Paediatric Intravenous Patient-Controlled Analgesia (PCA)

Analysis of safety and efficacy of intravenous PCA at the Dept. of Paediatric Anaesthesia, Medical University Graz,

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Graz, 21. März 2012

(Sebastian Fuchs)

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Zusammenfassung

Einleitung: Die Kinderanästhesie der Med. Univ. Graz besitzt eine mehr als 15-jährige Erfahrung mit der intravenösen Patienten-kontrollierten Schmerztherapie (PCA) kombiniert mit einer Hintergrundinfusion. Ziel dieser Diplomarbeit ist eine Analyse der Effektivität und Sicherheit dieser Therapieform.

Methoden: Retrospektiv wurden die Daten der Schmerzprotokolle des ersten komplett digital archivierten Jahres 2009 erhoben. Es wurden alle PatientInnen im Alter von 0-18 Jahre eingeschlossen, bei denen eine intravenöse PCA durchgeführt wurde. Mittels nicht-parametrischen Tests wurden zwei unterschiedlichen Füllungen (Tramadol / Metamizol vs. Piritramid) analysiert.

Ergebnisse: Unterhalb der Interventionsgrenzen (Schmerzwert 4) blieben 75% der beobachteten Patienten in der Altersgruppe der 0-5 jährigen, 43% der 6-13 jährigen und 27% der 14-18 jährigen. Patienten mit einer Tramadol/Metamizol PCA zeigten seltener Schmerzen als jene mit einer Piritramid PCA (53.3% bei Tramadol/Metamizol zu 31,3% bei Piritramid unter der Interventionsgrenze). Abfälle in der Sauerstoffsättigung (SaO_2 <94%) zeigten 8% der PatientInnen, wobei nur die am längsten durchgeführten Tramadol/Metamizol PCA-Behandlungen von insgesamt 7 Tagen mit einer erhöhten Inzidenz von Sauerstoffsättigung (SaO_2 <94%) verbunden waren. Übelkeit/Erbrechen in den ersten 24h postoperativ (PONV) hatten 8% der 0-5 jährigen, 55% der 6-13 jährigen, 68% der 14-18 jährigen Frauen und 23% der 14-18 jährigen Männer. Nach den ersten 24h postoperativ berichteten 22.9% aller PatientInnen über Übelkeit/ Erbrechen. Neunundachtzig Prozent der PatientInnen mit Übelkeit während der ersten 24h postoperativ berichteten auch danach über eine zusätzliche Übelkeitsepisode. Buben verweilten im Median 1 Tag länger in der Klinik.

Konklusion: PCA mit Hintergrundinfusion ist bei kinderchirurgischen PatientInnen im Alter von 0-18 Jahren eine effektive und sichere Behandlungsform zur Therapie von kindlichen/jugendlichen postoperativen Schmerzen, wobei in dieser Studie deren Effektivität in der Altersgruppe 14-18 Jahren abnimmt. Weiteres sollten Frauen im Alter von 14-18 Jahren und PatientInnen mit Übelkeit in den ersten 24 postoperativen Stunden als Hochrisiko-PatientInnen für Übelkeit und Erbrechen betrachtet werden. Zukünftige Studien sollen prospektiv unsere Ergebnisse untersuchen und die verblieben offenen Fragen beantworten.

Abstract

Introduction: The Paediatric Anaesthesia Department of the Medical University Graz has more than 15 years' worth of experience with patient-controlled analgesia (PCA) in combination with a continuous infusion. The aim of this thesis is to analysis its safety and efficacy.

Methods: The data of the first completely digitalised year 2009 were gathered retrospectively. It included all surgical, non-oncological patients in the range of 0-18 years who received intravenous PCA. Non-parametric tests were used to analyse two different fillings of PCA: tramadol/metamizole PCA and piritramide PCA.

Results: In the age group 0-5 years old 75% of the patients stayed beneath the threshold of intervention (pain score 4). For the age groups of 6-13 and 14-18 years old, 43% and 27% of the patients, respectively, stayed below the pain intervention threshold, respectively. Patients treated with tramadol/metamizole PCA reported pain less frequently than those treated with piritramide PCA (53.3% versus 31.3% were below intervention threshold). Eight per cent of all patients experienced oxygen desaturation (SaO_2 <94%). The longest use of tramadol / metamizole PCA which was 7 days in total showed an association with a more frequent occurrence of oxygen desaturation during these days. Nausea and/or emesis in the first 24h post-operative (PONV) were reported by 8% of the 0-5 years old, 55% of the 6-13 years old, 68% of the 14-18 years old females and 23% of the 14-18 years old males. After the first 24 post-operative hours 22.9% of all patients reported nausea and/or emesis. Eighty-nine per cent of the patients with nausea and/or emesis during the first 24 post-operative hours experienced it later on, too. In median, males stayed one day longer in the hospital.

Conclusion: PCA with continuous infusion is a safe and effective form of post-operative pain treatment for patients between the age of 0-18 years. We observed a decrease in its efficacy between 14-18 years of age. Moreover patients with incidences of nausea and/or emesis during the first 24 post-operative hours and female patients in the age of 14-18 years should be considered as high risk patients for nausea & emesis. Further studies have to examine our results and shall answer the remaining open questions prospectively.

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Glossary

CHIPPS	-	Children's and Infants' post-operative Pain Scale
Dept.	-	Department
e.g.	-	exempli gratia (for example)
FPS-r	-	reversed FACES Pain Scale
i.e.	-	id est (that is)
OP	-	Operation
PCA	-	Patient-controlled analgesia
PCEA	-	Patient-controlled epidural analgesia
PCRA	-	Patient-controlled regional analgesia
p.o.	-	per os
PONV	-	Post-operative nausea and vomiting (in the first 24 hours)
SaO_2	-	arterial oxygen saturation

A Introduction

More than forty years ago, a new approach to analgesia was developed with the intention of providing the patient the possibility of administering analgesics on her/his own as and when required.[1] The new approach gave the patient more autonomy and control.[2] In addition, the patient perceived the reduction of the time spent by medical staff in providing medication as a major advantage.[2, 3] This procedure, nowadays known as patient-controlled analgesia (PCA), is being used increasingly. In a national survey of American paediatric anaesthesiologists published in the year 2010, it was reported that 95% of all institutions provided intravenous PCA for paediatric patients and 59% offered it without any age restriction.[4] However, during this development some questions remained unsolved: for example, the accurate prediction of the efficacy, which is, inter alia, influenced by age, gender and the different types of analgesic drugs used.[5] In addition, there is concern about occurring side effects of the opioids administered by the PCA pump. One such severe side effect is respiratory depression, evidenced by oxygen desaturation.

Another common side effect is nausea and/or emesis. If PCA is used post-operatively, the operation can also trigger nausea and/or emesis, known as post-operative nausea and vomiting (PONV). At the moment of writing of this thesis the author is not aware of any study distinguishing PONV from nausea and/or emesis caused by post-operative PCA in paediatric/ adolescent patients. No conclusive data concerning this specific side effect of PCA was available until now.

The purpose of this thesis is to carry out a retrospective analysis of the safety and efficacy of intravenous PCA based on 15 years of experience in the use of PCA in paediatric or adolescent patients at the Dept. of Paediatric Anaesthesia of the Medical University of Graz.

Therefore, three hypotheses were postulated:

1. PCA is an effective treatment for postoperative pain management with low incidences of nausea and/or emesis and oxygen desaturation.
2. The occurrence of total pain relief, incidences of nausea and/or emesis and incidences of oxygen desaturation differ age- and gender-dependent as the physiology develops from newborn to adult.
3. The occurrence of total pain relief, incidences of nausea and/or emesis and incidences of oxygen desaturation are different for patients treated with tramadol / metamizole PCA when compared to patients treated with piritramide PCA.

B General part

B.1 What is Patient-Controlled Analgesia?

Patient-controlled analgesia (PCA) is a programmable motor pump for pain therapy which enables the patient to control his own application of predefined doses of analgesics or local anaesthetics whenever necessary. By pressing a button the patient can regulate how many analgesic drugs she/he wants. Simultaneously the patient may be administered the drug by a continuous background infusion. There are two common ways of application, namely intravenous PCA and patient-controlled regional analgesia. The latter concept is used for patient-controlled epidural analgesia and for patient-controlled peripheral regional analgesia. In addition, some less familiar applications of PCA are known, i.e. intra-nasal PCA or subcutaneous PCA .[6,7] This thesis focuses on intravenous PCA only. If the patient is too young to understand the handling and the consequences of the analgesic pump, a nurse or a parent is appointed to operate the pump by pressing the button. For this purpose the nurse or parent is instructed how to use a children pain scale to adequately providing the drugs. Patients who are assisted by an adult are nevertheless considered as PCA patients in this paper.

B.2 Pros and cons for preferring PCA

A meta-analysis including 2023 patients showed that “PCA provided better pain control and greater patient satisfaction than conventional parenteral 'as-needed' analgesia”.[8] In particular, “not having to wait for pain relief, not having injections and not having to bother nurses” are benefits pointed out by questioned patients.[3] However, some of these patients also reported that they did not trust the PCA machine, or feared getting an overdose or becoming addicted.[3]

Although PCA patients consume on average more opioids, it was not found that they suffered from significantly more side effects.[8] It would therefore seem that PCA can be a good alternative to conventional pain control.[8] It may be noticed that PCA is more expensive than the conventional analgesic treatment, because the pumps have to been purchased and maintained. Moreover PCA requires a well-trained staff with a view to preventing and minimising the occurrence of side effects.[3] It was found that with staff specially trained in PCA the side effects decreased significantly and inexperienced staff is one of the leading contributing factors for occurrence of PCA errors.[9, 10]

"Furthermore, the use of a PCA pump benefits the patient and families, providing the opportunity for children to control their pain and to feel directly involved in the management of their illness".[11]

It has been alleged that PCA can provide analgesia in an uninterrupted and successful way, so that post-operative complications may be overlooked, for example, urinary retention, compartment syndrome, pulmonary embolism, and myocardial infarction.[3, 12] However the masked symptom pain could be expressed in change of the PCA usage so on this way it signal a surgical or medical diagnosis.[3] These cases are rare and in some reported ones the observation could be considered as insufficient.[3]

B.3 The use of PCA at the Department of Paediatric Anaesthesia, Medical University of Graz

B.3.1 Important terms of PCA

A "continuous dose" is the dose given as a continuous infusion.

The "bolus dose" is the dose of analgesic drug given on demand.

The "4h maximum dose" is the maximum of medication the pump will provide in four hours. This is necessary to prevent an overdose of the analgesic drug. The maximum dose includes the continuous dose as well as the successfully requested boli.

The "lockout interval" is the time period after a successfully requested bolus, during which no further bolus is provided by the PCA infusion pump. For intravenous PCA a lockout interval of 5 minutes is common, because the analgesic peak effect is normally reached within 5 minutes. Applying a further bolus in this time period would therefore be superfluous.

B.3.2 The different PCA applications and analgesics

At the Department of Paediatric Anaesthesia in Graz there are two applications in use: intravenous PCA and patient-controlled regional analgesia. As explained in chapter B.1 above the latter concept is used for patient-controlled epidural analgesia (PCEA) and for patient-controlled peripheral regional analgesia (PCRA).

The local analgesic drug ropivacaine is preferred for PCEA and PCRA. Depending on the position of the catheter and/or the age of the patient clonidine and morphine are used as adjuvants.

For intravenous PCA one of the following two infusions is applied.

The first type of PCA infusion is a Tramadol / metamizole mixture, namely:

- 500mg tramadol = 10ml plus 5g metamizole = 10ml
  plus 80 ml aqua with 0. 9% sodium chloride

The doses for the continuous infusion are for tramadol 0.2mg/kg/h and for metamizole 2mg/kg/h. The does for the 4h maximum are for tramadol 1mg/kg and for metamizole 10mg/kg . The doses were rounded because the pumps are only programmable with one decimal.

Body weight [kg]	**Cont. infusion rate [ml/h]**	**Bolus [ml]**	**4h maximum dose [ml]**
5	0.2	0.1	1
10	0.4	0.1	2
15	0.6	0.2	3
20	0.8	0.2	4
25	1.0	0.2	5
30	1.2	0.3	6
35	1.4	0.3	7
40	1.6	0.3	8
45	1.8	0.3	9
50	2.0	0.4	10
55	2.2	0.4	11
60	2.4	0.4	12
65	2.6	0.5	13
70	2.8	0.5	14
≥75	3.0	0.5	15

Table 1: Tramadol / metamizole PCA - the initial dosage setting at the Department of Paediatric Anaesthesia, Medical University of Graz. The ml refers to the applied infusion: 500mg tramadol = 10ml plus 5g metamizole = 10ml and 80 ml aqua plus 0.9%. sodium chloride

The second type of PCA infusion is a piritramide infusion, which is applied in two different mixtures regarding the body weight of the patient:

- 12ml piritramide plus 213ml aqua with 0.9% sodium chloride for children above the weight of 30kg
- 6ml piritramide plus 219ml aqua with 0.9% sodium chloride for children below the weight of 30kg

The dose for the continuous infusion is 20µg/kg/h piritramide. The dose for the 4h maximum is 0.2mg/kg piritramide. The doses were also rounded because the pumps are only programmable with one decimal.

Body weight [kg]	**Cont. infusion rate [mg/h]**	**Bolus [mg]**	**4h maximum dose [mg]**
10	0.2	0.3	2
15	0.3	0.5	3
20	0.4	0.6	4
25	0.5	0.8	5
30	0.6	1.0	6
35	0.8	1.0	7
40	0.8	1.2	8
45	1.0	1.4	9
50	1.0	1.6	10
55	1.2	1.8	11
60	1.2	1.8	12
65	1.4	2.0	13
70	1.4	2.2	14
75	1.6	2.4	15
≥80	1.6	2.4	16
Dosage of piritramide	*20µg/kg*	*30µg/kg*	*0.2mg/kg*

Table 2: Piritramide PCA - the initial dosage setting at the Department of Paediatric Anaesthesia, Medical University of Graz. The mg refers to the mg of piritramide used.

B.3.3 Decision algorithm

This section and the next one (section B.3.4) are based on Vittinghoff et al.[13]

When regular post-operative analgesic drugs are required for at least two days patient-controlled post-operative analgesia should be considered. If possible, regional anaesthesia for intra- and post-operative pain management is preferred.

However, regional anaesthesia is not allowed in case of:

- any contraindication
- the parent and/or patient disagreement
- no possibility of provision of proper post-operative management of regional anaesthetic catheters.

If regional anaesthesia cannot be applied, intravenous PCA should be considered. Sometimes it is not possible to cover the whole operating area with regional anaesthesia. In these cases intravenous PCA is also chosen. This decision has to be made before the surgery and during the pre-operative consultation. The parents and the patient have to be informed and integrated into this process and informed consent has to be granted.

B.3.4 Intra- and post-operative procedures

If intravenous PCA is chosen, the choice between tramadol / metamizole and piritramide has to be made. For abdominal surgery, tramadol / metamizole is preferred. For any other operation field piritramide is used. For the purpose of multi-modal pain control a non-steroidal anti-rheumatic drug is applied as basal analgesics. Nausea and emesis are common side effects of both tramadol and piritramide. Therefore it is recommended to prescribe an anti-emetic, for example ondansetron.

In case of intra-operative use of short-term effective analgesics such as remifentanil, the first dose of the long-acting remedy of the PCA has to be given in a timely fashion. The aim of this procedure is that the patient is free of pain when he or she leaves the operating room, and up to the time the PCA pump is started in the recovery room.

At some institutions no continuous rate is applied, with the intention to preventing or minimising the possibility of side effects, in particular apnoea. However, for more than 15 years a continuous rate has been applied at the Department of Paediatric Anaesthesia in Graz, and no relevant complications have occurred during this period. The advantage of applying a continuous infusion is that it improves the night rest of the children.[14, 15] This continuous infusion is chosen to be about 20% of the 4h maximum dose for tramadol / metamizole and about 10% of the dose for piritramide. This dose is reduced as soon as possible up to the point that it is zero and only on-demand bolus applications remain. The 4h maximum dose remains the same. The pain scale, the number of demanded boli, the type of surgery and the patient's clinical condition serve as guidance for the rate of reduction. The lockout interval is set to 5 minutes, see section B.3.1.

In the recovery room, as soon as the patient is fully awake, the handling of the PCA pump is again explained to the patient and the parents. Only patients free of pain are transferred to the general ward.

Patients have to be regularly assessed and monitored. The development of the patient has to be logged and the reservoir of the analgesic drugs has to be refilled. This process can only be handled in a team, in which well-trained and instructed nurses are particularly essential. The surgeons, the patient and her/his parents have to be in favour of this method of pain management, because only if everyone acts in concert will the post-operative phase be properly managed. If the patient is not properly included in the decision-making procedure, anxiety can be generated, which significantly influences the outcome of the pain management in a negative way.

For a minimum of 24 hours all patients with PCA are post-operative monitored with pulse-oximetry. After this period, during the medical pain round it should be decided whether or not this oxygen saturation observation is still necessary. At least four times a day the pain score and possible side effects are documented and reported by a pain nurse.

Twice a day the responsible anaesthetist (acute pain service) completes a round of supervision in the ward in order to control and adjust the pain therapy.
When the pain was higher or equal 4 points the patient was advised to press the demand button twice. When the patient had already pressed the button, or the procedure did not succeed in pain control, the patient was offered a rescue analgesic drug like piritramide. The patient can decide whether s/he wants to receive it. Patients who declined were only receiving the PCA pain management.

B.3.5 Evaluation of pain

The pain was examined at rest and at strain. Strain includes every relevant manipulation of the body (external and internal – for example coughing, movement of fractured body parts). The pain at rest was graphed and the pain at strain documented in numerical terms. The examination was carried out by nurses, physiotherapists and ergo-therapists.

Usually all patients were examined four times a day, in the morning, at noon, in the evening and at night, each time if possible at rest and at strain. If the patient was asleep only an S was noted. The first examination was at the admission and the last one on the day of discharge. Additional examinations were made by physiotherapists and ergo-therapists and were marked as such. This was also done in case of pain expression, in which case the patient received if necessary, in addition to the PCA, an analgesic drug, which is explained above in section B.3.4. The pain examination was repeated 30-60 min after the application. For the measurement of pain two different pain scales were used. The German Version of CHIPPS (Children's and Infants' post-operative Pain Scale) "*KUSS Kindliche Unbehagens- und Schmerz-Skala"* was used for infants and children up to the age of four.[16] This scale is from 0-10 points and is the summation of five clinical aspects of the patient, namely crying, facial expression, posture of the trunk, posture of the legs and motor restlessness. Each aspect is given 0, 1 or 2 points (see table below).

Before assessing the pain level, it must be checked that the child is awake. If the child is asleep no examination is done. Anything inducing discomfort has to be excluded (for example hunger, thirst, wet diaper, noise and dazzling by light). The observation is performed during 15 seconds. If the behaviour changes after this period, this change is disregarded.

Points	0	1	2
Crying	none	whimpering, groaning	crying
Facial expression	relaxed, smiling	grimacing of mouth	grimacing of mouth and eyes
Posture of the trunk	neutral	unsettled	rearing bending
Posture of the legs	neutral	kicking	pulled to the body
Motoric restlessness	none	lightly	restless

Table 3: CHIPPS (Children's and Infants' post-operative Pain Scale) [16]

For children older than four years the revised FACES Pain Scale was used, provided that the child could understand the intention of the pictures.[17] A sheet of paper showing five faces with expressions of pain was presented to the patient. The patient was asked which face exhibited as strong a feeling of pain as s/he was experiencing. The patient indicated e.g. by pointing which face it was and the number underneath this one was noted down as pain points. The faces were lined up from left to right in increasing intensity of pain and were coded with numbers 0, 2, 4, 6, 8 and 10, representing the strength of illustrated pain, see the homepage www.painsourcebook.ca. The German pain scores, which were actually used, can be found in the appendix.

C Special Part

C.1 Methods and data collection

C.1.1 Including and excluding criteria

The year 2009 is the first in the history of the Department of Paediatric Anaesthesia in Graz, in which all patient files have been completely digitalised. For this reason this year was chosen for data collection. The data were retrospective collected from the digital archived patient files. In the appendix a blank example of a patient form that has been actually used is attached.

Included were primarily all patients who received an intravenous PCA in that year. All patients treated with an additional patient controlled regional analgesia, or patients who switched between two different PCAs were excluded, because distinguishing the effects of either treatment was not possible. This thesis focuses on paediatric and adolescent post-operative PCA, thus all patients older than the age of 18 years were also excluded. Moreover, patients with several weeks of stay in the intensive care unit were excluded, because of the numerous concomitant medications which might influence effect and side effects of the PCA. Furthermore, patients with several weeks of intensive care are considered as severely diseased. Oncological patients were also excluded for the same reasons. In the end, patients with missing data were excluded as well.

C.1.2 Definition and explanation of the variables.

The primary variables are:

- Total pain relief
- Absence of nausea & emesis > 24 h
- Oxygen desaturation issue.

Pain at rest and pain at strain are more specific variables of total pain relief. Nausea & emesis ≤ 24 h is a more specific variable of absence of nausea &emesis > 24 h.

The secondary variables together with the already mentioned variables are accurately described in the following tables.

Variable	**Explanation**
Total pain relief	If in no report (at rest, at strain) 4 or more points on the pain scale were reported, this is defined as total pain relief.
• Pain at rest	The number of times the patient reported 4 or more points on the pain scale at rest.
• Pain at strain	The number of times the patient reported 4 or more points on the pain scale at strain (e.g. during movement or physiotherapy). No data for children under 6 were collected, because for this age group, it is not possible to clearly distinguish whether pain is caused by strain or not.
Absence of nausea & emesis > 24 h	If there were no vomiting or complaints of nausea after the first 24 hours after the operation, this is defined as the absence of nausea and/or emesis.
• Nausea & emesis > 24 h	Counted times of nausea and/or emesis occurrence after the first 24 hours after the operation
Oxygen desaturation issue	If the peripheral oxygen saturation was at least once 93% or less measured with a pulse-oximetry, this is defined as an oxygen desaturation issue.

Table 4: Definition of the primary and their subordinated variables

Variable	Explanation
Gender	Female or male
Age group	Three age groups are considered: • age from 0-5 years • age from 6-13 years • age from 14-18 years The birthday is the cut off point. Patients, who were for example 5 years and 11 month old were considered in the age group 0-5 years.
PCA filling	Two groups of infusions are considered: • tramadol with metamizole • piritramide
Abdominal surgery	The area of surgery was distinguished in abdominal and non-abdominal surgery.
Absence of nausea & emesis ≤ 24 h	If there were no vomiting or complaints of nausea in the first 24 hours after the operation, this is defined as the absence of nausea and/or emesis.
• Nausea & emesis ≤ 24 h	Counted times of nausea and/or emesis occurrence during the first 24 hours after the operation.
Boli demanded	Number of boli the patient or his or her parents demanded by pressing the demand button.
Unsuccessful boli requests during the lockout interval	Number of boli demanded, which were not received because they were demanded during the lockout interval.

Table 5: Definition of the secondary variables, part I

Variable	Explanation
Intrahospital days	The days the patient stayed this time in the hospital – including the days without intravenous PCA.
Days of intensive care	The number of days the patient was in an intensive care unit. The days were rounded to the nearest half or full day.
Days of PCA usage	The number of days the patient was treated with a PCA infusion. Each partially consumed day was counted as a whole day.
Benzodiazepine received	Whether the patient received any benzodiazepine. In the analysed cases, either triazolam (Halcion®) or diazepam (Psychopax®) was applied.
• Triazolam in total [mg/kg]	The total amount of triazolam the patient received during the time of PCA usage in mg divided by her/his body weight in kg.
• Diazepam in total [mg/kg]	The total amount of diazepam the patient received during the time of PCA usage in mg divided by her/his body weight in kg.
Ondansetron in total [mg/kg]	The total amount of ondansetron the patient received during the time of PCA usage in mg divided by her/his body weight in kg.
Tramadol in total [mg/kg]	The total amount of tramadol the patient received, in addition to the PCA infusion, during the time of PCA usage in mg divided by her/his body weight in kg.

Table 6: Definition of the secondary variables, part II

Variable	Explanation
Metamizole in total [mg/kg]	The total amount of metamizole the patient received, in addition to the PCA infusion, during the time of PCA usage in mg divided by her/his body weight in kg.
Piritramide in total [mg/kg]	The amount of piritramide the patient received in addition to the PCA infusion during the time of PCA usage in mg divided by her/his body weight in kg.
Neodolpasse® in total [ml/kg]	The total amount of Neodolpasse® the patient received during the time of PCA usage in ml divided by her/his body weight in kg. Neodolpasse® is a mixture of 30mg diclofenac and 12mg orfenadrine per 100ml.
Diclofenac in total [mg/kg]	The total amount of diclofenac the patient received per os during the time of PCA usage in mg divided by her/his body weight in kg.

Table 7: Definition of the secondary variables, part III

C.1.3 Statistics

Testing for normal distribution was performed using the Kolmogorov-Smirnov Test. Since this test revealed a non-normal distribution, the non-parametric Kruskal Wallis Test and post-hoc Mann Whitney U Test or for two groups only Mann Whitney U Test were performed for cardinal scaled data. For nominal data the Fisher Yates Test (henceforth referred to as Fisher's Exact Test) was performed. SPSS Statistics Version 19 was used to run all tests. Missing data were excluded case by case. Only significant data, which are defined as having a $p \leq 0.05$, are presented. The cardinal scaled data are presented as medians ± quartiles with box plot. Nominal data are presented in absolute terms (number of events) and relative frequencies (percentage of events).

C.1.3.1 The overall efficacy

The overall efficacy is presented in frequencies and median ± quartiles of all relevant variables. In addition, the demographic data of the patients are presented.

C.1.3.2 Differences according to PCA infusions

The variables were compared for significant differences according to PCA infusion.

The cardinal scaled variables that were compared are: *pain at rest, pain at strain, nausea & emesis ≤ 24 h, nausea & emesis > 24 h, intrahospital days*, *boli demanded* and *unsuccessful boli requests during the lockout interval.*

The analgesic, anti-emetic and sedating medication in addition to the PCA infusions were compared for significant differences between the two PCA infusions, each in total: *ondansetron, triazolam, diazepam, tramadol, metamizole, piritramide, Neodolpasse®* and *diclofenac.*

The nominal scaled variables that were compared are: *total pain relief, oxygen desaturation issue, absence of nausea & emesis ≤ 24 h, absence of nausea & emesis > 24 h, abdominal surgery* and *gender.*

C.1.3.3 Differences according to age

The following variables were compared for significant differences between the three age groups:

The cardinal scaled variables that were compared are: *pain at rest, nausea & emesis ≤ 24 h, nausea & emesis > 24 h*, *intrahospital days, boli demanded* and *unsuccessful boli requests during the lockout interval.*

For *pain at strain* only the age groups of 6-13 years old and 14-18 years old were analysed for significant differences, the reason being that for the age group of 0-5 years old no data has been collected for this variable.

The nominal scaled variables that were compared are: *total pain relief, oxygen desaturation issue, gender, PCA filling*, *absence of nausea & emesis ≤ 24 h* and *absence of nausea & emesis > 24 h*.

C.1.3.4 Differences according to gender

The variables were compared for significant differences between females and males. The cardinal scaled variables that were compared are: *pain at rest, pain at strain, nausea & emesis ≤ 24 h, nausea & emesis > 24 h, intrahospital days, boli demanded* and *unsuccessful boli requests during the lockout interval.*

The analgesic, anti-emetic and sedating medication in addition to the PCA infusions were compared for significant differences between females and males, each in total: *ondansetron, triazolam, diazepam, tramadol, metamizole, piritramide, Neodolpasse® and diclofenac.*

The compared nominal variables are: *total pain relief, oxygen desaturation issue, age group, PCA filling , absence of nausea & emesis ≤ 24 h* and *absence of nausea & emesis > 24 h.*

Patients with gender-related operations have been excluded.

C.1.3.5 Correlation between age and gender

Three subgroups of age were considered:

- age range from 0-5 years old
- age range from 6-13 years old
- age range from 14-18 years old.

In each subgroup the differences between females and males were analysed regarding the following variables. For this purpose gender-related operations were excluded. For the subgroup of 0-5 years old only 3 females and 4 males remained. Therefore for this subgroup only a nominal scaled analysis was performed.

The cardinal scaled variables that were compared are: *pain at rest, pain at strain*, *nausea & emesis ≤ 24 h, nausea & emesis > 24 h, intrahospital days, boli demanded* and *unsuccessful boli requests during the lockout interval.*
In view of the low population no cardinal scaled variables were analysed in the age group of 0-5 years.

The nominal scaled variables that were compared are: *total pain relief, oxygen desaturation issue, PCA filling, absence of nausea & emesis ≤ 24 h, absence of nausea & emesis > 24 h* and *abdominal surgery* .

The analgesic, anti-emetic and sedating medication in addition to the PCA infusions are, each in total: *ondansetron, triazolam, diazepam, tramadol, metamizole, piritramide, Neodolpasse*® and *diclofenac.*

C.1.3.6 Correlation between PCA infusion and gender

Two subgroups of PCA infusion are considered:

- Tramadol with metamizole
- Piritramide.

In each subgroup the differences between females and males (gender-related surgeries were excluded) were analysed regarding following variables.
The cardinal scaled variables that were compared are: *pain at rest, pain at strain, nausea & emesis ≤ 24 h, nausea & emesis > 24 h, intrahospital days, boli demanded* and *unsuccessful boli requests during the lockout interval.*

The nominal scaled variables that were compared are: *total pain relief, oxygen desaturation issue, absence of nausea & emesis ≤ 24 h* and *absence of nausea & emesis > 24 h.*

The analgesic, anti-emetic and sedating medication in addition to the PCA infusions are, each in total: *ondansetron, triazolam, diazepam, tramadol, metamizole, piritramide, Neodolpasse®* and *diclofenac.*

C.1.3.7 Differences according to the surgical field

The variables were compared for significant differences between abdominal surgery and non-abdominal surgery.

The cardinal scaled variables that were compared are: *pain at rest, pain at strain, nausea & emesis ≤ 24 h, nausea & emesis > 24 h, intrahospital days, boli demanded* and *unsuccessful boli requests during the lockout interval.*

The nominal scaled variables that were compared are: *total pain relief, oxygen desaturation issue, absence of nausea & emesis ≤ 24 h, absence of nausea & emesis > 24 h, PCA filling* and *gender.*

C.1.3.8 Differences according to occurrence of an oxygen desaturation issue

The variables were compared for significant differences between patients who reported an oxygen desaturation issue and patients who did not.

The cardinal scaled variables that were compared are: *triazolam in total, diazepam in total, tramadol in total, piritramide in total* and *days of intensive care.*
The nominal scaled variables that were compared are: b*enzodiazepine received* and *PCA filling.*

C.1.3.9 Nausea < 24 h post-operative influencing nausea > 24 h post-operative

Absence of nausea & emesis > 24 h post-operative and *nausea & emesis > 24 h post-operative* were compared for difference between Patients who had nausea & emesis in the first 24 hours after OP versus those who had none..

C.1.3.10 Differences according to duration of PCA

The data have been divided into two subgroups of PCA infusions:

- Tramadol / metamizole
- Piritramide.

For each group the difference in side effects between the duration of PCA pump treatment was analysed by comparing the nominal and cardinal scaled variables: *oxygen desaturation issue* and *absence of nausea & emesis > 24 h, benzodiazepine received,* and *days of intensive care.*

C.2 Results

C.2.1 Participants flow

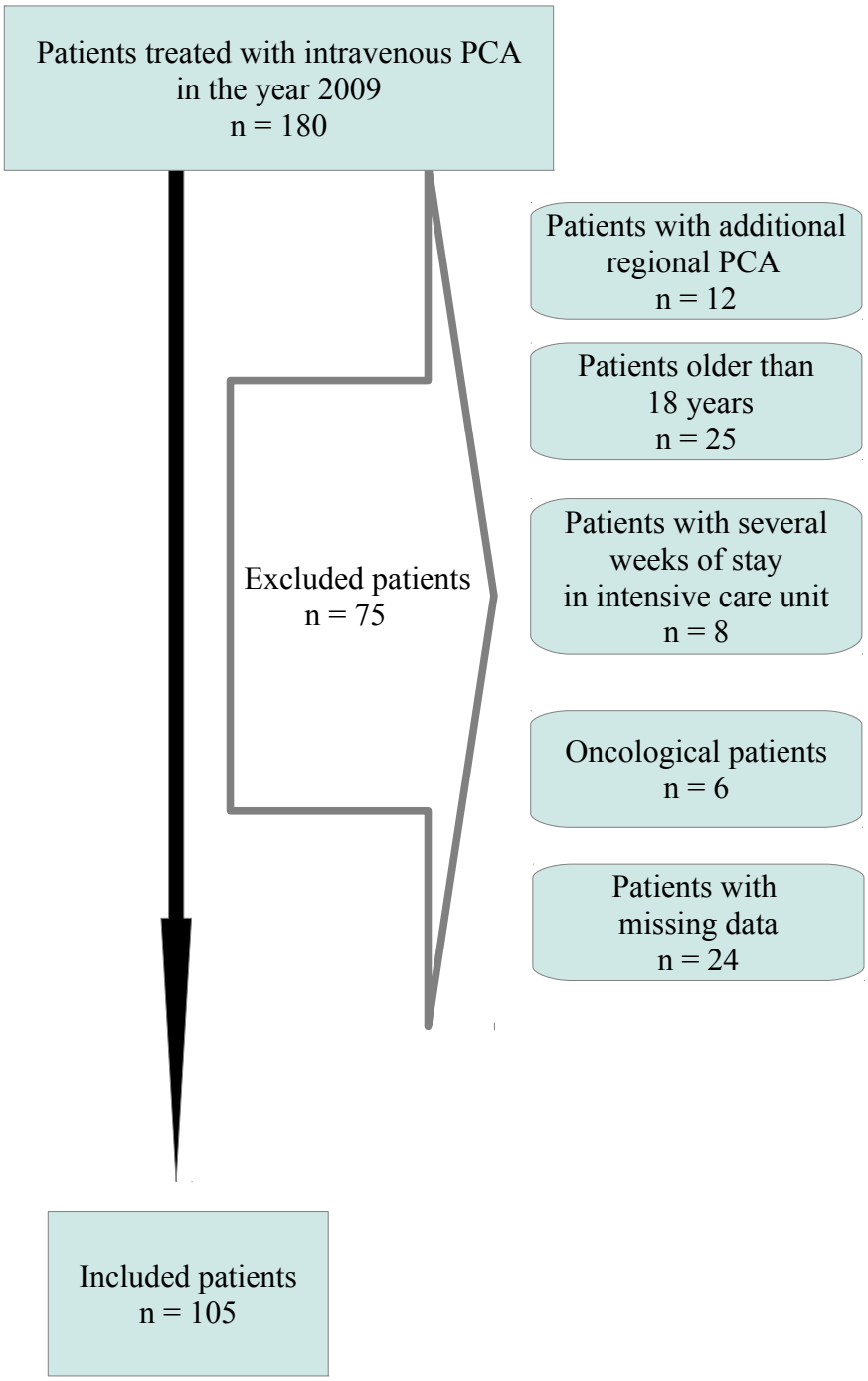

Figure 1: Flow chart of patients that were excluded

C.2.2 Overall outcome and demography

The following tables show the number of patients in each group and distribution amongst all patients.

	Number of Patients
Patients in total	105 (100%)
Age of 0-5 years	12 (11.4%)
Age of 6-13 years	44 (41.9%)
Age of 14-18 years	49 (46.7%)
Female	42 (40%)
Male	63 (60%)

Table 8: Demographic data of the study population

	Median ± quartiles
Nausea & emesis > 24 h	**0** (0 ; 0)
Days of intensive care	**0** (0 ; 0)
Ondansetron in total [mg/kg]	**0** (0 ; 0.13333)
Tramadol in total [mg/kg]	**0** (0 ; 0)
Diclofenac in total [mg/kg]	**0** (0 ; 0.76526)

*Table 9: Variables with **no** significant differences in the subgroups age, gender or PCA filling (median ± quartiles)*

	Number of Patients
Patients without nausea and/or emesis after the first 24 post-operative hours	81 (77.1%)
Patients with oxygen desaturation issue	8 (7.6%)
Patients with gender-related surgery	5 (4.8%)
Patients treated with ondansetron	52 (49.5%)
Patients treated with additional tramadol	3 (2.9%)
Patients treated with diclofenac p.o.	28 (26.7%)
Patients treated with benzodiazepine	9 (8.1%)
Patients treated with triazolam	6 (5.7%)
Patients treated with diazepam	3 (2.9%)

*Table 10: Treatment related distribution amongst all patients with **no** significant differences in the subgroups age, gender or PCA filling.*

C.2.3 Differences between tramadol / metamizole and piritramide PCA

There were **no** significant difference when comparing patients treated with tramadol / metamizole PCA to patients treated with piritramide PCA in the variables: *nausea & emesis ≤ 24 h, absence of nausea & emesis ≤ 24 h, nausea & emesis > 24 h, absence of nausea & emesis > 24 h, oxygen desaturation issue, intrahospital days, gender, ondansetron, triazolam, diazepam, tramadol* and *diclofenac.*

For the following variables were **significant** differences: *pain at rest* (p≤0.05)*, pain at strain* (p≤0.05)*, total pain relief* (p≤0.05)*, boli demanded* (p≤0.05)*, unsuccessful boli requests during the lockout interval* (p≤0.05)*, abdominal surgery* (p≤0.001)*, metamizole* (p≤0.001)*, piritramide* (p≤0.05) and *Neodolpasse®* (p≤0.001).

	Tramadol / metamizole n = 39	**Piritramide n = 66**
Pain at rest (CHIPPS, FPS-r)	**0** (0 ; 1)	**1** (0 ; 2)
Pain at strain[#] (CHIPPS, FPS-r)	**0** (0 ; 1)	**1** (0 , 3)
Boli demanded	**11** (6 ; 25)	**25** (6 ; 62)
Unsuccessful boli requests during the lockout interval	**1** (0 ; 3)	**2** (0 ; 12)
Piritramide in total [mg/kg]	**0** (0 ; 0.09574)	**0** (0 ; 0)
Metamizole in total [mg/kg]	**0** (0 ; 0)	**0** (0 ; 11.25)
Neodolpasse® in total [ml/kg]	**0** (0 ; 12.66)	**16.67** (5.79 ; 24.78)

Table 11: Variables with significant differences according to the PCA filling (Median ± quartiles). [#] =For pain at strain the total number of patients was n = 93 including n= 30 patients treated with tramadol / metamizole and n = 63 patients treated with piritramide PCA

	Tramadol / metamizole n = 39	**Piritramide n = 66**
Abdominal surgery “percentage of abdominal surgery”	22 (58%)	2 (3%)
Total pain relief	20 (52.3%)	21 (31.3%)

Table 12: Frequency of variables with significant differences according to the PCA filling

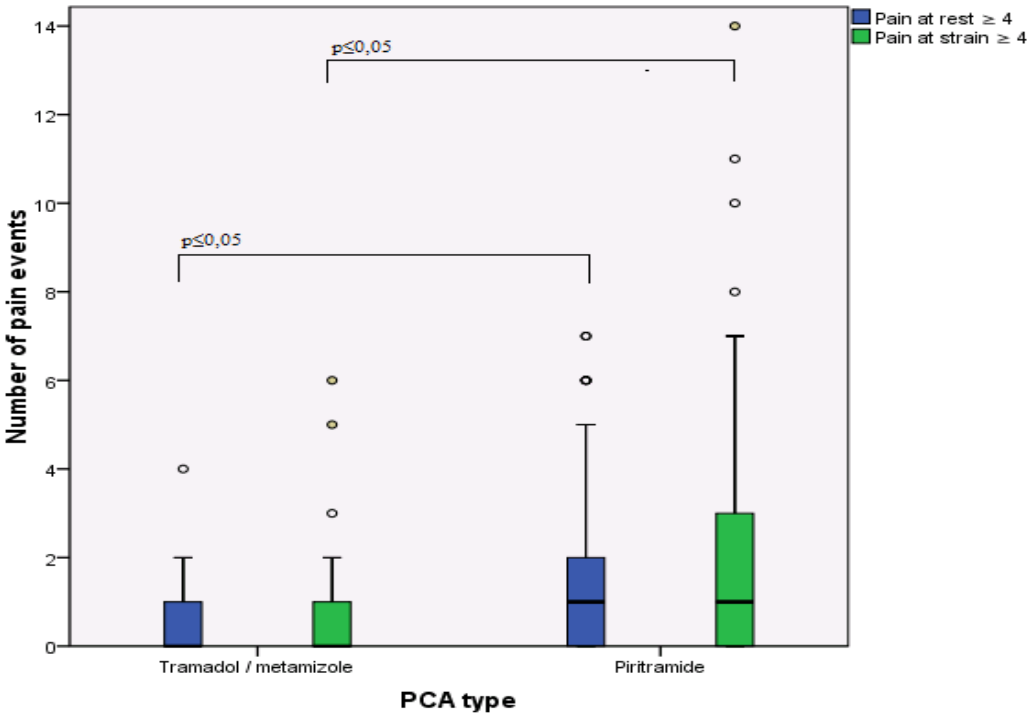

Figure 2: Number of pain events at rest and at strain for each group of PCA infusion. The significant different variables are marked with brackets and p-value. (box = 25-75 quartile, bold line = median, circle = outlier, bars = range)

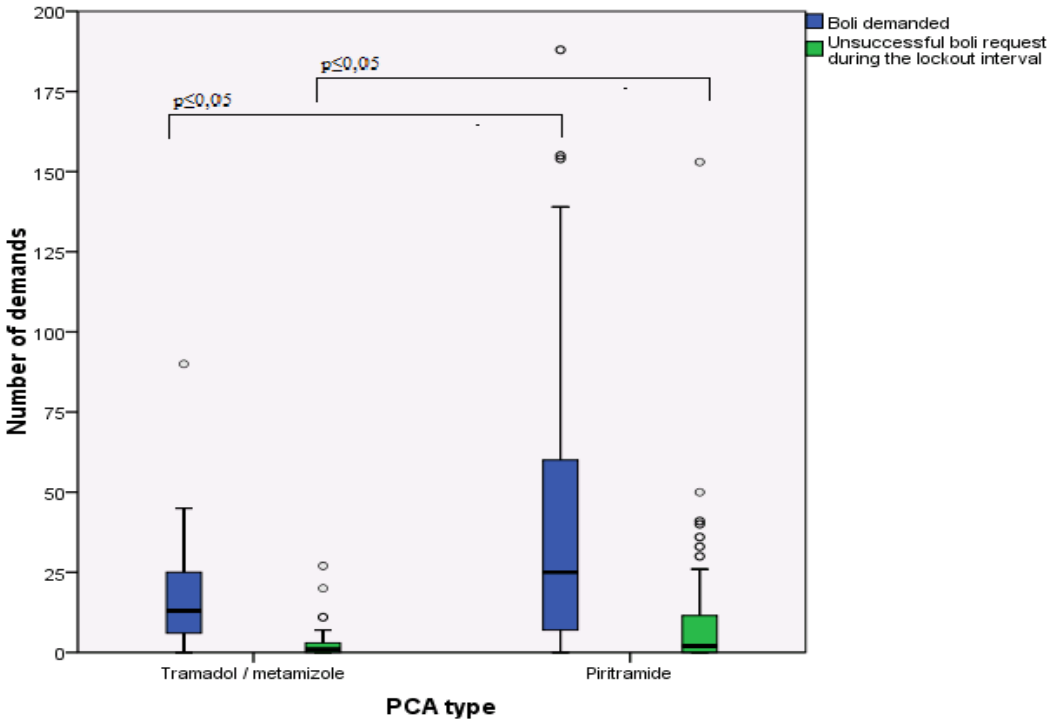

Figure 3: Boli demanded and unsuccessful boli requests during the lockout interval for each group of PCA infusion. The significant different variables are marked with brackets and p-value. (box = 25-75 quartile, bold line = median, circle = outlier, bars = range)

The number of abdominal surgeries was much higher in the tramadol / metamizole PCA infusion group. This is shown in the following chart. Moreover, it is shown that the percentage of patients with total pain relief is higher in the tramadol/ metamizole group than in the piritramide group.

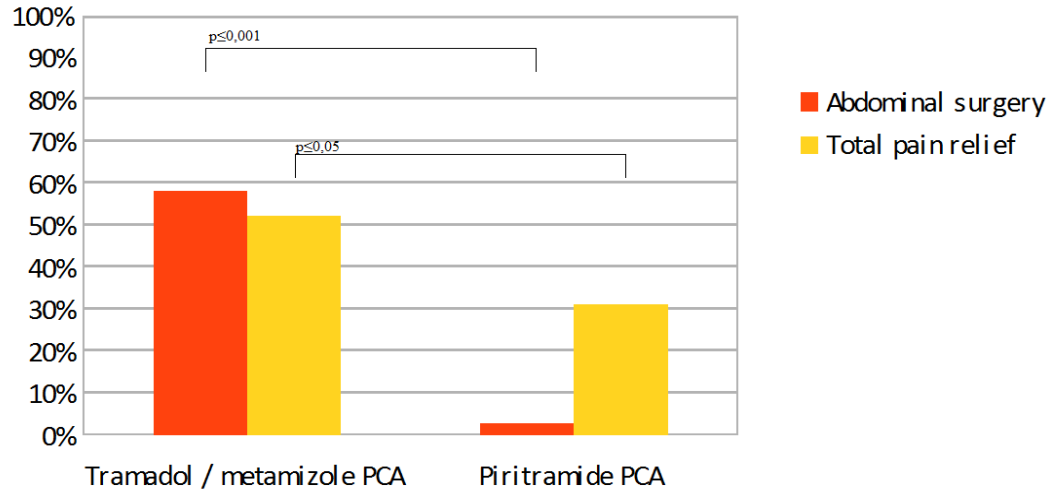

Figure 4: Distribution of abdominal surgery area and distribution of patients with total pain relief for each group of PCA infusion. The significant different variables are marked with brackets and p-value.

C.2.4 Differences according to age – results

From these data it can be concluded that there are **no** significant differences between the age groups in the variables: *pain at rest, pain at strain, nausea & emesis > 24 h, absence of nausea & emesis > 24 h, oxygen desaturation issue, intrahospital days, boli demanded* and *unsuccessful boli requests during the lockout interval,* and *gender*

However, there are **significant** differences according to the age groups in the *total pain relief* ($p \leq 0.01$), *absence of nausea & emesis ≤ 24 h* ($p \leq 0.01$), *nausea & emesis ≤ 24 h* ($p \leq 0.05$) and *PCA filling* ($p \leq 0.01$). The differences of the post hoc testing are marked in the charts below.

	0-5 years n = 12	**6-13 years n = 44**	**14-18 years n = 49**
Nausea & emesis ≤ 24 h	**0** (0 ; 0)	**1** (0 ; 2)	**0** (0 ; 1.5)

Table 13: Median ± quartiles of significant differences comparing age groups

	0-5 years n = 12	6-13 years n = 44	14-18 years n = 49
Total pain relief	9 of 12 (75%)	19 of 44 (43%)	13 of 49 (27%)
Absence of nausea & emesis ≤ 24 h	11 of 12 (92%)	20 of 44 (45%)	31 of 49 (63%)
PCA filling*	3 of 12 (25%)	26 of 44 (59%)	37 of 49 (76%)

*Table 14: Frequencies of the variables with significant differences comparing age groups. The total number of patients is n = 105. * The first number in each cell of the bottom row denotes the percentage of piritramide PCA*

The following box plot chart shows that the number of events of nausea and/or emesis in the first post-operative 24 hours regarding each age group. The highest number of events occurred in the age group of 6-13 years old and the fewest events have been reported in the age group of 0-5 years old with significant difference between these both groups.

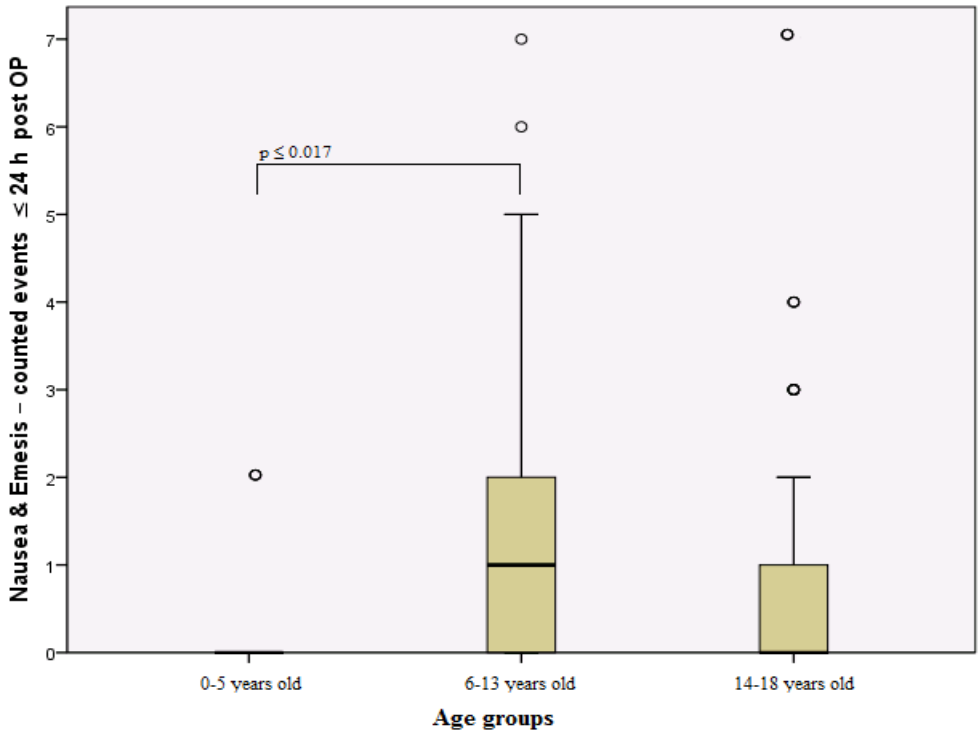

Figure 5: Number of events of nausea and/or emesis in the first 24 post-operative hours with significant difference for the age group 0-5 years and the age group 6-13 years (box = 25% - 75% quartile, bold line = median, circle = outlier, bars = range).

The following chart shows the distribution of patients with total pain relief. The percentage of patients with total pain relief and the patients treated with tramadol / metamizole PCA decreases with age and have significant differences between the age group 0-5 years old and the age group 14-18 years old. The percentage of patients with absence of nausea & emesis in the first 24 post-operative hours is the highest in the age group of 0-5 years old and the lowest in the age group of 6-13 years old, whilst they show significant difference between in these both age groups.

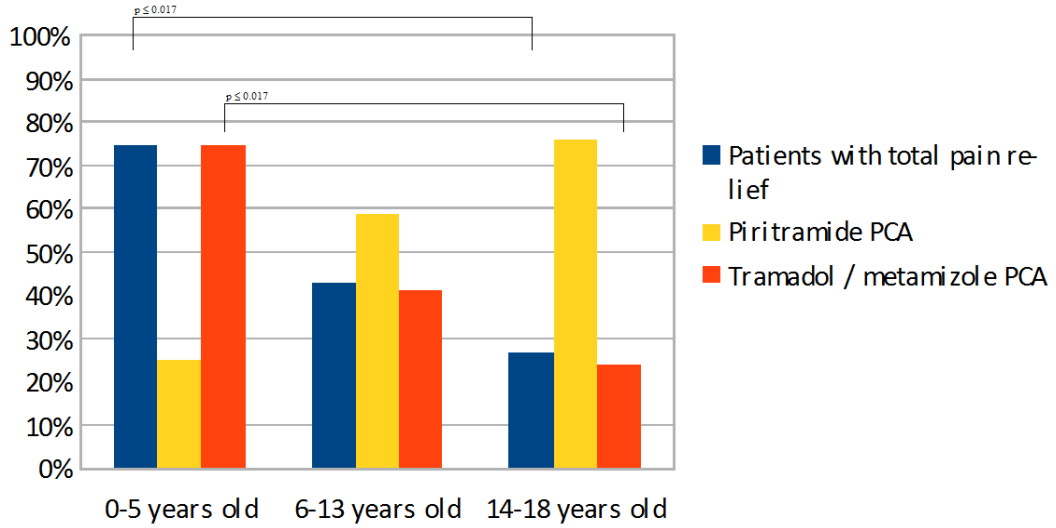

Figure 6: The variables total pain relief and PCA filling with significant differences between the age group of 0-5 years old and the age group of 14-18 years old.

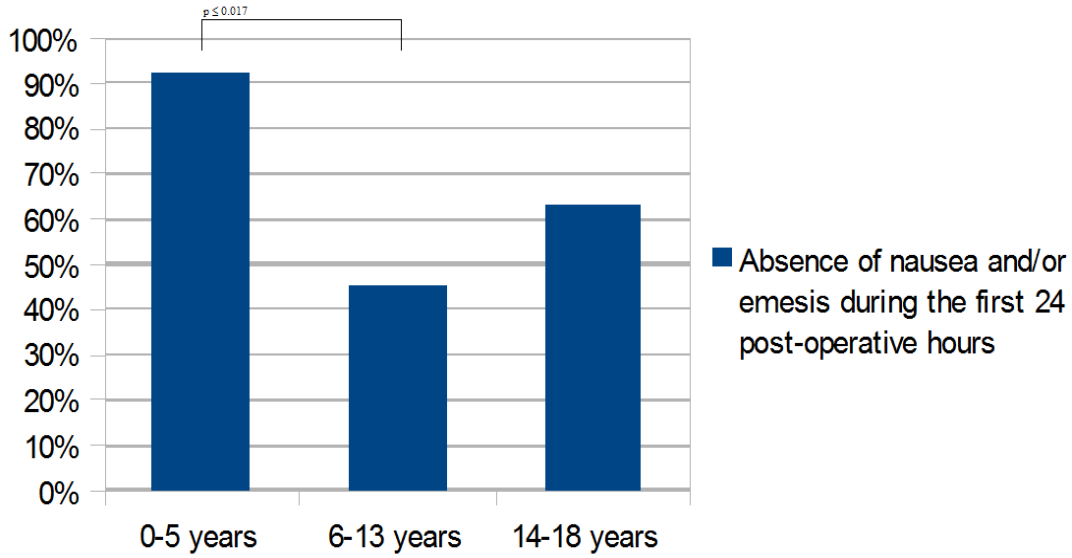

Figure 7: The variable absence of nausea & emesis ≤ 24 h post-operative shows significant differences between the age group of 0-5 years old and the age group of 6-13 years old.

C.2.5 Gender related differences – results

The chapters C.2.5 to C.2.10 all present results obtained by comparing females and males. The gender differences in the overall population are considered in chapter C.2.5. The chapters C.2.6 to C.2.8 present results focusing on the gender differences in each age group, which results are different from the results of the whole population. Chapters C.2.9and C.2.10 show the gender differences of those treated with tramadol / metamizole PCA and those treated with piritramide PCA, respectively.

After excluding the gender-related surgery the total number of patients were n = 100 for the chapters concerning gender differences.

In these data there are **no** significant differences between females and males in the variables: *pain at rest, pain at strain, nausea & emesis ≤ 24 h, absence of nausea & emesis ≤ 24 h, nausea & emesis > 24 h, absence of nausea & emesis > 24 h, oxygen desaturation issue, boli demanded, unsuccessful boli requests during the lockout interval, PCA filling, age group* and the variables relating to additional medication.

For *pain at strain* the total number of patients was n = 93 with n = 38 females and n = 55 males, the reason being that for the age group of 0-5 years old no data has been collected for this variable.

If all patients in the age of 0≤18 years are considered only the *intrahospital days* (p ≤0.05) have shown a **significant** difference according to gender. Females (n = 38) stayed in median **8** days and males (n = 55) in median **9** days, see the following box plot chart.

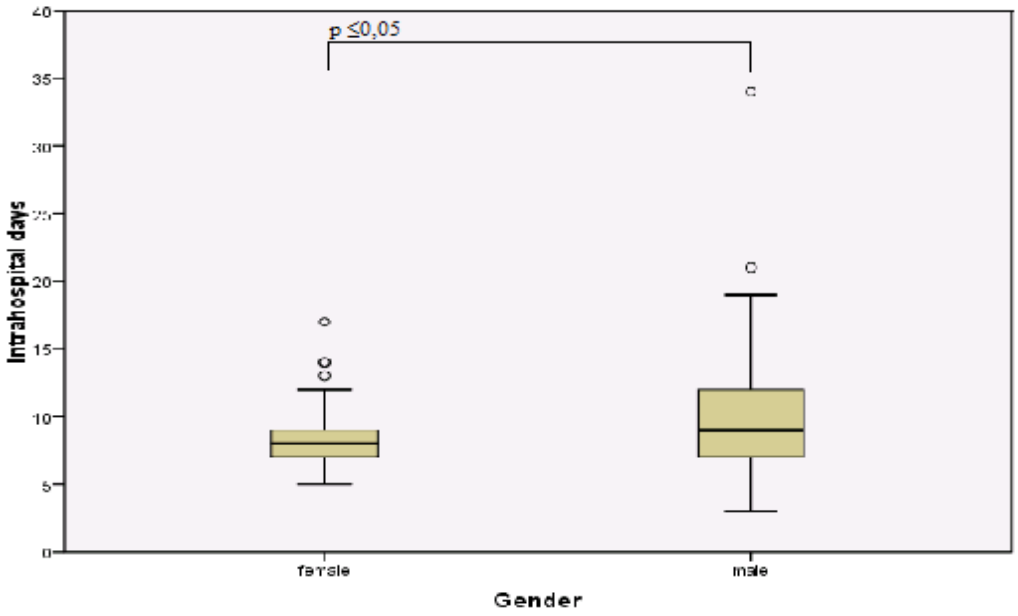

Figure 8: Intrahospital days with significant difference according to gender (box = 25-75 quartile, bold line = median, circle = outlier, bars = range)

C.2.6 Differences according to gender – age of 0-5 years

This chapter presents the differences of females and males in the age of 0-5 years.

Oxygen desaturation issue, PCA filling, absence of nausea & emesis ≤ 24 h , absence of nausea & emesis > 24 h and *abdominal surgery* showed **no** significant differences in patients in the age of 0-5 years according to their gender.

The variable *total pain relief* (p≤0.05) showed a **significant** difference according to gender, however the **low** population has to be taken into account! Only 3 females were compared with 4 males!

	Female n = 3	**Male n = 4**
Total pain relief	0 of 3	4 of 4

Table 15: Frequency of total pain relief of patients in the age group of 0-5 years according to gender. The total number of patients is n = 7 including 3 females and 4 males.

C.2.7 Differences according to gender – age of 6-13 years

This chapter presents the differences of females and males in the age of 6-13 years. Females and males in the age of 6-13 years showed no significant differences in the following variables according to gender: *pain at rest pain at strain, total pain relief, nausea & emesis ≤ 24 h, absence of nausea & emesis ≤ 24 h, oxygen desaturation issue boli demanded* and *unsuccessful boli requests during the lockout interval, PCA filling, abdominal surgery* and the *extra medication.*

Furthermore in this subgroup there are **significant** differences in *nausea & emesis > 24 h* ($p \leq 0.05$), *absence of nausea & emesis >24 h* ($p \leq 0.05$) and *intrahospital days* ($p \leq 0.05$).

	Female n = 19	**Male n = 25**
Nausea & emesis > 24 h	**0** (0 ; 0)	**0** (0 ; 1.5)
Intrahospital days	**7** (6 ; 9)	**9** (7 ; 12)

Table 16: Variables with significant differences in patients of the age group from 6-13 years old according to gender (median ± quartiles)

	Female n = 19	**Male n = 25**
Absence of nausea & emesis > 24 h	17 of 19 (89%)	14 of 25 (56%)

Table 17: Frequency of absence of nausea & emesis > 24 h of 6-13 year old patients with significant differences according to gender. The total number of patients is n= 44 including 19 females and 25 males

In the following two box plot, it is shown that males in the age range of 6-13 years stayed longer in the hospital and more often had events of nausea after the first 24 post-operative hours than females.

Figure 9: Intrahospital days with significant difference according to gender for the subgroup 6-13 years old (box = 25% - 75% quartile, bold line = median, circle = outlier, bars = range)

Figure 10: Number of events of nausea and/or emesis after the first 24 post-operative hours with significant difference according to gender for the subgroup of 6-13 years old (box = 25%-75% quartile, bold line = median, circle = outlier, bars = range).

As shown in the following chart, females of the age group 6-13 years more often experience no episode of nausea after the first 24 post-operative hours.

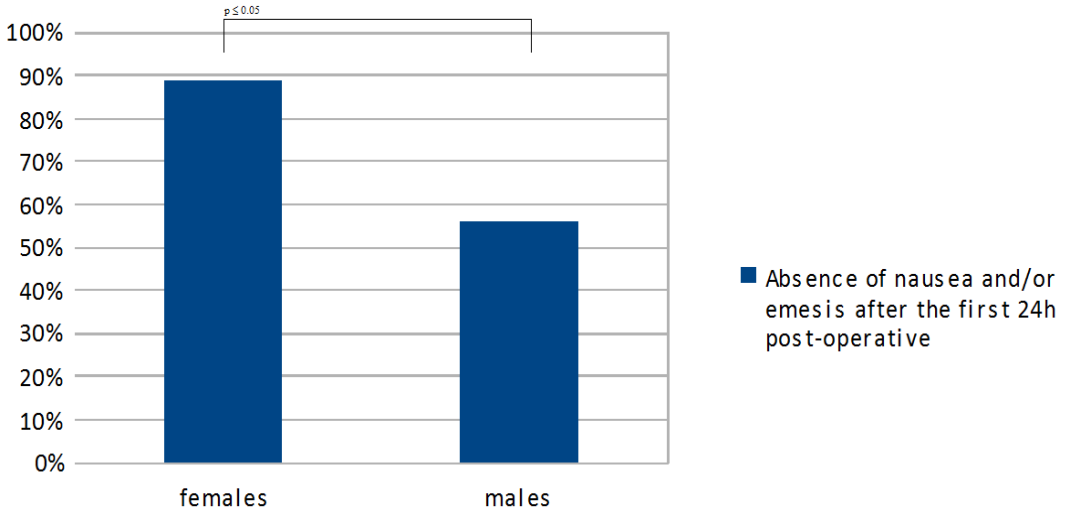

Figure 11: Absence of nausea and/or emesis after the first 24 post-operative hours with significant differences according to gender for the subgroup of 6-13 years olds

C.2.8 Differences according to gender – age of 14-18 years

The females and males in the age of 14-18 years showed **no** significant differences in the following variables according to gender: *pain at rest, pain at strain, total pain relief, nausea & emesis > 24 h , oxygen desaturation issue, boli demanded, unsuccessful boli requests during the lockout interval* and *intrahospital days, PCA filling, abdominal surgery* and the *variables relating to additional medication.*

Furthermore, in this subgroup there was *a **significant** difference in nausea & emesis ≤ 24 h* (p≤0.05)*, absence of nausea & emesis ≤ 24 h* (p≤0.05) and *absence of nausea & emesis > 24 h* (p≤0.05).

	Female n = 19	**Male n = 30**
Nausea & emesis ≤ 24 h	0 / **1** / 3	0 / **0** / 0.25

Table 18: Variable of 14 to 18 years old patients with significant differences according to gender (median ± quartiles)

	Female n = 19	**Male n = 30**
Absence of nausea & emesis ≤ 24 h	8 of 19 (42%)	23 of 30 (77%)
Absence of nausea & emesis > 24 h	12 of 19 (63%)	27 of 30 (90%)

Table 19: Frequency of variables of 14-18 years old patients with significant differences according to gender. The total number of patients is n =49 including 19 females and 30 males

In the following box plot, it is shown that females in the age of 14-18 have more often nausea events in the first 24 hours after surgery than males of the same age.

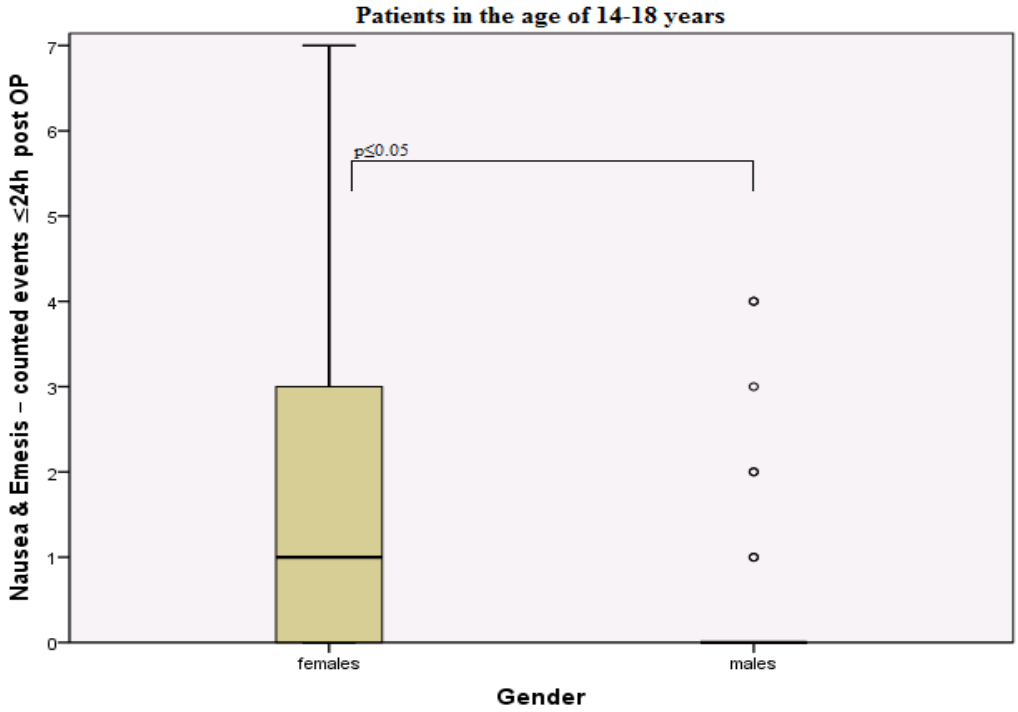

Figure 12: Number of events of nausea and/or emesis in the first 24 post-operative hours with significant difference according to gender for the subgroup of 14-18 years old (box = 25-75 quartile, bold line = median, circle = outlier, bars = range).

As shown in the following chart, males in the age of 14-18 years are more often free of nausea & emesis in the first 24 hours after operation and afterwards compared to females in the same age range.

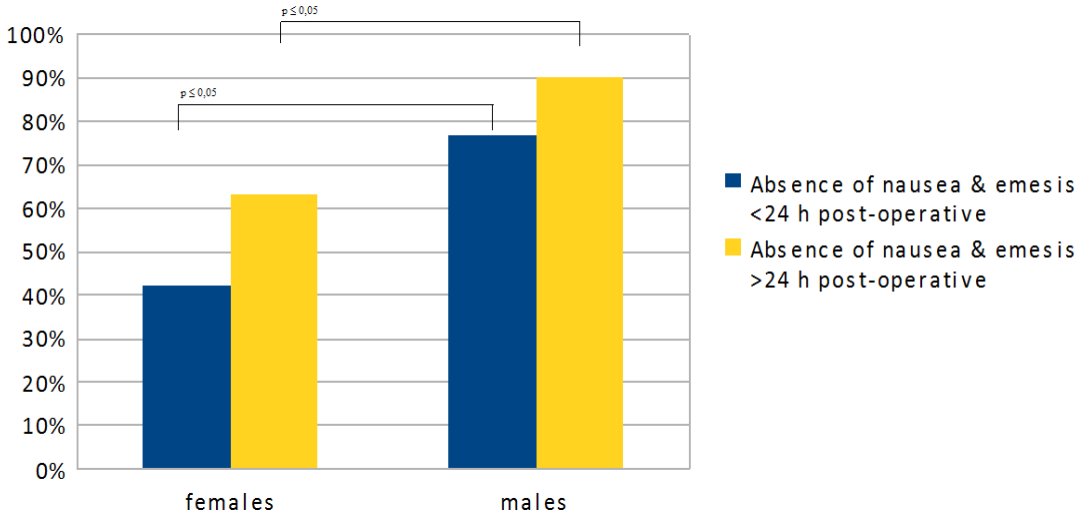

Figure 13: Absence of nausea and/or emesis in and after the 24 post-operative hours, respectively, with significant differences according to gender for the subgroup of 14-18 years old patients

C.2.9 Tramadol / metamizole PCA - differences according to gender

The number of patients treated with tramadol / metamizole PCA was in total n = 36. Those with gender related surgery were excluded. For *pain at strain* the total number of patients was n = 30 with n = 15 females and n = 15 males, the reason being that for the age group of 0-5 years old no data has been collected for this variable.

For *pain at rest, pain at strain, total pain relief, nausea & emesis ≤ 24 h, absence of nausea & emesis ≤ 24 h, nausea & emesis > 24 h, absence of nausea & emesis > 24 h, oxygen desaturation issue, boli demanded* and *unsuccessful boli requests during the lockout interval, ondansetron, triazolam, diazepam, tramadol, metamizole, Neodolpasse®* and *diclofenac* there were **no** significant differences between females and males having received a tramadol / metamizole infusion.

Piritramide in total ($p \leq 0.01$), which only contains additional piritramide given as rescue medication and no piritramide given by the piritramide PCA (see table 7), showed a **significant** difference when comparing females to males having received a tramadol/metamizole PCA infusion. *Intrahospital days* ($p = 0.055$) showed a **non-**significant tendency of difference.

n = 36	**Female n = 18**	**Male n = 18**
Intrahospital days[#]	**7** (6.75 ; 9)[#]	**9.5** (7 ; 14)[#]
Piritramide in total	**0.08585** (0 ; 0.12434)	**0.0** (0.0 ; 0.0)

Table 20: Median ± quartiles of variables of patient treated with tramadol / metamizole with significant differences according to gender, #= no significant difference according to gender!

The following box plot shows that females, who received the tramadol / metamizole infusion, were given more additional piritramide during the time they used a PCA pump than males.

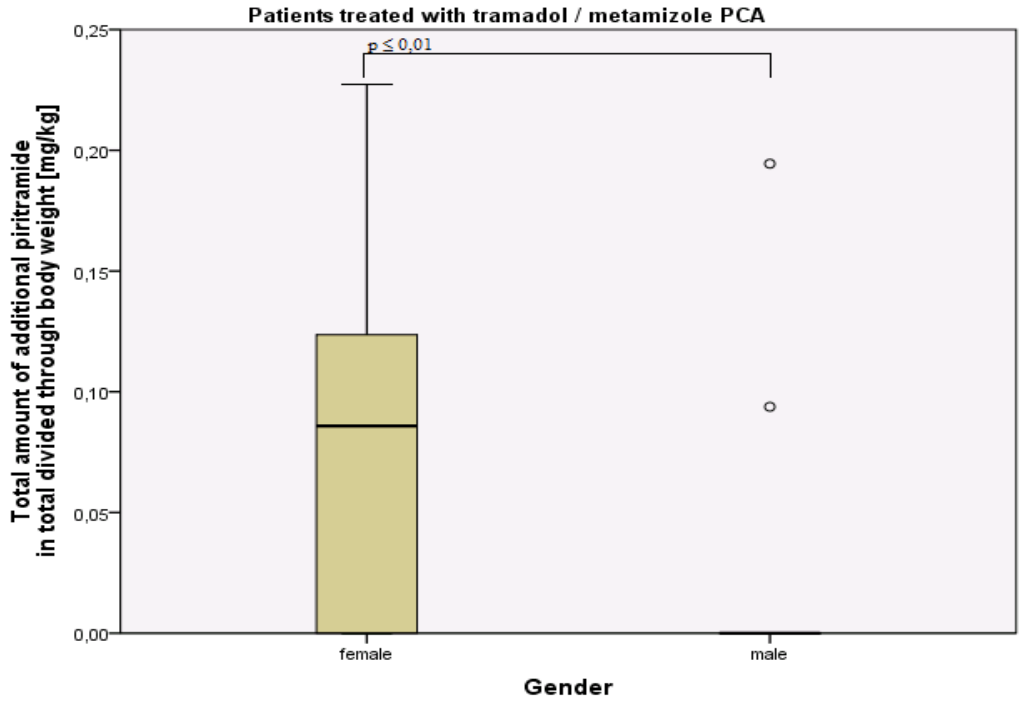

Figure 14: Patients treated with tramadol / metamizole PCA given extra piritramide with significant difference according to gender
(box = 25-75 quartile, bold line = median, circle = outlier, bars = range)

C.2.10 Piritramide PCA - differences according to gender

The number of patients treated with piritramide PCA was in total n = 64. Those with gender related surgery were excluded. For *pain at strain* the total number of this patients was n = 63 with n = 23 females and n = 40 males, the reason being that for the age group of 0-5 years old no data has been collected for this variable.

For *pain at strain total pain relief, nausea & emesis ≤ 24 h, absence of nausea & emesis ≤ 24 h, nausea & emesis > 24 h, absence of nausea & emesis > 24 h, oxygen desaturation issue, intrahospital days, boli demanded* and *unsuccessful boli requests during the lockout interval* and the *variables relating to additional medication* there were **no** significant differences according to gender within the data of patients having received a piritramide infusion.

In this subgroup *pain at rest* ($p \leq 0.05$) showed **significant** differences between females (n = 23) and males (n = 40). 75% of the female patients reported ≤ **5** pain events and 75% of the male patients ≤ **1.5** pain events, which is shown in the following box plot chart.

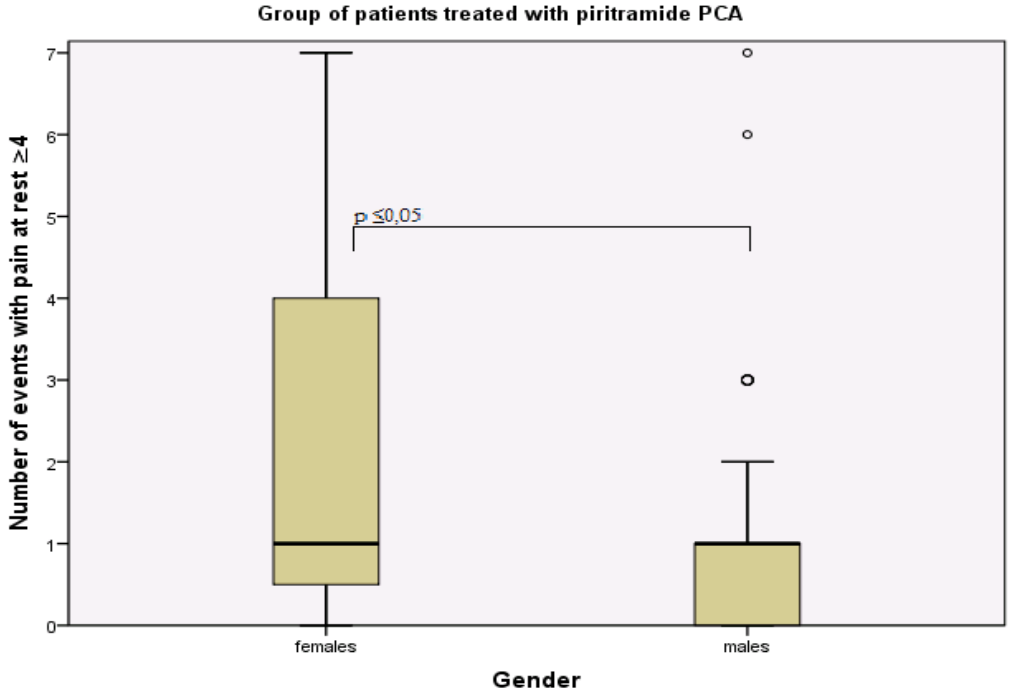

Figure 15: Number of events of pain at rest for patients treated with piritramide PCA with significant difference according to gender
(box = 25-75 quartile, bold line = median, circle = outlier,bars = range).

C.2.11 Differences between abdominal surgery and non-abdominal - results

Pain at rest, pain at strain, *nausea & emesis ≤ 24 h, nausea & emesis > 24 h, intrahospital days, boli demanded, unsuccessful boli requests during the lockout interval, total pain relief, oxygen desaturation issue, absence of nausea & emesis ≤ 24 h, absence of nausea & emesis > 24 h* and *gender* all showed **no** significant differences according to abdominal surgery.

For *pain at strain* the total number of patients was n = 93 with n = 20 patients with abdominal surgery and n = 73 patients with non-abdominal surgery, the reason being that for the age group of 0-5 years old no data has been collected for this variable.

The only variable that showed **significant** difference is the *PCA filling* ($p \leq 0.001$). On one hand **8**% of patients with an abdominal surgery received a piritramide PCA and **80**% of the patients with a non-abdominal surgery were treated with a piritramide PCA. On the other hand **92**% of patients with an abdominal surgery received a tramadol / metamizole PCA and **20**% of the patients with a non-abdominal surgery were treated with a tramadol / metamizole PCA.

C.2.12 Differences according to occurrence of an oxygen desaturation issue

There was **no** significant difference between the groups in occurrence or absence of an oxygen desaturation issue in *diazepam in total, piritramide in total* which only contains additional piritramide given as rescue medication and no piritramide given by the piritramide (see table 7) and *PCA filling*.

Triazolam in total ($p \leq 0.05$), *days of intensive car*e ($p \leq 0.001$) and *benzodiazepine received* ($p \leq 0.05$) showed a **significant** differences.
Benzodiazepine received included patients treated with triazolam and patients treated with diazepam (see table 6) and denote the number of patients receiving a benzodiazepine treatment. *Triazolam in total* and *diazepam in total* are cardinal scaled variables and denote the total amount of the named drug, which each patient received, divided through the body-weight of the patient.

Therefore *benzodiazepine received* presents a frequency of a treatment and *triazolam in total* and *diazepam in total* present how much the patients received of the specific drug during the whole treatment.

	Without O2 issue	**With O2 issue**
Triazolam in total	**0** (0 ; 0)	**0** (0 ; 0.00298)
Days of intensive care	**0** (0 ; 0)	**3.5** (0 **;** 4.25)

Table 21: Variables with significant differences according to the occurrence of an oxygen desaturation issue (median ± quartiles)

	Benzodiazepine received	**Without benzodiazepine**
Oxygen desaturation issue	3 of 9 (33.3%)	5 of 96 (5.20%)

Table 22: Distribution of patients with oxygen desaturation issue with significant difference according to the occurrence of benzodiazepine treatment. The total number of patients is n = 105

As shown in the following two box plot charts, it can be seen that the group of patients with an oxygen desaturation issue received more triazolam and stayed longer in intensive care.

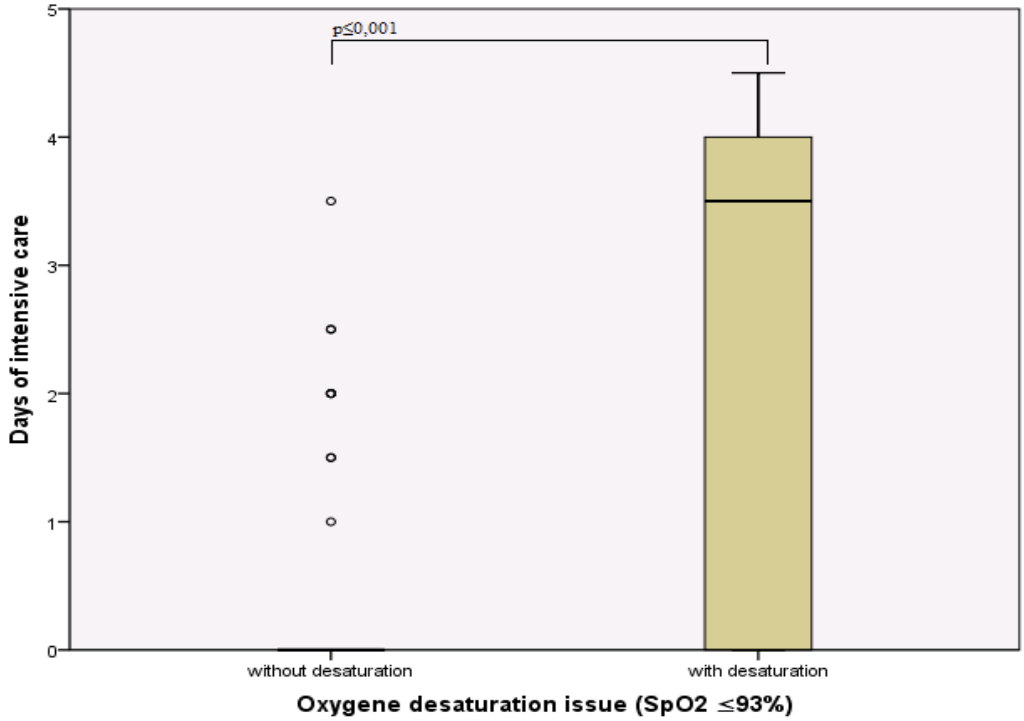

Figure 16: Oxygen desaturation issue in relation to days of intensive care (box = 25-75 quartile, bold line = median, circle = outlier, bars = range)

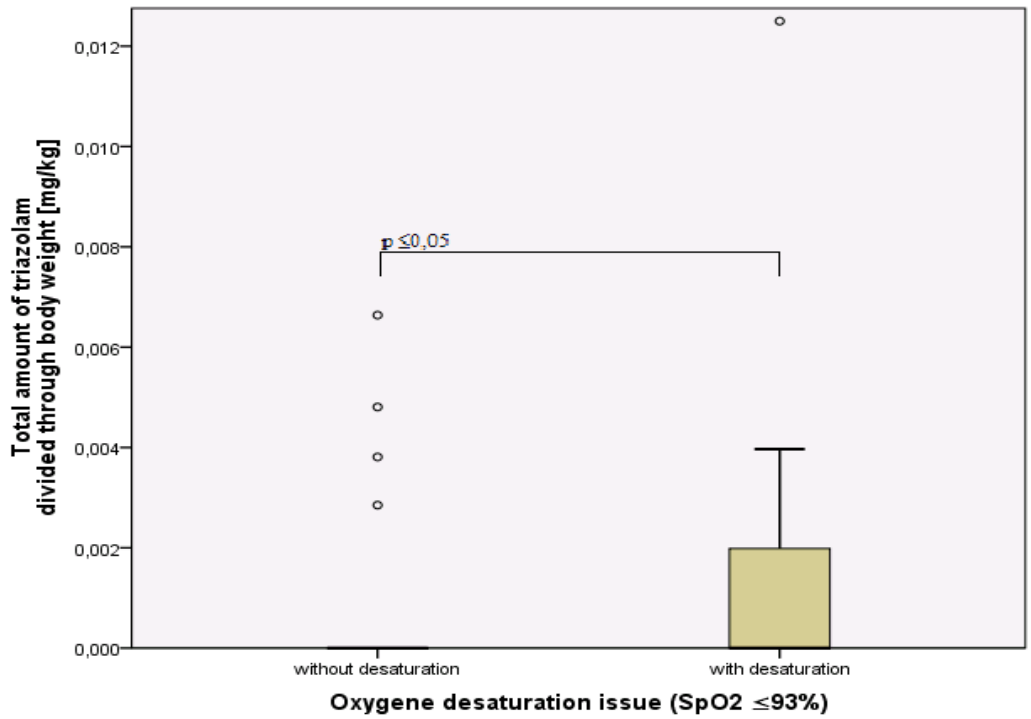

Figure 17: Oxygen desaturation issue in relation to the total amount of triazolam expressed in [mg/kg] (box = 25-75 quartile, bold line = median, circle = outlier, bars = range)

The following bar chart shows that in the group with benzodiazepine treatment are more patients with oxygen desaturation issue. As explained before the group with benzodiazepine treatment denotes only how many patients the treatment received not how much drug the patient received.

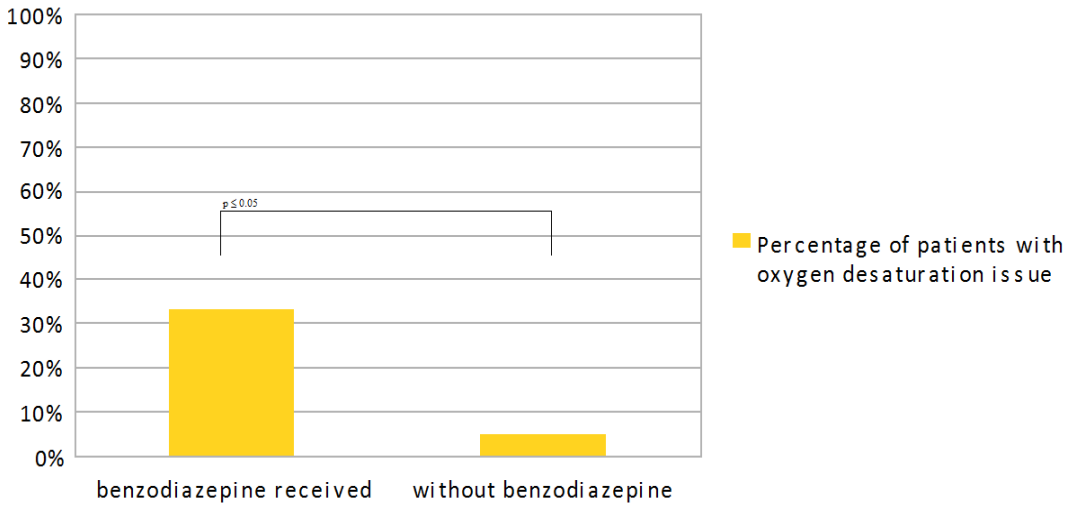

Figure 18: Distribution of patients with oxygen desaturation issue for patients who received or did not receive benzodiazepine, respectively

C.2.13 Nausea < 24 h post-operative influencing nausea > 24 h

Both *absence of nausea & emesis > 24 h*(p≤0.001) and *nausea & emesis > 24 h (*p≤0.001)showed **significant** differences regarding the group which reported nausea or emesis in the first 24 post-operative hours versus the group, which didn't report any.

75% of the patients with nausea and/or emesis in the first 24 post-operative hours reported below or equal to **1** event of nausea and/or emesis afterwards and at least 75% patients without nausea and/or emesis in the first 24 post-operative hours reported **zero** events of nausea afterwards.

60% of the patients with nausea and/or emesis in the first 24 post-operative hours and **89%** of the patients without nausea and/or emesis in the first 24 post-operative hours were completely free of nausea and/or emesis afterwards, which are shown in the following two charts.

Figure 19: Number of events of nausea and/or emesis after the first 24 post-operative hours for patients who reported nausea and/or emesis in the first 24 post-operative hours and patients who did not (box = 25-75 quartile, bold line = median, circle = outlier, bars = range).

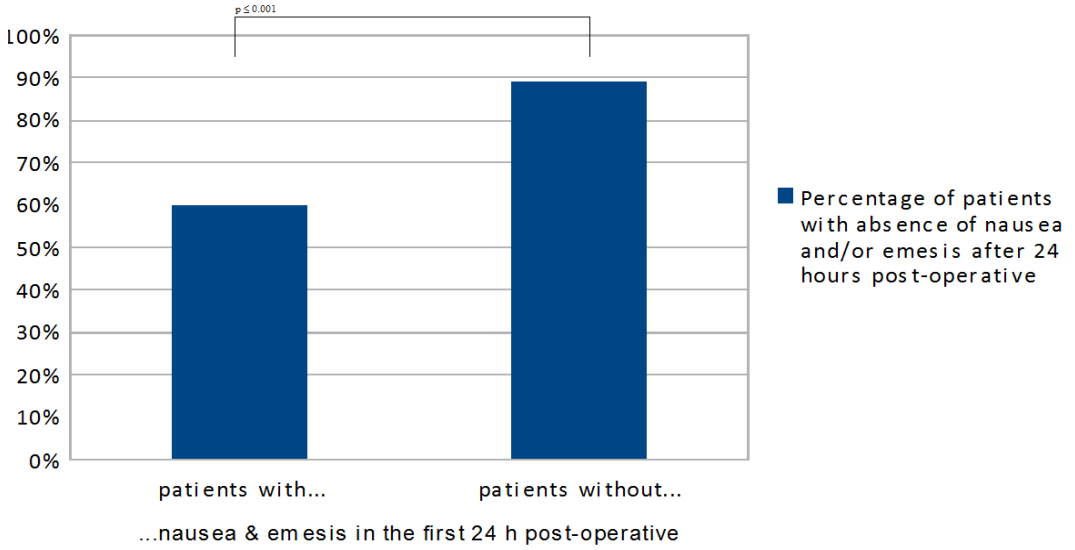

Figure 20: Percentage of patients with absence of nausea and/or emesis after 24 post-operative hours of patients who reported nausea and/or emesis in the first 24 post-operative hours and of patients who did not

All in all the patients with nausea and/or emesis in the first 24 h post-operative (PONV) are more likely to report again nausea and/or emesis after this first 24 h.

C.2.14 Differences according to duration of PCA pump treatment

C.2.14.1 Subgroup tramadol/metamizole PCA infusion

There was **no** significant difference in the group of tramadol / metamizole PCA infusion according to the number of days for which patients were given the PCA treatment, as far as the following variables were concerned: *absence of nausea & emesis > 24 h, benzodiazepine received* and *days of intensive care.*

However there was a **significant** difference regarding the *oxygen desaturation issue* ($p \leq 0.003$). It has to be mentioned that there were no patients with a tramadol / metamizole PCA treatment over 7 days or under 2 days in the data set.

Length of PCA usage	2 days	3 days	4 days	5 days	6 days	7 days
Oxygen desaturation issue	0 of 5	0 of 8	0 of 10	0 of 9	1 of 4 (25%)	2 of 3 (67%)

Table 23: The distribution of patients with at least once oxygen desaturation issue according to the maximum duration of the tramadol / metamizole PCA pump treatment

The following chart shows that the patients who received the tramadol / metamizole PCA treatment for 7 days more often complained about an oxygen desaturation issue during this 7 days than patients with a treatment duration of 4 or 5 days during 4 or 5, respectively.

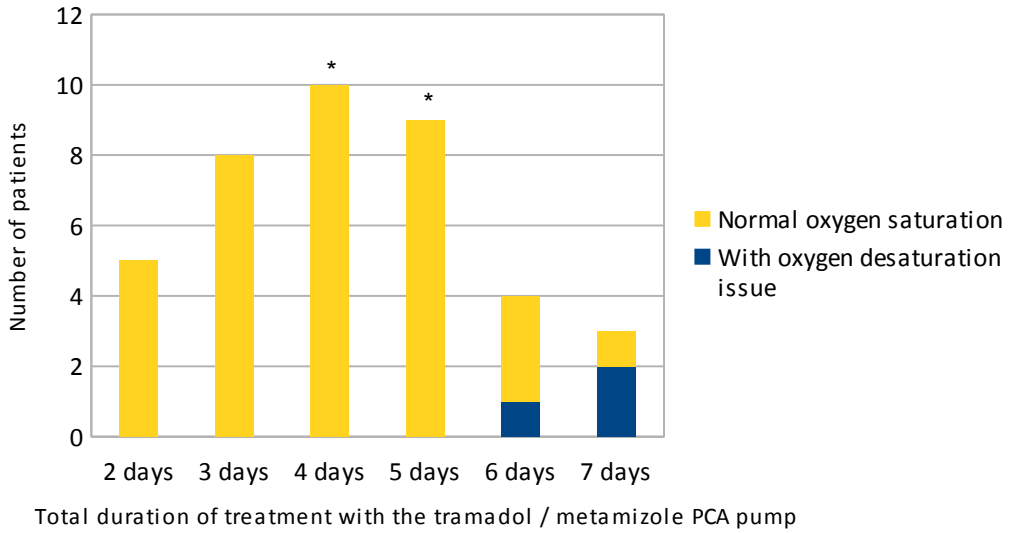

*Figure 21: Distribution of patients with oxygen desaturation issue according to the duration of the tramadol / metamizole PCA treatment The total number of patients is n = 39. * = significant difference to the group of 7 days*

C.2.14.2 Subgroup piritramide PCA infusion

There was **no** significant difference in the group receiving piritramide PCA infusion according to different numbers of days, the PCA treatment was provided, regarding following variables: oxygen desaturation issue, *absence of nausea & emesis > 24 h, benzodiazepine received* and *days of intensive care*.

D Discussion

This thesis showed among others that paediatric PCA is an effective post-operative pain control with a low incidence of oxygen desaturation and that patients with nausea and/or emesis during the first 24 post-operative hours (PONV) are high risk patients for nausea and/or emesis after these 24 hours.

D.1 Overall efficacy

During the whole treatment 75% of the patients in the age 0-5 years, 43% of the patients in the age of 6-13 years and 23% of the patients in the age of 14-18 years reported pain less or equal to 3 points on the pain scale both at rest and at strain, this level of pain was defined as total pain relief. In addition, 8.3% of our patients in the age of 0-5 years, 45.5% of our patients in the age of 6-13 years and 59.2% of our patients in the age of 14-18 years had occasionally pain scores higher than 3 points, but did not demand any rescue medication. When the pain was higher or equal to 4 points, the patients were again advised to press the demand button twice. Although all patients had been instructed at least twice prior to the operation how to use the PCA-pump, some of them hesitated to press the button repeatedly. This may explain the fact that they had intermittent pain scores of 4 or higher, although in the end they did have a proper pain relief with PCA only. When the procedure did not succeed in controlling the pain, the patient was offered a rescue analgesic drug. Patients without rescue medication did only receive PCA as pain treatment, can be considered as a successful treatment responder. Taking this into account, i.e. adding up therefore mentioned percentages 83.3% of the patients in the age of 0-5 years, 88.5% of the patients in the age of 6-13 years and 82.2% of the patients in the age of 14-18 years responded to PCA.

Dolin et al. found in review of 45 studies using conventional post-operative pain control and 75 studies using PCA post-operative pain control, that for conventional pain management, on average, 32.8% of the patients experienced pain at rest which was always at a level of less or equal to 3 points on the pain scale. [18]
Similarly, 22% of the patients experienced pain 'on movement' which was always at a level of less or equal to 3 on the pain scale. However, it has to be noted that for pain on movement only one study was reviewed for conventional pain control.
In contrast, for PCA pain management Dolin et al. found that, on average, 64.2% of patients experienced pain at rest which was always less or equal to 3 points on the pain scale and that 75% of the patients experienced pain 'on movement' which was always at a level of less or equal to 3 on the pain scale.[18]

Zafar et al. reported that 90.8% patients older than 16 years and treated with PCA having pain at rest less or equal to 3 points on the pain scale and that 83% of the patients experienced pain 'on movement' which was always at a level of less than or equal to 3 on the pain scale. and 83% of the patients on movement.[19]

In view of these two studies, it seems that the total pain relief of the PCA treatment of the data set “Graz 2009” is superior to conventional post-operative pain control and inferior to published PCA post-operative pain management results. However, it has to be noted that Zafar et al. and Dolin et al. also included adult patients. Zafar et al. excluded patients with emergency surgery, who were, however, included in the data set “Graz 2009”. And in addition when concerning the successful treatment response the results are similar to the total pain relief in the literature.
Focusing on our patients in the age of 0-5 years 75% of them had total pain relief and 83.3% of them were treatment responder. This result is similar to the PCA treatment results published in the literature and is also similar to the results obtain by Monitto et al. who reported 80% patients under 6 years old having pain less or equal to 3 points on the pain scale.[20]

8% of our patients in the age of 0-5 years, 55% of the patients in the age of 6-13 years and 37% of the patients in the age of 14-18 years had nausea and/or emesis during the first 24 post-operative hours and 22.9 % of all our patients after the first 24 post-operative hours.

Walder et al. reviewed ten studies comparing PCA with conventional pain management and found no significant difference regarding the average occurrence of nausea and/or vomiting which about 31% of the patients experienced in both cases.[21] Two other studies reported corresponding figures of about 28% and 47.6%, respectively.[19, 22] Murphy et al. distinguished between treatment with tramadol PCA and other opioid PCAs for which the figures were 37% and 30%, respectively.[23] Our results seem to be comparable to this wide range of occurrences of nausea and/or emesis.

The patients in the age group 6-13 years normally have a higher risk for PONV (see chapter D.3), which could explain the higher incidence of nausea and/or emesis in the first 24 post-operative hours in this age group.

Focusing on the patients in the age of 0-5 years only 8% them experienced nausea and/or emesis in the first 24 post-operative hours, which is similar reported by Monitto et al. for the same age group namely 12%.[20]

7.6% of our patients had at least once a peripheral oxygen saturation less or equal to SaO_2 93%. This could be seen superior to the results of the review by Walder et al., which showed 15.2% of the patients treated with PCA and 18.2% of the patients treated with conventional pain management experienced oxygen saturation under SaO_2 90%, and the study Voepel et al., which showed that 19% of the patients treated with PCA and 14% of the patients treated with conventional pain management experienced oxygen saturation below SaO2 90%.[21, 24] The percentage of patients with an oxygen saturation under 94% in both studies must be higher than the figures given for SaO_2 <90%should be considered as even higher. For example Voepel et al. showed 55% of the patients treated with PCA and 60% of the patients treated with conventional pain management experienced an oxygen saturation under SaO_2 96%.[24]

D.2 Influence of type of the PCA infusion

On the basis of the data set "Graz 2009" patients receiving tramadol / metamizole PCA infusion seem to have better pain control than patients treated with piritramide PCA, since the former have a lesser number of pain events at strain and at rest (see chapter C.2.3) and a higher percentage of total pain relief. It may be noted that the literature for adult population on this topic is inconclusive: in Murphy et al reported that adult patients treated with tramadol PCA and patients treated with other opioid PCAs experienced comparable pain, whereas Yuen et al. reported that tramadol PCA was superior to other opioid PCAs.[23, 25] In the data set "Graz 2009" it was found that patients treated with piritramide PCA had a higher number of both boli demanded and of unsuccessful boli requests during the lockout interval (see chapter C.2.3). At first sight this would seem to confirm that patients treated with piritramide PCA experienced more pain. However, Katz et al. argued that solely on the basis of a higher number of unsuccessful boli requests it cannot be concluded that the patient is in greater pain.[26]

Apart from efficacy of the treatment there is the issue of side effects. Tramadol is known as a more emetic drug than other opioids used in PCA in the adult population.[23] However, in the data set "Graz 2009" this was not confirmed. This result cannot be explained by the fact that instead of pure tramadol a mix of tramadol / metamizole was applied, because it is known from Montes et al. that tramadol and metamizole show a synergistic or additive effect, i.e. the side effects increase.[27] In the data set Graz 2009 the mix was 1 : 10 which is similar to the one suggested for synergistic mixture.[27] In view of this an even higher occurrence of side effect would have been expected.

In the data set Graz 2009 a preselection in favour of tramadol / metamizole PCA was made, because this infusion was preferred for abdominal surgeries. For this reason the two PCA groups in this study are prima facie not equal / comparable. The influence of the operation site (abdominal / non abdominal) was therefore further investigated.

However, it was found that there was no significant difference between abdominal and non-abdominal surgery, which suggests that the above result, namely that tramadol / metamizole PCA is superior in pain management without having more side effects than piritramide PCA, may be valid.
In this context, the different doses of continuous background infusion should be mentioned. The continuous dose for tramadol was 0.2mg/kg/h, which is equivalent to 0.02mg/kg/h morphine iv., and for piritramide it was 0.03 mg/kg/h, which is equivalent to about 0.014 mg/kg/h morphine iv. Taking these continuous doses into account tramadol was continuous provided with an 43% stronger dosage, which is likely to bias the results.

The two PCA infusions show in general no difference in the occurrence of an oxygen desaturation issue. However, patients with tramadol / metamizole PCA infusions reported more occurrences of a peripheral oxygen desaturation issue when the total duration of treatment with the PCA pump was 6 or 7 days and not less (see figure 21). In these cases there were no significant differences in benzodiazepine consumption. Furthermore, the influence of a longer stay at an intensive care unit was also **not** significant. It may be noted that the maximum duration of the PCA treatment, rather than the day on which the oxygen desaturation issue occurred, was taken into account. Occurrences of oxygen desaturation issue could not be attributed to a specific day on which they occurred.

Patients treated with piritramide PCA infusions received significantly more Neodolpasse® infusions and metamizole than ones treated with tramadol / metamizole PCA. Every patient was treated, following an multi-modal pain concept, with an opioid together with a non-opioid analgesic drug. In the tramadol / metamizole PCA infusion was already a non-opioid included. For the piritramide PCA infusion either metamizole or Neodolpasse® was additional added, so the significant difference should be considered as irrelevant.

Patients received piritramide as a rescue analgesic drug during severe pain. Accordingly, the higher rate of additional piritramide in the patients receiving tramadol / metamizole PCA could indicate a higher rate of severe pain of these patients. Each time a patient reported 4 or more points on the pain scale this was counted as one pain event irrespective of the actual intensity of the pain. In other words, the data retrieved from the data set Graz 2009 only included counts of pain events and no information about the strength of the pain. Severe pain could not be distinguished from moderate pain corresponding to 4 points on the pain scale. In the view of this the rate of severe pain could only be estimated.

Moreover, the age distributions of both PCA groups were completely different. Whilst patients in the age of 0-5 years received more often tramadol / metamizole PCA, patients in the age of 14-18 years received more often piritramide PCA. It could therefore not be ascertained whether the main influence on the results was age or the type of PCA infusion.

D.3 Influence of age

Grouped according to the age ranges 0-5 years old, 6-13 years old and 14-18 years old, the data showed that patients reported in the age of 14-18 years old more pain than those in the age of 0-5 years old. Each time the patient reported 4 or more pain points a nurse had to check the patient again 30 minutes later. Taking this into account prolonged pain peaks could express even more pain events, which was not analysed in this study. Maclean et al. suggested that as children grow older they may conceal symptoms more often.[28] If this is true, the fact that the older patients in our study expressed more pain, cannot be explained by their higher age in itself. On the contrary, the higher age could even mask an even higher pain of our patients. It is to be noted, that with increasing age the percentage of piritramide PCA infusion is significantly higher. Insofar as our patients with piritramide infusion expressed more pain compared with the tramadol / metamizole infusion, the number of pain events can be viewed with suspicion as biased.

There is yet another aspect related to age and that is that in the different age groups the surgical procedures are sometimes quite different in scope and complexity. The type of surgery is a potential variable, which has not been taken into account at all.

In Eberhart et al. patients below 14 years showed a rate of PONV which increased with age.[29] This result was found in the data set Graz 2009 as well, for the group of patients of 0-5 years old and 6-13 years old. In the latter group more patients reported post-operative nausea and emesis. However, in the group of 14-18 years old, the patients reported a **non** significant decreasing incidence of PONV compared with the 6-13 years old patients. In Kovac et al. the patients showed increasing rates of PONV up until puberty, which rate then decreased thereafter, this decrease could not be corroborated with significance by our study.[30] Although our age groups differ in the distribution of the types of PCA infusions, this two PCA infusions do not cause significant differences in the occurrence of post-operative nausea and emesis.

D.4 Influence of gender

In this study males stayed in median one day longer in hospital than females. In this comparison, and all other gender comparisons, gender-related surgery was excluded.

In an adult population of trauma patients in age of ≤50 years, there was no difference between genders in length of stay, whereas children showed significant differences in length of stay, namely females stayed longer.[31, 32] The pain management in these studies was conventional. The length of stay between conventional and PCA does not show any difference and thus they should be comparable.[8] Adolescent females more often use emotional support as a coping strategy,[33] which could influence the length of stay. MacLean et al. found that girls in the age range of 10-15 years having symptoms are also more likely to report these symptoms, whereas boys having symptoms do not.[28] Since the medical staff is therefore better informed about the condition of the girls, this could possibly lead to better care and a faster recovery.

In the data set Graz 2009 the group of 6-13 years old patients showed a significantly longer length of stay for boys than girls. The boys in this age group stayed in median 2 days longer and they also showed more frequently nausea and emesis after 24 post-operative hours (11 of 24 males compared to 2 of 19 females). They did not show significantly more nausea and emesis in the first 24 post-operative hours. In order to distinguish between PONV and nausea & emesis caused by the PCA infusion, nausea and emesis in the first 24 post-operative hours was defined as PONV. Nausea and emesis after the first 24 post-operative hours are more likely to be caused by the PCA infusion or other medications than by the surgery. The additional medication did not differ significantly between genders in the age of 6-13years old, therefore this nausea and/or emesis seems to be caused by the PCA.

Predictive factors for PONV in paediatric patients (e.g. body weight, history of motion sickness, anxiety, gastroparesis, the underlying disease, type of surgery, history of PONV) are unaccounted for these data.[34] They can bias the results. In the majority of cases the type of surgery seems to have no influence on post-operative vomiting.[29]

Furthermore, in other studies males of this age presented an equal or lower risk for PONV. After the menarche, however, the gender follows a predictable logic for PONV.[30, 34] This was corroborated by our study: the female patients between 14-18 years of age reported significantly more frequent occurrence of events of nausea and/or emesis in the first 24 post-operative hours and fewer an total absence of those symptoms. More female patients than males in this age group complained at least once about nausea and vomiting after the first 24 post-operative hours. Because the females showed a higher percentage of at least one form of nausea and emesis in both time periods, it is not possible to clearly distinguish what caused this result, PCA infusion / medication or prolonged PONV. Moreover, boys of the age group 0-5 years showed a superior successful response to the PCA treatment when compared to the girls in the same age. However, because of the low population, this result was considered **not** representative.

The boys treated with a tramadol / metamizole PCA infusion showed overall a **non-significant** tendency to stay longer in hospital. Whereas, the girls treated with tramadol / metamizole PCA received significantly more piritramide as a rescue analgesic drug. In addition, the pain reported by the girls showed no significant difference when compared to the boys. The higher rate of additional piritramide could indicate a higher rate of severe pain in these patients. However, each time the patient reported 4 or more points on the pain scale this was counted as one pain event. Since moderate and severe pain were mixed in one variable, a possible significant difference between genders in respect of severe pain could be obscured by this data retrieval. As can be expected, in Kalkman et al. severe post-operative pain in the adult population was influenced inter alia (preoperative pain, type of surgery and anxiety) by gender: females more often showed severe pain than males.[35]

Girls treated with a piritramide PCA infusion reported significantly more pain at rest than boys. With no significant difference regarding pain at strain or total pain relief, it would seem, at first glance, to be a lower response to piritramide PCA for pain at rest. However, in the group, there was no further indication of superior pain control (e.g. length of stay, boli demanded or additional analgesics). On the other hand, a bias in the pain report due to gender could be an explanation, because boys tend to conceal symptoms.[28] In Logan et al. it was shown that girls report more pain.[33] Comparing the results of the study of Logan et al. with our case is questionable, because our data set used different pain variables than those used by Logan et al..

D.5 PONV influencing nausea and emesis during PCA usage

This study shows that patients, who complained of nausea and/or emesis in the first 24 post-operative hours, were also more likely to express these complaints again after the first 24 post-operative hours. However, this result could have been biased by prolonged PONV, which could not clearly be excluded. At the moment of writing this thesis the author is not aware of any study distinguishing PONV from nausea and/or emesis caused by post-operative PCA and analysing the relation between them. However, it is known that PONV is a risk factor for the occurrence of nausea.[34] On the basis of the data set Graz 2009 it could only be stated that "newly occurring" PONV is also a risk factor for the occurrence of nausea thereafter.

D.6 Oxygen saturation

When comparing all cases of oxygen desaturation, it would appear that the patients concerned were more likely to have received benzodiazepines. These patients also stayed longer in the intensive care unit. Benzodiazepines are known to affect respiration. Therefore an increase in the occurrence of oxygen desaturation was to be expected. According to the literature, there is a risk for respiratory depression when PCA is combined with sedatives.[11]

In our study patients with benzodiazepine treatment received either diazepam or triazolam. When comparing how much of triazolam or diazepam a patient received only the amount of triazolam showed a significant relation with oxygen desaturation. However, the non-significance of diazepam could also be explained by the low population of patients receiving this drug.

E Conclusion

E.1 Safety and efficacy of PCA

The intravenous PCA treatment of the "data set 2009" showed a low occurrence of oxygen desaturation (even lower than the average occurrence postulated in the literature) and a moderate incidence of nausea and emesis, which indicates an proper safety of the PCA pain management. In addition the response of the patients to the pain treatment was found to be above 80 % of the patients for each age group, which clearly demonstrates the efficacy of this pain treatment. Taken all this into account, it can be concluded that the intravenous PCA is a safe and effective post-operative pain treatment in paediatric and adolescent patients.

E.2 Influence of the PCA type and duration of treatment

Tramadol / metamizole PCA infusions showed better general pain management than piritramide PCA infusions.

In contrast, the patients with tramadol / metamizole PCA received more often rescue analgesics than patients treated with piritramide PCA, which could indicate a higher rate of severe pain. However, this both outcomes should be considered to be strongly biased (see section D.2). In view of this further research with comparable groups is needed.

In the data set Graz 2009 no significant difference occurred in the emetic effect of tramadol / metamizole infusions compared with piritramide infusions. No definite conclusion is possible at this point, since the age distribution of both groups was significantly different.

Some patients with a total of 6 or 7 days of tramadol / metamizole PCA treatment reported an oxygen desaturation. None of the patients with a shorter duration of this treatment reported such an issue. This needs to be further investigated.

For other side effects no significant difference could be distinguished.

E.3 Influence of age and gender

The outcome of pain management depends on the age of the patient. However, the age groups were not completely comparable. The age groups had a significant different ratio between tramadol / metamizole PCA infusions and piritramide PCA, whilst the outcome is also PCA type dependent. In view of this further research is needed to distinguish the effects of age and PCA infusion respectively.

This thesis corroborated the findings in the literature that PONV increases with age until puberty.

Females after the menarche are known to show a higher risk for PONV compared to males.[30, 34] This is corroborated by this study. It is therefore recommended that the anti-emetic treatment and surveillance of female patients older than 14 is intensified.

Further study is also needed to analyse whether females have higher and/or more frequent severe pain peaks than boys during treatment by tramadol / metamizole PCA infusion and whether females have a lower response to pain management with piritramide PCA, as suggested by this study.

Males stayed longer in the hospital than females, especially in the age group of 6-13 years of age. Further research should be considered. For example, is the difference in age influenced by the type of treatment or caused by some unknown factor present in the Department of Paediatric Anaesthesia in Graz?

E.4 Additional findings

Patients with PONV showed a higher risk for nausea and emesis after the first 24 post-operative hours. Therefore nausea in the first 24 hours could be a predictor of higher nausea and emesis in subsequent treatment with PCA. However, further research is needed to clearly distinguish PONV and nausea caused by PCA.

It is recommended that the anti-emetic treatment and surveillance of patients having nausea and/or emesis in the first 24 post-operative hours is intensified. In this study 89% of these patients had another episode of nausea and/or emesis in the subsequent intrahospital stay!

The use of benzodiazepines constitutes an increasing risk for experiencing an oxygen desaturation issue. For that reason at least an additive influence on the occurrence of side effects of PCA should be considered. Further research is needed to investigate the risks of using benzodiazepines.

F References

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G Curriculum vitae

Name	Sebastian Fuchs
Date and place of birth	13 June 1986; Starnberg
Nationality	German
Languages:	German (mother tongue)
	English
	Basic Chinese (Mandarin)

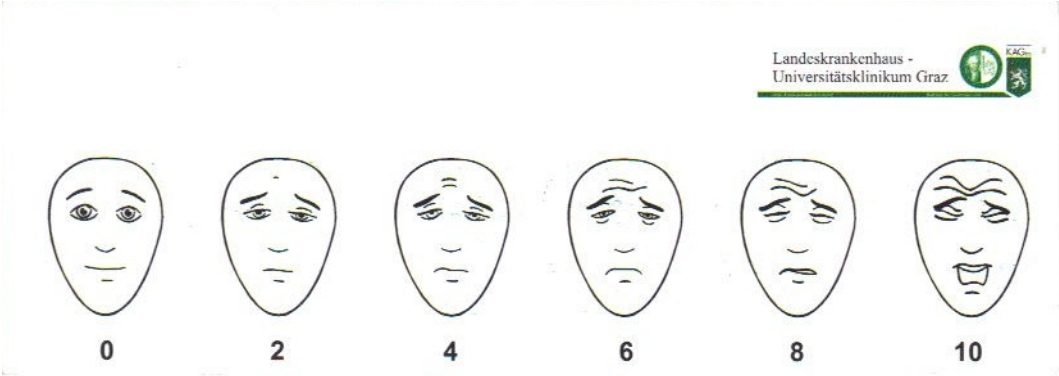
EDUCATION

9/1992 – 7/1996	Primary school: Grundschule an der Feldbergstr, München
9/1996 – 6/2005	Secondary school: Michaeli Gymnasium München
	graduated with Abitur in June 2005
10/2005 - present	Study of human-medicine at the Medical University of Graz

ADDITIONAL MEDICAL TRAINING

2010	Acupuncture, in Graz at ÖGKA (140 h)

H Appendix



The German version of FACES[17] used at the Dept. of Paediatric Anaesthesia, Medical University of Graz

Gesichter- Skala ab ca. 4 Jahren

Diese Gesichter zeigen, wie weh etwas tun/ schmerzen kann. Vermeiden Sie daher Worte wie „glücklich" und „traurig". Zeigen Sie auf das Gesicht ganz links (= 0) und sagen Sie, dass dieses Gesicht zeigt, dass es gar nicht weh tut/ schmerzt. Zeigen Sie dann auf die Gesichter der Reihe nach, von links nach rechts und sagen Sie, dass die anderen Gesichter zeigen, dass es mehr und mehr weh tut/ schmerzt bis hin zum Gesicht ganz rechts (= 10), das zeigt, dass es ganz stark weh tut/ schmerzt.

Fordern Sie dann das Kind auf, das Gesicht zu zeigen, das am besten zeigt, wie sehr es ihm gerade weh tut/ wie stark seine Schmerzen gerade sind.

Faces Pain Scale - Revised. Hicks CL et al, Pain 2001; 93(2): 173-183. www.painsourcebook.ca

The German version of FACES[17] used at the Dept. of Paediatric Anaesthesia, Medical University of Graz

KUSS : Kindliche Unbehagens- und Schmerz- Skala

Landeskrankenhaus - Universitätsklinikum Graz

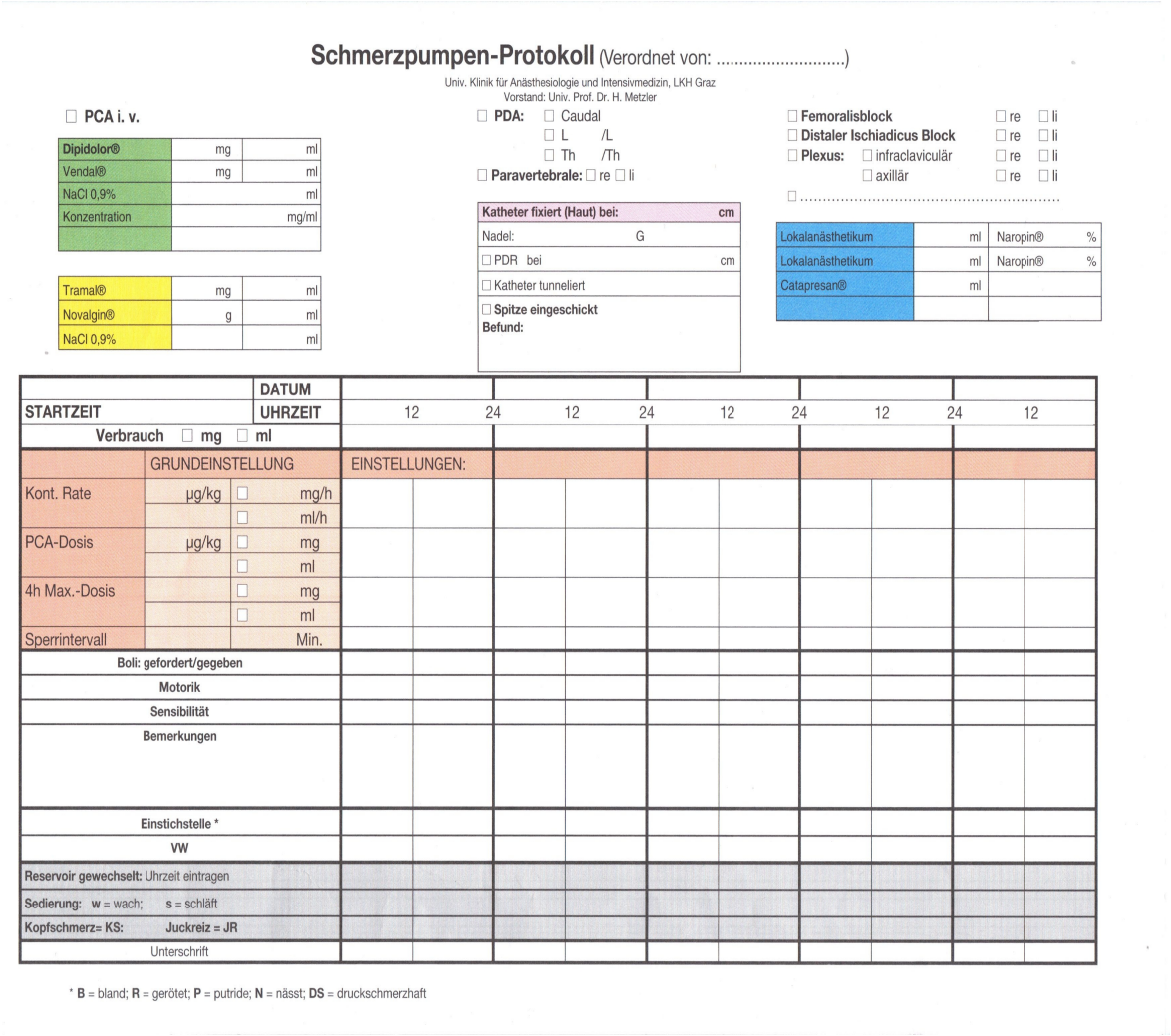
Beobachtung	Bewertung			Punkte
	= 0	= 1	= 2	
Weinen	Gar nicht	Stöhnen; Jammern; Wimmern	Schreien	
Gesichtsausdruck	Entspannt, Lächelt	Mund verzerrt	Mund und Augen grimassieren	
Rumpfhaltung	Neutral	Unstet	Aufbäumen, Krümmen	
Beinhaltung	Neutral	Strampelnd, Tretend	An den Körper gezogen	
Motorische Unruhe	Nicht vorhanden	Mäßig	Ruhelos	
			Addition der Punkte	

Aus: Büttner et al, AINS 1998, 33(6):353-61; DOI: 10.1055/s-2007-994263 mit frdl. Genehmigung der Georg Thieme Verlag KG.

KUSS the German version of CHIPPS[16] used at the Dept. of Paediatric Anaesthesia, Medical University of Graz

- Für Säuglinge und Kleinkinder bis zum Abschluss des 4. Lebensjahres
- Der Wachheitsgrad muss zuerst kontrolliert werden: Ein schlafendes Kind hat keinen akuten Schmerzmittelbedarf! Schläft ein Kind, so muss es zur Erhebung des KUSS- Wertes nicht aufgeweckt werden.
- Faktoren, die Unbehagen verursachen, sollen vor der Beurteilung ausgeschlossen werden: z.B.: Hunger, Durst, nasse Windeln, unbequeme Lagerung; Störung durch Licht, Lärm, Kälte,....
- Die 5 Verhaltensweisen werden innerhalb von 15 Sekunden beobachtet und je einem Punktewert von 0 - 2 zugeordnet. Die erhobenen Punkte werden addiert und dokumentiert (Wert= zwischen 0 und 10).
- Nur die Daten aus dieser Beobachtungszeit werden festgehalten, auch wenn sich das Verhalten des Kindes unmittelbar danach ändert.

KUSS the German version of CHIPPS[16] used at the Dept. of Paediatric Anaesthesia, Medical University of Graz



Schmerzpumpen-Protokoll (Verordnet von: .....)

Univ. Klinik für Anästhesiologie und Intensivmedizin, LKH Graz
Vorstand: Univ. Prof. Dr. H. Metzler

☐ **PCA i. v.**

Dipidolor®	mg	ml
Vendal®	mg	ml
NaCl 0,9%		ml
Konzentration		mg/ml

Tramal®	mg	ml
Novalgin®	g	ml
NaCl 0,9%		ml

☐ **PDA:** ☐ Caudal
☐ L /L
☐ Th /Th

☐ **Paravertebrale:** ☐ re ☐ li

Katheter fixiert (Haut) bei:	cm
Nadel:	G
☐ PDR bei	cm
☐ Katheter tunneliert	
☐ **Spitze eingeschickt**	
Befund:	

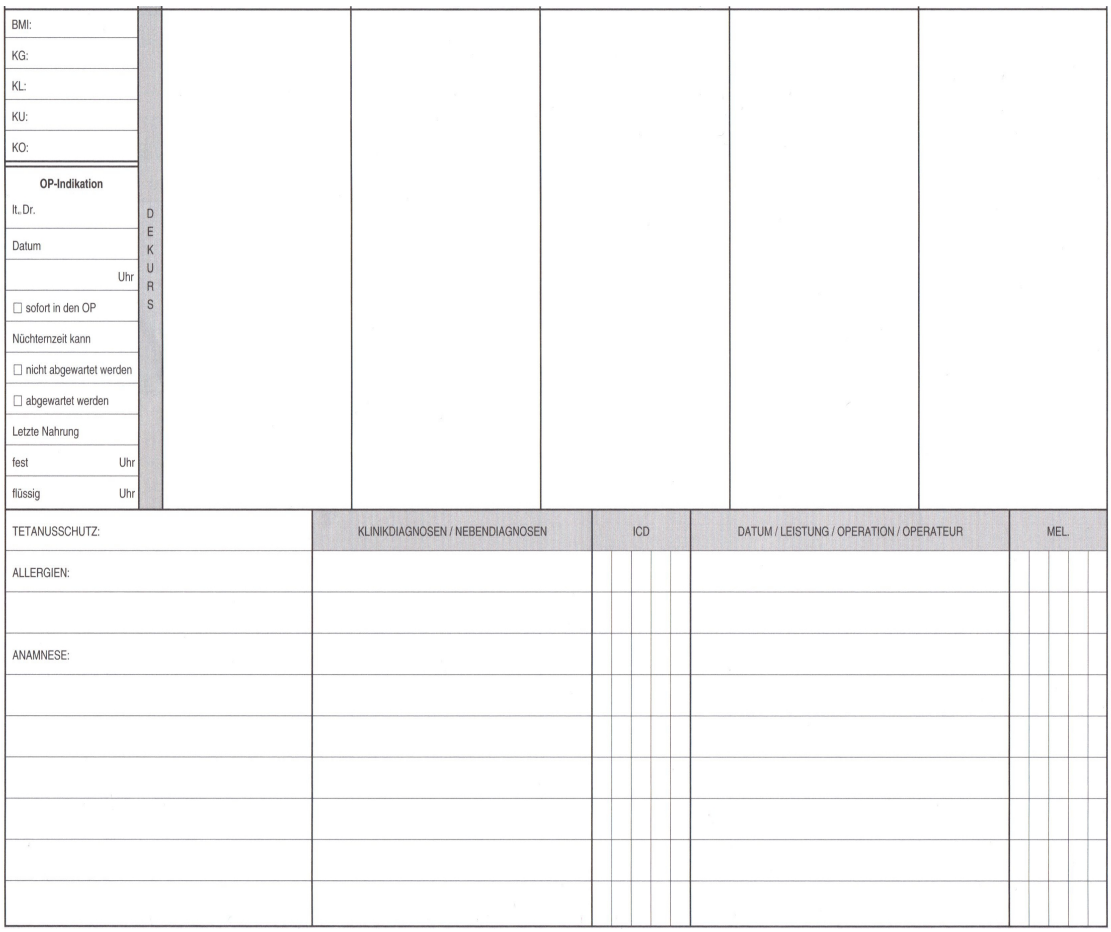
☐ **Femoralisblock** ☐ re ☐ li
☐ **Distaler Ischiadicus Block** ☐ re ☐ li
☐ **Plexus:** ☐ infraclaviculär ☐ re ☐ li
☐ axillär ☐ re ☐ li
☐ .....

Lokalanästhetikum	ml	Naropin®	%
Lokalanästhetikum	ml	Naropin®	%
Catapresan®	ml		

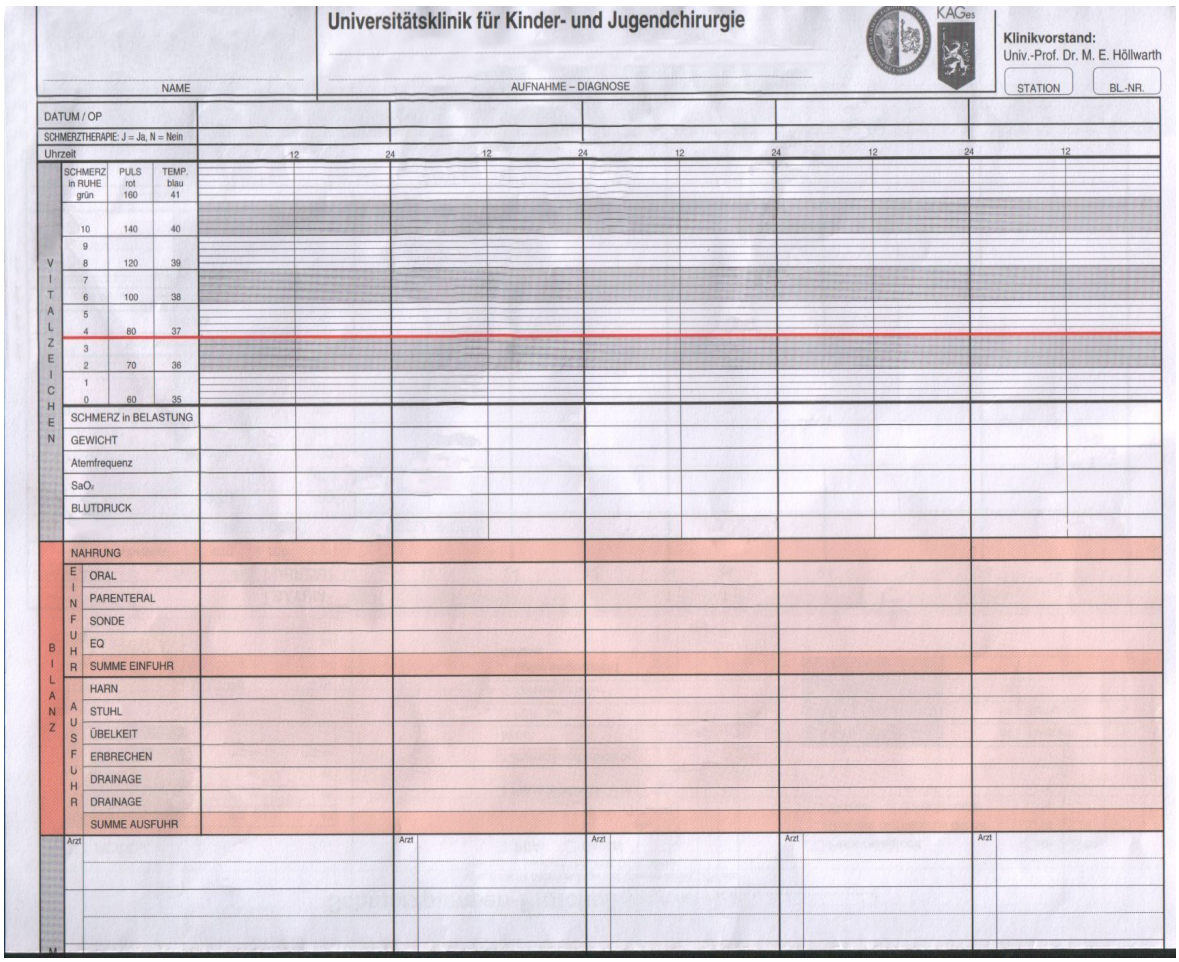
		DATUM																			
STARTZEIT		**UHRZEIT**	12		24		12		24		12		24		12		24		12		
Verbrauch ☐ **mg** ☐ **ml**																					
	GRUNDEINSTELLUNG		EINSTELLUNGEN:																		
Kont. Rate	µg/kg	☐ mg/h																			
		☐ ml/h																			
PCA-Dosis	µg/kg	☐ mg																			
		☐ ml																			
4h Max.-Dosis		☐ mg																			
		☐ ml																			
Sperrintervall		Min.																			
Boli: gefordert/gegeben																					
Motorik																					
Sensibilität																					
Bemerkungen																					
Einstichstelle *																					
VW																					
Reservoir gewechselt: Uhrzeit eintragen																					
Sedierung: **w** = wach; **s** = schläft																					
Kopfschmerz= KS: **Juckreiz = JR**																					
Unterschrift																					

* **B** = bland; **R** = gerötet; **P** = putride; **N** = nässt; **DS** = druckschmerzhaft

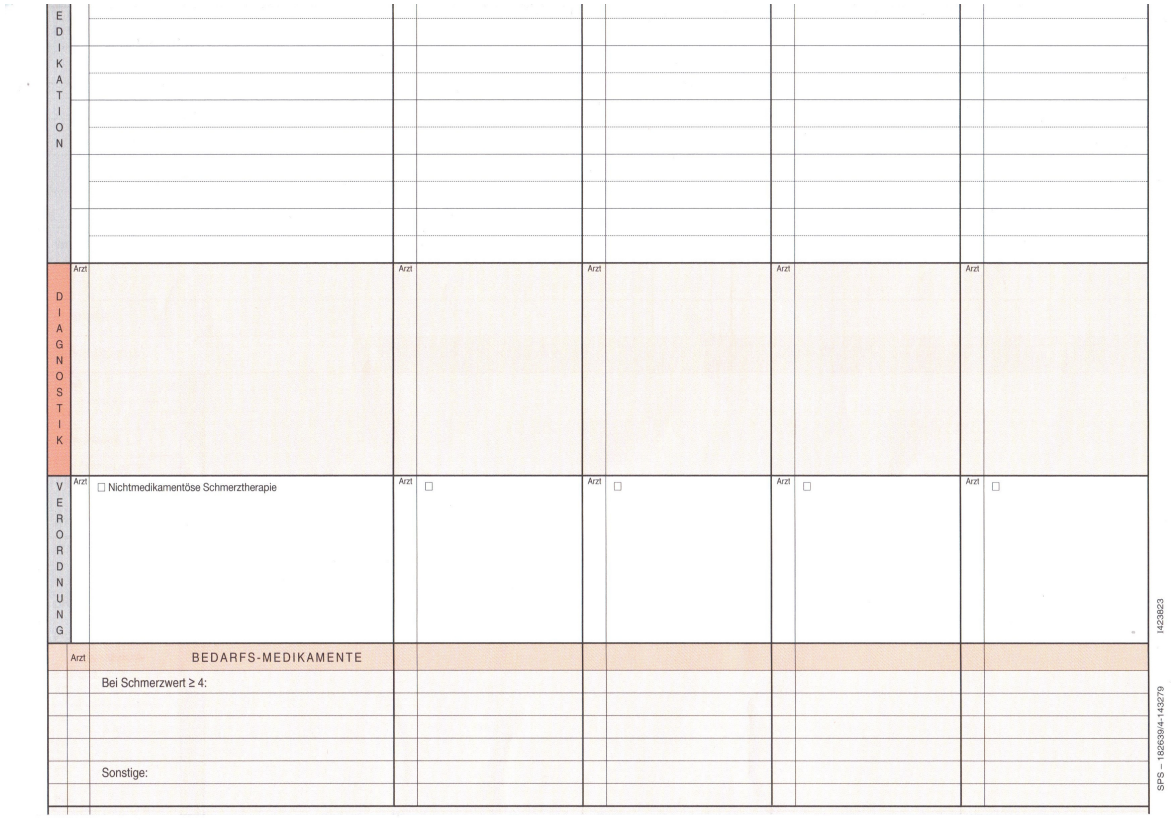
Patient file used in the Dept. of Paediatric Anaesthesia, Medical University of Graz



Patient file used in the Dept. of Paediatric Anaesthesia, Medical University of Graz



Patient file used in the Dept. of Paediatric Anaesthesia, Medical University of Graz



Patient file used in the Dept. of Paediatric Anaesthesia, Medical University of Graz