



Is It All Worthwhile? Effectiveness of Intensive Interdisciplinary Pain Treatment

16

Lorin Stahlschmidt, Michael Dobe, Boris Zernikow, and Julia Wager

Contents

16.1	Studies on the Inpatient Pain Treatment of the GPPC.....	290
16.1.1	Study 1: Prospective Study on Treatment Effectiveness: Sex and Age Differences.....	291
16.1.2	Study 2: Retrospective Analysis of All Patients.....	292
16.1.3	Study 3: Efficacy of Treatment and Long-Term Outcome.....	293
16.1.4	Study 4: Monitoring Treatment Outcome by Means of Chronic Pain Grading.....	295
16.1.5	Study 5: Efficacy of Pain Provocation.....	296
16.1.6	Conclusion.....	297
16.2	International Studies.....	297
	References.....	297

Abstract

Chronic pain in childhood is likely to persist into adulthood, if not treated adequately. At the beginning of this chapter, we shortly present the long-term consequences of no or insufficient treatment of chronic pain in children and adolescents. Then, we discuss the effectiveness of the inpatient treatment programme of the German Paediatric Pain Centre (GPPC) described in detail in this manual. Finally, results of international studies on the effectiveness of similar treatment programmes for children and adolescents are summarised.

L. Stahlschmidt (✉) · M. Dobe · B. Zernikow · J. Wager
German Paediatric Pain Centre, Children's and Adolescents' Hospital – Witten/Herdecke University, Datteln, Germany
e-mail: l.stahlschmidt@deutsches-kinderschmerzzentrum.de; M.Dobe@kinderklinik-datteln.de; B.Zernikow@kinderklinik-datteln.de; j.wager@deutsches-kinderschmerzzentrum.de

Chronic and recurrent pain is a common problem in children and adolescents. In representative studies, 25–40% of all children and adolescents are affected (Ellert et al. 2007; Huguet and Miro 2008; Perquin et al. 2000). Approximately every 20th child has a pain disorder (Huguet and Miro 2008) that leads to such strong physical and emotional impairment that an interdisciplinary pain treatment is indicated to prevent negative long-term effects on the physical, psychological and psychosocial level (e.g. developmental deficits, emotional disorders, medication overuse or misuse).

For children and adolescents who are less severely affected, an outpatient interdisciplinary pain treatment focusing on education, active pain coping and adequate pharmacological treatment may suffice (Hechler et al. 2011; Hechler et al. 2014b; Stahlschmidt et al. 2017). But if the chronic pain leads to a substantial number of school days missed, social withdrawal, and a high emotional burden for the child and his/her family, an inpatient interdisciplinary pain treatment is indicated (Hechler et al. 2010c). In these cases, continuing outpatient pain treatment is likely to fail (Hechler et al. 2014b) and there is an urgent need for action in light of the severe impairment in life and school (see Sect. 5.1).

If chronic pain in childhood remains untreated or is not treated adequately, it is likely to persist into adulthood (Brattberg 2004; Brna et al. 2005; Hestbaek et al. 2006; Mirovsky et al. 2002; Walker et al. 2010). Chronic pain in adulthood will likely lead to a large number of medical treatments and considerable work loss. It is a strong burden for the healthcare system due to resulting medical and indirect costs (e.g. work loss due to illness) (Hogan et al. 2016; Mäntyselkä et al. 2002; Pradalier et al. 2004; van Leeuwen et al. 2006).

In the past, pain in childhood was assumed to be self-limiting. Meanwhile, it is well known that persistent pain in childhood is a predisposition for the development of chronic pain in adulthood (Brattberg 2004; Brna et al. 2005; Hestbaek et al. 2006; Mirovsky et al. 2002; Walker et al. 2010).

Additionally, affected children and adolescents have an increased risk of psychiatric comorbidities, such as an anxiety disorder or depression (Fearon and Hotopf 2001; Shelby et al. 2013). Chronic pain in childhood already causes substantial costs for the healthcare system and the affected families (Groenewald et al. 2014; Ruhe et al. 2013; Sled et al. 2005). Furthermore, children and adolescents with chronic pain are often severely impaired in school, resulting in limited performance and a worse professional perspective (Logan et al. 2008). The following chapter addresses the question of whether these negative consequences can be prevented with a specialised paediatric inpatient pain treatment.

16.1 Studies on the Inpatient Pain Treatment of the GPPC

Several studies have been conducted at the GPPC to investigate the effectiveness of its inpatient interdisciplinary pain treatment. In the following, we will present these studies and the most important results.

16.1.1 Study 1: Prospective Study on Treatment Effectiveness: Sex and Age Differences

The first prospective study on the long-term effectiveness of the inpatient interdisciplinary pain treatment at the GPPC was conducted between 2004 and 2007. Patients provided data at admission and 3, 6 and 12 months after treatment. Three months after treatment, data were collected in the context of an outpatient follow-up visit. Six and 12 months after treatment, data were additionally collected via post and telephone. Overall, $N = 215$ children and adolescents received an interdisciplinary inpatient pain treatment at the GPPC between January 2004 and December 2006. Of these patients, $N = 167$ patients were included in the study 3 months later. After 6 months, data of $N = 150$ patients were available, and $N = 163$ provided data after 12 months. At all measurement time points, data were collected with validated questionnaires for pain, coping and emotional distress (see Sects. 3.3 and 3.5.1).

Statistical analysis of the long-term effects for the primary outcome of pain revealed a significant strong reduction of pain intensity, pain-related disability and pain-related school absence 3 months after treatment. These improvements were maintained 6 and 12 months after treatment, with no further improvement observed over time (Dobe et al. 2011; Hirschfeld et al. 2013). Significant reductions were also found for general anxiety, depressive symptoms and dysfunctional coping strategies (Dobe et al. 2011). The decrease of dysfunctional and the increase of functional coping strategies was directly associated with the improvements in pain-related disability (Hechler et al. 2010d).

Apart from these statistical effects, the clinical significance of the treatment effects for children and adolescents was also investigated. A *clinically significant change* implies that there is a statistically significant improvement and that additionally, the score after treatment is below a certain cut-off point. This cut-off point represents unproblematic scores. The patients have to improve from a usually alarmingly high score to a normal score which is equivalent to a score of healthy children and adolescents. The results regarding clinical significance of the pain characteristics (pain intensity, pain-related disability and school absence) are further integrated into a measure of *overall improvement*. The prerequisite for an overall improvement is that the patient did not deteriorate in any one of the pain characteristics and displays a clinically significant improvement in at least pain-related disability or school absence.

Three and 12 months after treatment, about 70% of the children and adolescents had clinically significant improvements in average pain intensity. The percentage of patients with clinically significant improvements in pain-related disability was approximately 50%, and 40% for school days missed. Emotional distress (general anxiety, depression) was clinically significantly improved for about a quarter of the patients, respectively. Both 3 and 12 months after treatment, approximately 55% of the children displayed overall improvement of their pain disorder, irrespective of any somatic or psychiatric comorbidity (Hechler et al. 2009; Hirschfeld et al. 2013). Patients with a high number of school days missed before treatment were more likely to be overall improved 12 months after treatment (Hirschfeld et al. 2013).

Apart from these general long-term effects of treatment, this study also analysed whether the progress after the inpatient pain treatment at the GPPC was dependent on the age of the patients (Dobe et al. 2011; Hechler et al. 2010a). Children (7–10 years) and adolescents (11–18 years) benefitted equally with regard to changes in pain intensity, pain-related school absence, coping strategies, anxiety and depression. However, children more frequently searched for social support and showed less passive behaviour than adolescents. Pain-related disability was more strongly reduced in adolescents than in children. Adolescents had a higher pain-related disability before treatment than children, and this difference disappeared after treatment (Dobe et al. 2011; Hechler et al. 2010a).

With regards to sex, boys reported a significantly stronger reduction in pain intensity than girls (Dobe et al. 2011; Hechler et al. 2010a). Furthermore, before treatment, boys reported more school days missed due to pain than girls, but less school days missed than girls 12 months after treatment. Further sex differences were found regarding the reduction of dysfunctional coping strategies with boys displaying a stronger decrease. Thus, boys benefitted more from treatment than girls with regard to pain intensity, pain-related school absence and coping. There were no sex differences for pain-related disability in everyday life, anxiety and depression.

Summary of Main Results

This study was the first to demonstrate that the inpatient pain treatment programme of the GPPC leads to statistically and clinically significant improvements in pain characteristics (pain intensity, pain-related disability, pain-related school absence, pain coping) and emotional distress (general anxiety, depression). Approximately 55% of patients experienced an overall improvement. No major influence of age on the effectiveness of the treatment was found. Initial evidence suggests that boys may benefit slightly more than girls.

16.1.2 Study 2: Retrospective Analysis of All Patients

In a retrospective study, the treatment outcome of all patients who initially presented to the outpatient clinic between July 2005 and June 2010 was analysed (Hechler et al. 2014b). Due to overlapping periods of data collection, some of the patients of study 1 were also included in study 2; there is also overlap with study 3 (see below). Data of pain intensity, pain-related disability and school absence were collected in the context of the initial examination before inpatient treatment and a follow-up visit in the year after inpatient treatment. Overall, $N = 512$ children and adolescents received inpatient treatment during this period. Of these patients, $N = 320$ returned to the clinic for an outpatient follow-up visit within a year (on average 3–4 months after treatment) and were included in the study. The results of study 1 regarding significant strong reductions could be confirmed for all three outcomes. Comparable to study 1, 52% of the patients displayed clinically significant improvements in pain intensity and 46% in pain-related disability.

Summary of Main Results

This retrospective study confirmed the statistically and clinically significant improvements in pain characteristics with a large patient sample.

16.1.3 Study 3: Efficacy of Treatment and Long-Term Outcome

From late 2009 to mid-2011, $N = 120$ children and adolescents were included in a randomised controlled trial on the efficacy of the interdisciplinary inpatient pain treatment for children and adolescents at the GPPC. Study participants were randomly assigned to one of two groups: they either received inpatient treatment directly after the initial examination (intervention group) or after a waiting period of 3 weeks (waitlist control group).

Short-Term Treatment Efficacy

The primary research interest was the comparison between both groups at the time point 3 weeks after initial examination when the intervention group had already received inpatient treatment and the waitlist control group had not. Validated questionnaires were used to assess pain characteristics, emotional characteristics and pain-related cognitions (see Sects. 3.3 and 3.5.1). Of the original 120 study participants, some were subsequently excluded, resulting in data available for 104 patients.

The inpatient interdisciplinary treatment had a considerable effect. Of those patients who had already received treatment (intervention group), 55% displayed overall improvement, compared with 14% in the waitlist control group. This difference was statistically significant (Hechler et al. 2014a).

Furthermore 3 weeks after the initial examination, the patients in the intervention group were significantly improved regarding pain-related disability, school absence, depression and catastrophising. No improvements were found in the waitlist control group (Hechler et al. 2014a).

Long-Term Treatment Effectiveness

Both study groups were followed over a period of 4 years with data collected 6, 12 and 48 months after inpatient treatment via telephone or post. Six months after treatment, data of 96% of the patients could be collected. After 12 months, data of 83% of the patients were available, and still 69% of the patients provided data 48 months after treatment. Since at these time points, both groups had received the inpatient treatment, no group differences between intervention and control group were analysed. At all follow-up time points, patients reported significant improvements in all pain-related and emotional parameters; these improvements continued to be stable 4 years after treatment (Hechler et al. 2014a; Zernikow et al. 2018). Particularly those patients who had a severe pain disorder with a high number of school days missed before treatment showed strong pain-related improvements (Wager et al. 2014). Four years after treatment, 66% of the patients reported clinically significant improvements in pain intensity, 54% in pain-related disability and 27% in school days missed (Zernikow et al. 2018). Overall improvement of the pain

disorder was found in 60% of the patients. Younger patients were more likely to show overall improvement than older patients. Clinically significant improvement in anxiety was present in 24% of the patients and in 28% and 50% regarding depression and catastrophising, respectively.

In addition to changes observed in the children and adolescents receiving inpatient pain treatment, there were also changes in the parents who are actively integrated into the pain treatment. Parental reactions to pain changed significantly after treatment. Parents less often displayed solicitous behaviour when their child was in pain (Frerker et al. 2016). This is in line with the aims of the treatment, since intensive parental care is associated with increased chronic pain of the children (Kaczynski et al. 2009). Another goal of treatment is that parents support their children in active distraction from pain. On this matter, only a short-term significant increase of distracting behaviour was found that was not maintained in the long run (Frerker et al. 2016).

Both patients and their parents indicated that they were satisfied with the inpatient treatment at the GPPC (Stahlschmidt et al. 2018). The main reasons for the satisfaction were the treatment methods (e.g. education, psychotherapy), the interdisciplinary team and the improvement of the pain disorder. Patients reported that they were satisfied, because they were able to resume a normal life and to control their pain. The age of the patients and the extent of depressive symptoms before treatment were found to have an impact on satisfaction. Younger patients were more likely to be dissatisfied, as well as parents whose children had higher depression scores before treatment. Overall, there was no relationship between the children's and their parents' satisfaction and the long-term treatment outcome.

Cost–Benefit Analysis of the Treatment

Comprehensive economic data were collected for a cost-benefit analysis of the interdisciplinary inpatient pain treatment (Hechler et al. 2014a; Ruhe et al. 2013; Ruhe et al. 2017; Zernikow et al. 2018). Both, costs for the families (assessed in the last 6 months) and for the health insurances (assessed in the last 12 months) were considered. Before treatment and 6, 12 and 48 months after treatment, parents provided information about how many medical and social services their child had used due to pain. Additionally, they reported how many days they had been absent from work due to their child's illness and how they perceived the financial burden of the child's pain for the family. The financial burden was assessed both subjectively with categories (no burden, moderate, high, very high) and directly on the basis of incurred costs. Overall, healthcare utilisation (e.g. general practitioner, psychotherapy, physical therapy, osteopathy) was significantly reduced (Hechler et al. 2014a; Ruhe et al. 2013; Zernikow et al. 2018). Furthermore, there was a significant decrease in the number of parents' work days missed. Before treatment, parents reported 4 days of work absenteeism (median) within 6 months due to their child's pain. After treatment, the median was zero (Hechler et al. 2014a). The financial burden for the family likewise decreased. Parents reported less costs for example for medicinal products, travel costs or private lessons. Before treatment, the financial burden was 100€ per month (median). Six months after treatment, it decreased to

60€ and after 12 months, parents reported a financial burden of 25€. However, this reduction was not statistically significant (Ruhe et al. 2013). The subjective financial burden was significantly decreased 4 years after treatment (Hechler et al. 2014a; Ruhe et al. 2013; Zernikow et al. 2018). Overall, positive economic effects were particularly found for patients with an overall improvement of the pain disorder (Hechler et al. 2014a; Zernikow et al. 2018).

To investigate economic effects of the treatment for health insurances, health-care claims data of 65 study participants were analysed for the 12 months before and 12 months after treatment (Ruhe et al. 2017). Overall, total costs for health insurances did not decrease after treatment. Costs for outpatient services even significantly increased. But results revealed that healthcare is provided more purposefully. Significantly less patients went to the radiologist, but more patients received psychotherapy. This is in line with the aims of treatment to prevent exaggerated diagnostic procedures and to initiate psychotherapy, if indicated. Furthermore, fewer patients were treated in an inpatient setting after pain treatment. Moreover, medication utilisation was significantly reduced. There was an association between treatment outcome and costs after treatment (Ruhe et al. 2017). Patients with a good treatment outcome (Chronic Pain Grading (CPG) 0 or 1; see below) had significantly less costs than patients with an unsatisfactory treatment outcome (CPG 2–4).

Summary of Main Results

The short-term efficacy of the inpatient pain treatment could be demonstrated in a randomised controlled trial with a waitlist control group. Additionally, the study revealed that the statistically and clinically significant improvements of pain characteristics and emotional distress were maintained for up to 4 years after treatment. Long-term overall improvement was found in 60% of the patients. Positive effects on parental behaviour could also be demonstrated. Patients and their parents were very satisfied with the treatment. The financial burden on the families was reduced, while costs for the healthcare system remained unchanged. Healthcare utilisation seems to be more purposeful following treatment.

16.1.4 Study 4: Monitoring Treatment Outcome by Means of Chronic Pain Grading

For this study, all children and adolescents who initially presented to the outpatient pain clinic of the GPPC during January 2013 to March 2014 were contacted 1 year after their initial examination. To investigate treatment outcome, data of $N = 267$ patients were analysed regarding pain intensity, pain-related disability and school absence (Stahlschmidt et al. 2017). The Chronic Pain Grading (CPG) was used as an overall measure of treatment outcome.

The *Chronic Pain Grading* (CPG) integrates data on pain intensity, pain-related disability in everyday life and school absence into an overall measure of pain severity (Wager et al. 2013). Contrary to the overall improvement, the CPG does not

focus on change, but on the patients' state after treatment. Patients are assigned to one of five grades, ranging from grade 0 without chronic pain to grade 4 with chronic pain with high disability that is severely limiting.

Approximately half of the patients included in study 4 received an inpatient pain treatment. Before treatment, about 80% of these patients were in the highest CPG grades 3 and 4. No patient was assigned to grade 0 or 1, which can be considered clinically unproblematic grades. After treatment, approximately 30% of the patients were in grade 0 or 1 and only about 20% were in grade 3 or 4. Most patients were assigned to grade 2; this means they still had strong pain, but they were no longer impaired by this pain. Overall, 12 months after treatment, the CPG grade was improved for two-thirds of the patients, 40% were improved by two grades. This improvement was statistically significant (Stahlschmidt et al. 2017).

Summary of Main Results

One year after treatment, 30% of the patients had no longer had clinically relevant pain symptoms. Further, 50% of the patients still reported pain, but without relevant impairments in everyday life.

16.1.5 Study 5: Efficacy of Pain Provocation

In the context of study 5, the efficacy of a single treatment component (pain provocation, see Sect. 9.5.5) of the interdisciplinary pain treatment was investigated for the first time. After a pilot study had demonstrated promising results (Hechler et al. 2010b), a randomised controlled trial was conducted (Flack et al. 2018). Between May 2014 and August 2016, $N = 126$ patients who received an inpatient treatment at the GPPC participated in the study. Overall, $N = 104$ patients could be included in analyses. Study participants were randomly assigned to one of two study groups: they either were taught pain provocation in addition to the standard inpatient treatment (intervention group) or a relaxation technique, the progressive muscle relaxation (control group). The study participants completed validated questionnaires on pain data (pain intensity, pain-related disability, school absence, fear of pain) and emotional distress (general anxiety, anxiety sensitivity, catastrophising). Data were provided at admission to inpatient treatment, discharge and 3 months after treatment. Overall, both groups demonstrated significant reductions in all pain characteristics, fear of pain and catastrophising (Flack et al. 2018). However, there was no stronger decrease for patients in the intervention group compared to the control group. Results confirm the general effectiveness of the interdisciplinary inpatient pain treatment. An additional benefit of the pain provocation technique compared to the relaxation technique could not be determined. However, exploratory analyses revealed that patients with a high fear of pain before treatment and patients with abdominal pain benefitted more from pain provocation than from relaxation. These findings may be useful for deciding who should receive additional pain provocation during inpatient treatment. Such an individualised treatment may perhaps contribute to the improvement of treatment outcome.

Summary of Main Results

The pain provocation technique seems to be particularly beneficial for reducing fear of pain in patients with abdominal pain or high fear of pain before treatment.

16.1.6 Conclusion

All studies support the hypothesis that the 3- to 4-week inpatient pain treatment at the GPPC is beneficial in the long run for children with a pain disorder irrespective of pain location and somatic or psychiatric comorbidity. Apart from the positive impact on pain, impairment and emotional burden, positive financial effects result for the affected families.

At a time of limited human resources and a shift to technical medicine, the inpatient pain treatment programme of the GPPC requiring a large interdisciplinary team and focusing on the child and his/her family may seem to be a relic from the past. However, it is exactly this personnel-intensive approach that makes the programme so successful.

16.2 International Studies

Across the world, research on the effectiveness of intensive interdisciplinary pain treatment for children and adolescents has progressed a lot in recent years. Meanwhile, there are studies on different inpatient and day-hospital pain treatment programmes with a structure and treatment approach similar to the GPPC (for an overview, see Stahlschmidt et al. 2016). Two reviews have summarised the most important results of these effectiveness studies (Hechler et al. 2015; Stahlschmidt et al. 2016). Some of the studies described above were also included in these reviews. The reviews confirm that the pain treatment programmes lead to both short-term and long-term reductions in pain intensity, pain-related disability and school absence. Emotional distress also substantially decreases through the treatment. Furthermore, some studies were able to prove positive economic effects. One study concludes that an intensive interdisciplinary pain treatment is a cost-effective therapy for chronic pain in children and adolescents (Evans et al. 2016). Additionally, improvements were demonstrated regarding sleep quality (e.g. fewer sleeping disorders, daytime sleepiness, night-time awakenings).

References

- Brattberg G (2004) Do pain problems in young school children persist into early adulthood? A 13-year follow-up. *Eur J Pain* 8:187–199
- Brna P, Dooley J, Gordon K, Dewan T (2005) The prognosis of childhood headache: a 20-year follow-up. *Arch Pediatr Adolesc Med* 159:1157–1160
- Dobe M, Hechler T, Behlert J, Kosfelder J, Zernikow B (2011) [Pain therapy with children and adolescents severely disabled due to chronic pain: long-term outcome after inpatient pain therapy]. *Schmerz* 25:411–422

- Ellert U, Neuhauser H, Roth-Isigkeit A (2007) [Pain in children and adolescents in Germany: the prevalence and usage of medical services. Results of the German health interview and examination survey for children and adolescents (KiGGS)]. *Bundesgesundheitsbl* 50: 711–717
- Evans JR, Benore E, Banez GA (2016) The cost-effectiveness of intensive interdisciplinary pediatric chronic pain rehabilitation. *J Pediatr Psychol* 41:849–856
- Fearon P, Hotopf M (2001) Relation between headache in childhood and physical and psychiatric symptoms in adulthood: national birth cohort study. *Br Med J* 322:1145–1148
- Flack F, Stahlschmidt L, Dobe M, Hirschfeld G, Kesper A, Michalak J, Wager J, Zernikow B (2018) Efficacy of adding interoceptive exposure to intensive interdisciplinary treatment for adolescents with chronic pain: a randomized controlled trial. *Pain* 159(11):2223–2233
- Frerker M, Hechler T, Schmidt P, Zernikow B (2016) [Pain-related parental behavior: maternal and paternal responses to chronic pain of their child and modifications following inpatient interdisciplinary pain treatment]. *Schmerz* 30:241–247
- Groenewald CB, Essner BS, Wright D, Fesinmeyer MD, Palermo TM (2014) The economic costs of chronic pain among a cohort of treatment-seeking adolescents in the united states. *J Pain* 15:925–933
- Hechler T, Blankenburg M, Dobe M, Kosfelder J, Hübner B, Zernikow B (2010a) Effectiveness of a multimodal inpatient treatment for pediatric chronic pain: a comparison between children and adolescents. *Eur J Pain* 14:97.e91–97.e99
- Hechler T, Dobe M, Damschen U, Blankenburg M, Schroeder S, Kosfelder J, Zernikow B (2010b) The pain provocation technique for adolescents with chronic pain: preliminary evidence for its effectiveness. *Pain Med* 11:897–910
- Hechler T, Dobe M, Kosfelder J, Damschen U, Hübner B, Blankenburg M, Sauer C, Zernikow B (2009) Effectiveness of a three-week multimodal inpatient pain treatment for adolescents suffering from chronic pain: statistical and clinical significance. *Clin J Pain* 25:156–166
- Hechler T, Dobe M, Zernikow B (2010c) Commentary: a worldwide call for multimodal inpatient treatment for children and adolescents suffering from chronic pain and pain-related disability. *J Pediatr Psychol* 35:138–140
- Hechler T, Kanstrup M, Holley AL, Simons LE, Wicksell R, Hirschfeld G, Zernikow B (2015) Systematic review on intensive interdisciplinary pain treatment of children with chronic pain. *Pediatrics* 136:115–127
- Hechler T, Kosfelder J, Vocks S, Mönninger T, Blankenburg M, Dobe M, Gerlach AL, Denecke H, Zernikow B (2010d) Changes in pain-related coping strategies and their importance for treatment outcome following multimodal inpatient treatment: does sex matter? *J Pain* 11:472–483
- Hechler T, Martin A, Blankenburg M, Schroeder S, Kosfelder J, Hölscher L, Denecke H, Zernikow B (2011) Specialized multimodal outpatient treatment for children with chronic pain: Treatment pathways and long-term outcome. *Eur J Pain* 15:976–984
- Hechler T, Ruhe AK, Schmidt P, Hirsch J, Wager J, Dobe M, Krummenauer F, Zernikow B (2014a) Inpatient-based intensive interdisciplinary pain treatment for highly impaired children with severe chronic pain: randomized controlled trial of efficacy and economic effects. *Pain* 155:118–128
- Hechler T, Wager J, Zernikow B (2014b) Chronic pain treatment in children and adolescents: less is good, more is sometimes better. *BMC Pediatr* 14:262
- Hestbaek L, Leboeuf-Yde C, Kyvik KO, Manniche C (2006) The course of low back pain from adolescence to adulthood: eight-year follow-up of 9600 twins. *Spine (Phila PA 1976)* 31: 468–472
- Hirschfeld G, Hechler T, Dobe M, Wager J, Blankenburg M, Kosfelder J, Zernikow B (2013) Maintaining lasting improvements: one-year follow-up of children with severe chronic pain undergoing multimodal inpatient treatment. *J Pediatr Psychol* 38:224–236
- Hogan M-E, Taddio A, Katz J, Shah V, Krahn M (2016) Incremental health care costs for chronic pain in Ontario, Canada: a population-based matched cohort study of adolescents and adults using administrative data. *Pain* 157:1626–1633

- Huguet A, Miro J (2008) The severity of chronic paediatric pain: an epidemiological study. *J Pain* 9:226–236
- Kaczynski KJ, Claar RL, Logan DE (2009) Testing gender as a moderator of associations between psychosocial variables and functional disability in children and adolescents with chronic pain. *J Pediatr Psychol* 34:738–748
- Logan DE, Simons LE, Stein MJ, Chastain L (2008) School impairment in adolescents with chronic pain. *J Pain* 9:407–416
- Mäntyselkä PT, Kumpusalo EA, Ahonen RS, Takala JK (2002) Direct and indirect costs of managing patients with musculoskeletal pain - challenge for health care. *Eur J Pain* 6:141–148
- Mirovsky Y, Jakim I, Halperin N, Lev L (2002) Non-specific back pain in children and adolescents: A prospective study until maturity. *J Pediatr Orthop B* 11:275–278
- Perquin CW, Hazebroek-Kampschreur AA, Hunfeld JAM, Bohnen AM, van Suijlekom-Smit LWA, Passchier J, van der Wouden JC (2000) Pain in children and adolescents: a common experience. *Pain* 87:51–58
- Pradalier A, Auray JP, El Hasnaoui A, Alzahouri K, Dartigues JF, Duru G, Henry P, Lanteri-Minet M, Lucas C, Chazot G, Gaudin AF (2004) Economic impact of migraine and other episodic headaches in france: data from the grim2000 study. *Pharmacoeconomics* 22:985–999
- Ruhe A-K, Frosch M, Wager J, Linder R, Pfenning I, Sauerland D, Zernikow B (2017) Health care utilization and cost in children and adolescents with chronic pain: analysis of health care claims data one year before and after intensive interdisciplinary pain treatment. *Clin J Pain* 33:767–776
- Ruhe A, Wager J, Schmidt P, Zernikow B (2013) [Economic effects of chronic pain in childhood and adolescence: self-assessment of health care costs for affected families before and after a multidisciplinary inpatient pain therapy]. *Schmerz* 27:577–587
- Shelby GD, Shirkey KC, Sherman AL, Beck JE, Haman K, Shears AR, Horst SN, Smith CA, Garber J, Walker LS (2013) Functional abdominal pain in childhood and long-term vulnerability to anxiety disorders. *Pediatrics* 132:475–482
- Sleed M, Eccleston C, Beecham J, Knapp M, Jordan A (2005) The economic impact of chronic pain in adolescence: methodological considerations and a preliminary costs-of-illness study. *Pain* 119:183–190
- Stahlschmidt L, Barth F, Zernikow B, Wager J (2017) [Therapy outcome one year after pediatric outpatient chronic pain evaluation: chronic pain grading (CPG) for adolescent pain patients]. *Schmerz* 6:601–609
- Stahlschmidt L, Zernikow B, Wager J (2016) Specialized rehabilitation programs for children and adolescents with severe disabling chronic pain: Indications, treatment and outcomes. *Children* 3:33
- Stahlschmidt L, Zernikow B, Wager J (2018) Satisfaction with an intensive interdisciplinary pain treatment for children and adolescents: an independent outcome measure? *Clin J Pain* 34(9):795–803
- van Leeuwen MT, Blyth FM, March LM, Nicholas MK, Cousins MJ (2006) Chronic pain and reduced work effectiveness: the hidden cost to australian employers. *Eur J Pain* 10:161–166
- Wager J, Hechler T, Darlington AS, Hirschfeld G, Vocks S, Zernikow B (2013) Classifying the severity of paediatric chronic pain – an application of the chronic pain grading. *Eur J Pain* 17(9):1393–1402
- Wager J, Zernikow B, Darlington AS, Vocks S, Hechler T (2014) Identifying subgroups of pediatric chronic pain patients: a cluster-analytic approach. *Eur J Pain* 18:1352–1362
- Walker LS, Dengler-Criss CM, Rippel S, Bruehl S (2010) Functional abdominal pain in childhood and adolescence increases risk for chronic pain in adulthood. *Pain* 150:568–572
- Zernikow B, Ruhe A-K, Stahlschmidt L, Schmidt P, Staratzke T, Frosch M, Wager J (2018) Clinical and economic long-term treatment outcome of children and adolescents with disabling chronic pain. *Pain Med* 19:16–28