedures, for which non-pharmacological as well as pharmacological measures should be considered.

The authors would like to thank Professor B. Roth, Kinderklinikum Köln (Germany), Prof. H.U. Bucher, Neonatology Department of Zürich University Hospital (Switzerland), and Prof. O. Baenziger, Children's University Hospital Zürich, for their contribution to this survey. Financial support is acknowledged from the Executive Directory of Nursing at Bern University Hospital, Switzerland (Ms. B. Buchmann and Dr. V. Hantikainen), and from the "Stiftung Mercator Schweiz" (Switzerland).

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