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A prospective follow-up study on the role of clinical pharmacists in sustainably optimized pain measurement and pain therapy consequences

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Received January 4, 2019, accepted February 14, 2019

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Pharmazie 74: 313-318 (2019) *doi: 10.1691/ph.2019.9304*

Appropriate analgesic therapy requires adequate pain measurement. A few studies have already demonstrated benefits of clinical pharmacists supporting physicians' prescribing. Nevertheless, there are still open questions about pharmaceutical interventions at the nursing level in order to optimise pain therapy sustainably. We performed a prospective controlled follow-up intervention study to analyse the sustainability of improved pain measurement performance (PMP) and its therapeutic consequences. Half a year after a successful guidance implementation in two study units (control and intervention unit), pharmacists performed an individual coaching for nurses only in the intervention unit. We consecutively monitored patient-nurse contacts and evaluated PMP with a 7-point scale (from 0: no pain measurement to 6: optimal pain measurement) in three 4-week periods (t_1: before guidance implementation, t_2: directly after guidance implementation, t_3: half a year after guidance implementation) on both units. Therapeutic consequences of PMP were evaluated in a post-hoc patient chart review. In the t_1 period, we found a median PMP of 0 in both units which rose to 6 (control unit) vs. 5 (intervention unit) in t_2 period due to guidance implementation in both units. In the t_3 period, we found a decrease of PMP to 0 in controls vs. to 4 in the intervention unit ($p<0.001$). We also found, that improved PMP did not lead to a more individualised analgesic prescribing and administration of more on-demand analgesics. A coaching concept of clinical pharmacists improved the sustainability of nurses' PMP after a successful guidance implementation. Our results illustrate the potential of including clinical pharmacist in interprofessional pain therapy teams.

1. Introduction

Despite the wide range of analgesic therapeutic options, a great challenge exists in the quality of routine pain therapy and patient care. Hospitals success in improving pain therapy varies considerably from each other (Meißner et al. 2017). Postoperative patients, in particular, still suffer from unacceptable pain, partly during their entire hospital stay (Gerbershagen et al. 2013; Lin et al. 2016).

Guidelines recommend pain measurement, standardisation, and individualisation of pain therapy (Registered Nurses' Association of Ontario 2013; Chou et al. 2016). Structured pain measurement is thereby one of the most essential keystones to ensure appropriate decision-making and individualised therapy (Chou et al. 2016). Nurses' good pain measurement performance (PMP) is therefore substantial. Whether an improved pain measurement actually results in improved therapy outcomes and by this in better patient care is still under discussion (Gordon et al. 2016; Ahluwalia et al. 2018).

An algorithm-based guidance implemented by clinical pharmacists has already shown to enhance pain guideline adherence and pain measurement in nurses (Schiek et al. 2016b). However, preserving the successes achieved is the more difficult challenge of implementation strategies. Coaching might be a promising instrument also for pharmaceutical interventions. Coaching considers individual needs of the participants. They receive feedback and are actively involved in decision processes (Cranley et al. 2017). By this means, the participants support consensual decisions to a greater extent.

In this study, we aimed at investigating a coaching concept for nurses implemented by clinical pharmacists and its effect on the sustainability of initially improved pain measurement. In addition, we analysed the impact of pain measurement on physicians' analgesic prescriptions and nurses' administration of pain medication.

2. Investigations and results

2.1. Ethical and legal aspects

The study protocol was approved by the local ethical committee. The local data protection officer was involved. All patients participated voluntarily and were informed in advance. They were asked for their consent concerning the monitors' documentation of the patient-nurse contact. Because nurses participated in the study within the scope of their employment relationship, we informed the Workers Council about the study in advance. All nurses participated voluntarily. They had been informed about the fact that they were monitored during their routine activities in the units for scientific reasons about pain measurement.

2.2. Participants and setting

Patients and nurses of two orthopaedic units (intervention unit, control unit) with each 30 beds at a university hospital offering routine tertiary care were included in this study. Patients in the concerning units were mainly hospitalised for surgical interventions. Pain measurement was, therefore, regularly required in these patients (German Network for Quality Development in Nursing Care 2011). Organisational structure and pain management conditions were equivalent in both units. Nurses were in charge of pain measurement and orthopaedic physicians of analgesic therapy. Pain specialists were only consulted for difficult to manage pain on request. Special pain nurses were on duty only for patients

with patient-controlled analgesia, peridural catheters, or peripheral ropivacaine catheters during the first days after surgery. We consecutively included all patients with at least one monitored patient-nurse contact (inclusion criterion).

2.3. Study design

We conducted a controlled follow-up intervention study in the two units. In both units, we firstly observed status quo of PMP with a 7-point scale (Table 1) in the two study units (t_1). Secondly, we implemented a pain guidance in both study units and evaluated its effect on PMP (t_2). Thirdly, we implemented a follow-up intervention: clinical pharmacists performed an individualised 2-week coaching for nurses (intervention unit). Subsequently we evaluated PMP again (t_3). In the control unit, only standard care without further support was offered.
Additionally, therapeutic consequences of PMP were evaluated in a post-hoc patient chart review for all included patients.

2.4. Intervention

We developed and implemented a coaching concept by clinical pharmacists for nurses in pain measurement in the intervention unit half a year after pain guidance implementation. The concept included a team coaching session with discussions as well as individual coaching sessions for all nurses in the intervention unit. This way the nurses should reflect and discuss experiences with pain measurement. They further should identify overall difficulties and barriers with pain measurement and should find consensual ways how to overcome those barriers. In the individual coaching, they identified difficulties and barriers and received feedback on their individual PMP. A checklist with feedback was handed out to the nurses. The individual coaching sessions took part during and after nurses' ward rounds in the evening. They were provided for two weeks to enable all nurses to participate. In the control unit, we provided a standard procedure without additional support to each nurse.

2.5. Data collection and analysis

2.5.1. Monitoring analysis: pain measurement performance (PMP)

To analyse routine patient contacts, we used a real-time monitoring procedure (direct observation) well established in our group (Bertsche et al. 2008) and adjusted it to the direct observation of pain measurement. Altogether twelve advanced pharmacy students monitored the participants during ward rounds in the evening hours. Two supervisors organised the monitoring. Before the monitors were allowed to collect study data, they had been trained in pain management, clinical procedures on the ward, and acting as a monitor. They were obliged to document patient contacts without any further interpretation based on a checklist. The supervisor checked and discussed monitoring data with the monitors to ensure appropriateness of monitoring data.

Table 1: 7-point quality scale to evaluate quality of nurses' pain measurement performance (PMP) in monitored patient contacts

Scale	PMP
0	No measurement of pain at all
1	Pain addressed in general without including pain intensity
2	Pain intensity addressed without using any scale
3	Pain intensity addressed by using at least verbal rating
4	Pain intensity addressed by using NRS scale without distinguishing between resting or movement pain
5	Pain intensity addressed by using NRS scale distinguishing between resting or movement pain
6	Pain intensity addressed by using NRS scale with assessing both resting and movement pain

We monitored consecutive patient contacts during routine nurses' evening ward rounds. We chose evening ward rounds to evaluate patient contacts with most frequent pain-related nursing interventions. We considered them as most critical in pain measurement for the night. In a typical patient contact in our setting during evening ward rounds, nurses administer evening medication, measure parameters, e.g. pain, and ask patients about their needs for the night.
We analysed patient contacts received by the monitoring procedure. To evaluate the quality of PMP, we developed a 7-point scale (Table 1). The supervisors scaled the quality of assessed PMP of included patient contacts. In case of incongruent scaling, we discussed discrepancies in an expert panel to find a consensual decision.

2.5.2. Post-hoc patient chart review: pain therapy consequences

To evaluate therapeutic consequences of PMP, we performed an additional post-hoc analysis of patient charts. We analysed prescribed analgesics and administered on-demand analgesics on each day of treatment of all included patients. We used the parameter administration of on-demand analgesics and adjustment of pain medication because we expected a more individualised prescription behaviour or enhanced analgesic administrations resulting from an optimised pain measurement.

2.6. Statistical analysis

Depending on the data scale, we present data either as proportions, as medians with first (Q_{25}) and third quartile (Q_{75}) or as regression coefficient with standard error and odds ratio with confidence interval. Descriptive data and data of PMP and pain therapeutic consequence were statistically tested using Kruskal-Wallis test, chi square test (dichotomous data) or Man Whitney-U test (not normally distributed data) as appropriate. For pairwise comparisons regarding PMP evaluation, we used the non-parametric Kruskal-Wallis one-way ANOVA. We performed a univariate logistic regression analysis of the consequence analysis parameters (administration of on-demand analgesics by nurses and adjustment of pain medication by physicians as dependent variables) to get a more detailed overview of possible competing barriers in the consequences of PMP. In all calculations, a p-value <0.05 was considered significant. Calculations were conducted using SPSS (Statistical Package for the Social Science, Version 25, IBM, USA).

2.7. Included patients, nurses, and monitored patient-nurse contacts

The nursing staff was consistent in time period t_1, t_2, and t_3 (Table 2). In t_1, we included 75 patients with 371 contacts in the intervention unit and 85 patients with 290 contacts in the control unit. In t_2, we included 75 patients with 321 contacts in die intervention unit and 91 patients with 355 contacts in the control unit. In t_3, we included 96 patients with 353 contacts in the intervention unit and 105 patients with 418 contacts in the control unit (Table 2).

2.8. Results of the monitoring analysis: pain measurement performance (PMP)

The baseline PMP at t_1 was in median 0 (Q_{25}/Q_{75}: 0/0) in both units. Directly after guidance implementation, levels of PMP were 5 in the intervention unit (3/6) and 6 in control unit (5/6). Half a year after implementation (t_2), we found a median PMP of 4 (3/4) with the additional coaching in the intervention unit. With standard care, the median PMP was almost at baseline level with 0 (0/1) in the control unit (t_3, $p<0.001$; intervention unit vs. control unit, Table 3).

2.9. Results of the post-hoc patient chart review: pain therapeutic consequences

Patients received 17 to 26 % of their prescribed on-demand analgesics and in median only one single dose per day. This only slightly

Table 2: Descriptive characteristics of patients, their days of treatments, nurses and patient-nurse contacts

	Intervention unit				Control unit				
	t_1	t_2	t_3	*p*-Value Intervention unit*	t_1	t_2	t_3	*p*-Value Control unit*	*p*-Value Intervention vs. control unit**
Patients [n]	75	75	96		85	91	105		
Female [n (%)]	41 (55%)	40 (53%)	53 (55%)	0.490	53 (62%)	44 (48%)	58 (55%)	0.231	0.726
Age [Median (Q_{25}/Q_{75})]	73 (65/78)	71 (59/81)	68 (56/78)	0.311	60 (48/71)	60 (49/72)	59 (48/72)	0.965	<0.001
Patients undergoing surgery [n (%)]	71 (95%)	73 (97%)	78 (81%)	0.002	41 (48%)	47 (52%)	56 (53%)	0.782	<0.001
Hospital stay [Median (Q_{25}/Q_{75})]	11 (11/22)	12 (8/22)	9 (7/13)	0.015	7 (4/9)	7 (3/12)	7 (4/14)	0.597	<0.001
Prescribed analgesics per day of treatment [Median (Q_{25}/Q_{75})]	4 (3/4)	3 (3/4)	3 (2/4)	<0.001	2 (1/4)	3 (2/4)	3 (2/4)	0.002	<0.001
Prescribed on-demand analgesics per day of treatment [Median (Q_{25}/Q_{75})]	2 (1/3)	2 (1/3)	1 (1/2)	<0.001	1 (0/1)	1 (0/2)	1 (1/2)	<0.001	<0.001
Days of treatment with acute pain service [n (%)]	58 (9%)	53 (8%)	39 (6%)	0.062	16 (3%)	34 (6%)	50 (7%)	0.005	0.006
Nurses [n]	12	13	13		15	15	14		
Monitored patient-nurse contacts [n]	371	321	353		290	355	418		
Monitored patient contacts per nurse [Median (Q_{25}/Q_{75})]	36 (4/50)	23 (8/44)	25 (15/44)	0.714	22 (9/33)	22 (15/27)	30 (17/42)	0.375	0.602
Monitored patient contacts per patient [Median (Q_{25}/Q_{75})]	4 (4/7)	4 (2/6)	3 (2/5)	0.030	2 (1/4)	3 (2/5)	3 (2/5)	0.233	0.074

(*) Kruskal-Wallis test; (**) Chi-Square test for dichotomous data, Mann Whitney-U test for not normally distributed data.
t_1: before guidance implementation; t_2: directly after implementation; t_3: half a year after guidance implementation; intervention unit: with 2 weeks of coaching, control unit with standard care prior to t_3.

differs throughout the periods and units (Table 3). Daily doses of prescribed analgesic were thereby hardly exploited in full. Physicians modified prescribed analgesic therapy in 10 to 19 % in the assessed days of treatment. The most modification types were new prescription/withdraw/substitution of drugs (9-18 %). Modifying of dosing, dosage form or changes of on-demand and around-the-clock analgesics were hardly seen (0 to 4% days of treatment).
Among the parameters which enhance administration of prescribed on-demand analgesics were documented pain intensity levels (β=0.563, p<0.001), patients with higher pain intensity levels (β=0.689, p<0.001), and new prescription of analgesic (β=1.328, p<0.001). Parameter *inter alia* which reduced the frequency of on-demand analgesic administration were upper stages of the WHO-ladder (β=-0.222, p<0.001), prescription of more than two on-demand analgesics at the same time (β=-0.141, p=0.037), prescription of parenteral dosage forms despite the possibility of oral administration (β=-1.703, p<0.001), and missing information about dosing (β=-0.450, p<0.001) in the prescription. Physicians modified pain medication more frequently e.g. in patients with pain documentation (β=0.661, p<0.001) and higher pain intensity levels (β=0.287, p<0.001; Table 4).

3. Discussion

Pain is a major burden for inpatients especially in the context of surgery or orthopaedics. To improve pain therapy, guidelines are available (American Society of Anesthesiologists Task Force on Acute Pain Management et al. 2012). We have already shown (Bertsche et al. 2009), that clinical pharmacists in interdisciplinary collaboration with physicians succeed in improving guideline adherence in routine pain therapy. Guidelines, however, do not only address analgesic prescription by physicians but also pain measurement and analgesics administration by nurses (Registered Nurses' Association of Ontario 2013; Chou et al. 2016). We recently found (Schiek et al. 2016a), that systematic pain measurement had been suboptimally standardized and implemented in routine care. In another prospective intervention study (Schiek et al. 2016b), we saw that current guidelines had not been strictly followed by nurses when administering analgesics and that their guideline adherence improved eightfold by implementing an algorithm-based guidance.
The sustainability of such implemented guidelines remains largely unknown. Therefore, we aimed at assessing sustained effects of the guidance implementation. Additionally we aimed at investigating the effect of a newly developed coaching concept to support sustainability. For this purpose, we analysed the quality of nurses' PMP in routine care with a 7-point scale reaching from 0 with no pain measurement at all to 6 with optimal pain measurement. In addition, we analysed further consequences of pain measurement in patients' pain therapy.
In the present study, we found that nurses' performance was not sustained without any further support. The 7-point scale decreased dramatically nearly to baseline levels six months after guidance implementation. This indicates that guideline implementation on its own is insufficient in long-term quality improvement. Even the additional individual coaching concept did not result in continued best practice pain measurement but was at least able to nearly hold achieved results. As reasons for this effect, we identified missing consequences in pain therapy adjustment, i.e. appropriate analgesic prescribing by physicians. As a consequence of our findings, we

Table 3: Quality scale of pain measurement performance (PMP) in routine patient contacts during nurses' ward rounds in the evening and therapeutic consequences: administration of on-demand analgesics by nurses and adjustment of pain medication by physicians per day of treatment (multiple categories possible)

	Intervention unit				Control unit				
	t_1	t_2	t_3	*p*-Value Intervention unit*	t_1	t_2	t_3	*p*-Value Control unit*	*p*-Value Intervention vs. control unit**
Pain measurement performance (PMP) of nurses according to the 7-point quality scale									
PMP [Median (Q_{25}/Q_{75})][1]	0 (0/0)	5 (3/6)[a/c]	**4 (3/4)**[a/b/c]	<0.001	0 (0/0)	6 (5/6)[a/c]	**0 (0/1)**[a/b/c]	<0.001	<0.001
Therapeutic consequence: administration of on-demand analgesics by nurses									
Administered on-demand analgesics of prescribed on-demand analgesics [n / n (%)]	203 / 1207 (17%)	336 / 1286 (26%)	202 / 921 (22%)	<0.001	86 / 501 (17%)	176 / 686 (26%)	197 / 1025 (19%)	0.001	0.364
Therefrom administered doses per days of treatment [Median (Q_{25}/Q_{75})]	1 (1/1)	1 (1/1.25)	1 (1/2)	0.634	1 (1/1)	1 (1/2)	1 (1/2)	0.263	0.254
Therapeutic consequence: adjustment of pain medication by physicians per day of treatment									
Assessed days of treatment [n]	634	646	673		553	560	723		
Any modification [n (%)]	65 (10%)	98 (15%)	107 (16%)	0.006	70 (13%)	106 (19%)	110 (15%)	0.015	0.128
Escalation [n (%)]	47 (7%)	46 (7%)	63 (9%)	0.263	43 (8%)	60 (11%)	59 (8%)	0.162	0.354
De-escalation [n (%)]	22 (3%)	50 (8%)	44 (7%)	0.004	34 (6%)	49 (9%)	55 (8%)	0.256	0.052
New prescription/withdraw/ substitution of drugs [n (%)]	56 (9%)	82 (13%)	97 (14%)	0.007	56 (10%)	98 (18%)	97 (13%)	0.002	0.132
Modification of dosing [n (%)]	12 (2%)	15 (2%)	7 (1%)	0.193	23 (4%)	17 (3%)	16 (2%)	0.135	0.008
Modification of dosage form [n (%)]	4 (1%)	5 (1%)	4 (1%)	0.915	9 (2%)	9 (2%)	2 (0%)	0.026	0.161
Change of on-demand and around-the-clock medication [n (%)]	4 (1%)	4 (1%)	5 (1%)	0.954	10 (2%)	7 (1%)	4 (1%)	0.108	0.119

(*) Kruskal-Wallis test; (**) Mann Whitney-U test.
1) PMP – pairwise comparison of the Kruskal-Wallis one-way ANOVA: t_1 intervention unit vs. control unit: n.s.; others differ significantly with a, b, c imply significant differences compared to corresponding (a) time period t_1, (b) t_2, or (c) Intervention unit vs control unit within study periods.
t_1: before guidance implementation; t_2: directly after implementation; t_3: half a year after guidance implementation; intervention unit: with 2 weeks of coaching, control unit with standard care prior to t_3.

found important fields of pharmaceutical collaboration in closed-loop-processes of medication. Firstly, consecutive individualised support by pharmacists is required to reach optimal sustained results in routine care. Secondly, and not less relevant, pharmacists should support symptom measurements and its translation into optimised patient's therapy. In summary, individual measures should be in line with clearly regulated and optimised process flows. Clinical pharmacists can effectively support both strategies. Our results demonstrate that missing ongoing training and support lead to long-term failure of guidance implementation. There is, indeed, still a need to increase nurses' knowledge of pain management (Francis and Fitzpatrick 2013). Generalised and individual teaching should be combined to reach long-term effects (Grønning et al. 2014). Coaching and active participation of nurses in the implementation process is promising to overcome barriers and change personal impeding factors (Fielden et al. 2009). Following this hypothesis, nurses find consensual decisions. They get feedback to their own performance, should reflect their own behaviour, should find ways to solve implementation difficulties and engage in improvement strategies. However, it requires participants who are open for reflection and are willing to change existing routines (Godfrey et al. 2014).

To go behind the barriers of sustained implementation, we intended to further investigate therapeutic consequences of pain measurement. We, therefore, included a comprehensive post-hoc patient chart review in our study and analysed the entire administration of on-demand analgesics by nurses (consequence in the actual analgesic consumption) and adjustment of pain therapy by physicians (consequence in prescribing behaviour). In routine care, one might assume that increased pain measurement almost automatically leads to improved pain management. The recognised patients' pain levels should initiate a more adequate analgesic supply, nurses should administer more doses of prescribed analgesics. In cases in which the current patients' medication were insufficient, physicians should escalate pain therapy. Descended pain intensity levels, in turn, should lead to pain therapy de-escalation. What we found, instead, were fixed analgesic regimens without individualisation. Prescribed on-demand analgesics, which probably should address individual patients' needs, reached the patient comparatively seldom. This was particularly surprising since we chose a setting with orthopaedic patients having variable acute and chronic pain levels. Our results support the assumption that physicians did not appropriately consider the assessed and documented pain levels when making therapeutic decisions. Their analgesic prescriptions followed fixed procedures without individualisation and without appropriately considering patient's individual clinical situation. Interestingly, inappropriate prescribing showed to be a further

Table 4: Univariate logistic regression analysis of therapeutic consequences (dependent variables: administration of on-demand analgesics by nurses and adjustment of pain medication by physicians)

	Administration of on-demand analgesics				Adjustment of pain medication			
	Regression coefficient	Standard error	*p*-Value	Odds ratio (CI)	Regression coefficient	Standard error	*p*-Value	Odds ratio (CI)
Intervention unit vs. control unit	-0.061	0.067	0.364	0.941 (0.826-1.073)	0.140	0.092	0.128	1.150 (0.961-1.377)
t_1 vs. t_2 vs. t_3	0.097	0.041	0.017	1.102 (1.017-1.193)	0.161	0.056	0.004	1.174 (1.052-1.311)
Patient's age	-0.006	0.002	0.003	0.994 (0.989-0.998)	-0.002	0.003	0.572	0.998 (0.993-1.004)
Female vs. male patients	0.038	0.066	0.559	1.039 (0.913-1.182)	-0.036	0.093	0.698	0.964 (0.803-1.158)
Surgery patients vs. conservative patients	0.309	0.099	0.002	1.362 (1.120-1.655)	0.058	0.109	0.597	1.060 (0.855-1.313)
Postoperative day	-0.037	0.007	<0.001	0.964 (0.951-0.977)	-0.072	0.012	<0.001	0.931 (0.909-0.953)
Acute pain service	0.966	0.086	<0.001	2.628 (2.221-3.109)	1.563	0.138	<0.001	4.773 (3.642-6.256)
Pain intensity documentation	0.563	0.069	<0.001	1.755 (1.534-2.009)	0.661	0.099	<0.001	1.936 (1.596-2.349)
Highest documented pain intensity	0.689	0.046	<0.001	1.992 (1.819-2.180)	0.287	0.05	<0.001	1.332 (1.205-1.473)
WHO-ladder	-0.222	0.037	<0.001	0.801 (0.745-0.861)	Not relevant			
Newly prescribed analgesics	1.328	0.160	<0.001	3.775 (2.760-5.163)	Not relevant			
Quality parameters								
Prescription of more than 2 on-demand analgesics	-0.141	0.068	0.037	0.868 (0.761-0.991)	Not relevant			
Prescribed parenteral analgesics despite the possibility of peroral administration	-1.703	0.109	<0.001	0.182 (0.147-0.226)	Not relevant			
Missing dosing information in prescription (single dose or dose regimen)	-0.450	0.066	<0.001	0.638 (0.561-0.726)	Not relevant			

t_1: before guidance implementation; t_2: directly after implementation; t_3: half a year after guidance implementation; intervention unit: with 2 weeks of coaching, control unit with standard care prior to t_3. CI= confidence interval.

barrier for analgesic administration. Missing information about dosing or prescribing of to many on-demand options, not surprisingly, decreased their administration frequency. Diligent analgesic prescriptions would facilitate the realisation of the intendent use and would increase therapy safety. This knowledge needs to be placed more extensively in the focus of quality strategies in pain and other symptom therapy.

Our results complement pain management medical errors in assessment, documentation, treatment, and management (McNeill et al. 2004). We demonstrated that optimising pain measurement did not automatically lead to clinically relevant improvement of pain therapy. Even if pain management guidelines recommend regular pain measurement in routine care, it has to be clarified that pain measurement should not be a self-purpose. Despite this disappointing fact, pain measurement positively influenced pain therapy following the results of the logistic regression. They just seem to be insufficient. Improving pain management, therefore, also requires changing procedures considering believes and attitudes, improved quality standards in prescribing as well as ongoing support. As shown by our study, clinical pharmacists can play a key role in supporting these measures.

As a limitation, we did not verify whether certain pain therapy strategies were actually effective but assessed the cohering overall structural impact of pain measurement. As we performed our study in orthopaedic patients, conclusions for other settings or hospitals should be drawn with care. Due to the monitoring procedure a *Hawthorne* and a *Rosenthal* effect have to be considered. We chose evening ward rounds as critical time-periods to evaluate nurses' PMP. We cannot exclude the possibility of different results in the morning hours.

In our prospective controlled follow-up intervention study, clinical pharmacists developed and implemented a coaching concept for nurses in a setting with a recently implemented pain therapy guidance. By this, we enhanced sustainability of improved nurses' pain measurement performance. However, the coaching did not succeed in eradicating insufficient consequences in analgesic therapy. Our results indicate that the still unsatisfied pain situation in routine inpatients lays in missing consideration of the overall process of patients' care. Clinical pharmacists should therefore contribute their expertise to measures addressing all process steps of medication therapy. Additionally, they should contribute to optimizing symptom therapy – not only in the area of pain therapy.

Acknowledgments: We would like to thank all participating nurses, physicians, pharmacists and students for their kind support. We would like to thank Professor Benjamin R. Auer for guidance in the statistical analysis of the data.

Conflict of interest: None declared.

References

Ahluwalia SC, Giannitrapani KF, Dobscha SK, Cromer R, Lorenz KA (2018) "It Encourages them to complain": A qualitative study of the unintended consequences of assessing patient-reported pain. J Pain 19: 562-568.

American Society of Anesthesiologists Task Force on Acute Pain Management (2012) Practice guidelines for acute pain management in the perioperative setting: an updated report by the American Society of Anesthesiologists Task Force on Acute Pain Management. Anesthesiology 116: 248-273.

Bertsche T, Askoxylakis V, Habl G, Laidig F, Kaltschmidt J, Schmitt SP, Ghaderi H, Bois AZ, Milker-Zabel S, Debus J, Bardenheuer HJ, Haefeli WE (2009) Multidisciplinary pain management based on a computerized clinical decision support system in cancer pain patients. Pain 147: 20-28.

Bertsche T, Niemann D, Mayer Y, Ingram K, Hoppe-Tichy T, Haefeli WE (2008) Prioritising the prevention of medication handling errors. Pharm World Sci 30: 907-915.

Chou R, Gordon DB, de Leon-Casasola OA, Rosenberg JM, Bickler S, Brennan T, Carter T, Cassidy CL, Chittenden EH, Degenhardt E, Griffith S, Manworren R, McCarberg B, Montgomery R, Murphy J, Perkal MF, Suresh S, Sluka K, Strassels S, Thirlby R, Viscusi E, Walco GA, Warner L, Weisman SJ, Wu CL (2016) Management of postoperative pain: A clinical practice guideline from the American Pain Society, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists' Committee on Regional Anesthesia, Executive Committee, and Administrative Council. J Pain 17: 131-157.

Cranley LA, Cummings GG, Profetto-McGrath J, Toth F, Estabrooks CA (2017) Facilitation roles and characteristics associated with research use by healthcare professionals: a scoping review. BMJ Open 7: e014384..

Fielden SL, Davidson MJ, Sutherland VJ (2009) Innovations in coaching and mentoring: implications for nurse leadership development. Health Serv Manage Res 22: 92-99.

Francis L, Fitzpatrick JJ (2013) Postoperative pain: nurses' knowledge and patients' experiences. Pain Manag Nurs 14: 351-357.

Gerbershagen HJ, Aduckathil S, van Wijck AJ, Peelen LM, Kalkman CJ, Meissner W (2013) Pain intensity on the first day after surgery: a prospective cohort study comparing 179 surgical procedures. Anesthesiology 118: 934-944.

German Network for Quality Development in Nursing Care [Deutsches Netzwerk für Qualitätsentwicklung in der Pflege – DNQP] (2011) Expertenstandard Schmerzmanagement in der Pflege bei akuten Schmerzen. 1st ed. Osnabrück: DNQP. Available from https://www.dnqp.de/de/expertenstandards-und-auditinstrumente/#c18069. Accessed November 30, 2018.

Godfrey MM, Andersson-Gare B, Nelson EC, Nilsson M, Ahlstrom G (2014) Coaching interprofessional health care improvement teams: the coachee, the coach and the leader perspectives. J Nurs Manag 22: 452-464.

Gordon DB, de Leon-Casasola OA, Wu CL, Sluka KA, Brennan TJ, Chou R (2016) Research gaps in practice guidelines for acute postoperative pain management in adults: findings from a review of the evidence for an American Pain Society Clinical Practice Guideline. J Pain 17: 158-166.

Grønning K, Rannestad T, Skomsvoll JF, Rygg LØ, Steinsbekk A (2014) Long-term effects of a nurse-led group and individual patient education programme for patients with chronic inflammatory polyarthritis - a randomised controlled trial. J Clin Nurs 23: 1005-1017.

Lin RJ, Reid MC, Chused AE, Evans AT (2016) Quality Assessment of Acute Inpatient Pain Management in an Academic Health Center. Am J Hosp Palliat Care 33: 16-19.

McNeill JA, Sherwood GD, Starck PL (2004) The hidden error of mismanaged pain: a systems approach. J Pain Symptom Manage 28: 47-58.

Meißner W, Komann M, Erlenwein J, Stamer U, Scherag A (2017) The quality of postoperative pain therapy in German hospitals. Dtsch Arztebl Int 114: 161-167.

Registered Nurses' Association of Ontario - RNAO (2013) Guideline on Assessment and Management of Pain. Available from http://rnao.ca/bpg/guidelines/assessment-and-management-pain. Accessed November, 30th, 2018.

Schiek S, Ghanem M, Frontini R, Hertel G, von Salis-Soglio G, Bertsche T (2016a) [Pain assessment in routine care: A prospective observational study in an orthopedic unit]. Schmerz 30: 257-265.

Schiek S, Moritz K, Seichter SJ, Ghanem M, von Salis-Soglio G, Frontini R, Bertsche T (2016b) Standardising analgesic administration for nurses: a prospective intervention study. Int J Clin Pharm 38: 1497-1504.