

# Frequency of Disturbed Defecation Pattern in Neurosurgical Critically Ill Patients and Influence on Intracranial Pressure and Intensive Care Treatment

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## Abstract

**Background:** Inadequate bowel movement is a common problem in intensive care patients. Aim of this study was to quantify the frequency of disturbed defecation pattern in critical ill neurosurgical patients and examine the influence on intracranial pressure (ICP) and treatment on intensive care unit (ICU).

**Patients and Methods:** Data were collected retrospectively during treatment on a neurosurgical ICU over a period of three years. Daily bowel movement was regarded to be sufficient when stool volume was more than 150 ml liquid or mushy stool or the patient produced enough formed stool. Patients were classified into group "adequate defecation" when no period of more than three consecutive days without sufficient bowel movement was seen during ICU treatment or into group "inadequate defecation" respectively. A third group was built with patients showing constipation on seven consecutive days or longer.

**Results:** In a total of 73 recorded patients, 11 showed an adequate defecation pattern. Within the first ten days of ICU stay mean daily ICP values did not differ. However, patients with inadequate defecation had to be ventilated mechanically significantly longer (15.9 vs. 8.8 days) and had a significant longer need for ICU treatment (24.8 vs. 15.6 days). The mean cumulative dose of sedatives, sufentanil and norepinephrine was significantly higher in patients showing inadequate defecation. However, even long periods of constipation were not associated with a clinically relevant increase of ICP.

**Conclusion:** Neurosurgical ICU patients often show constipation. This does not cause elevated ICP values compared to patients without constipation. Disturbed bowel movement is associated with higher dosage of analgesation and vasopressor therapy. Patients without constipation have to be ventilated less long and can be discharged from ICU earlier.

**Keywords:** Bowel movement; Defecation; Constipation; Intracranial pressure; Neurosurgical intensive care

movements per se on ICP and length of respirator dependency or ICU stay in patients with an acute serious cerebral disorder.

## Introduction

Motility disorders and disturbed defecation pattern seem to have impact on the development of increased ICP in patients with brain injury. Various reasons as e.g., prolonged periods of analgesation, as often necessary after traumatic brain injury (TBI) or subarachnoid hemorrhage (SAH) may lead to insufficient bowel movement and even a state resembling paralytic ileus. This can result in an increase in intra-abdominal pressure (IAP) and potentially an increased intracranial pressure (ICP) [1-3]. In addition, an insufficient defecation rate is possibly associated with prolonged ventilation, increased rate of bacterial infection and a higher mortality rate [4-10].

Recently we could show that the implementation of a standard operating procedure (SOP) for treatment of constipation on a ICU increased the stool frequency but had no impact on ICP [11]. The aim of the following study was therefore to evaluate the effects of bowel

## Patients and Methods

The study was approved and conducted according to the ethical care committee of the University of Regensburg (approval number 12-101-0240).

Criteria for being included into this study were an age older than 18 years, a severe brain injury such as TBI, SAH, intracerebral hemorrhage (ICH) or other serious cerebral disorders and the necessity of continuous ICP monitoring, continuous analgesation and invasive ventilation for more than three days. Exclusion criteria were pregnancy and severe gastro-intestinal diseases. Data from all patients who had met these criteria and had been treated on the neurosurgical ICU of the University Hospital Regensburg within a period of three years between January 2011 and December 2013 were collected retrospectively.

For each day of ICU treatment the following data were extracted from the patient data management system (PDMS, MetaVision SuiteTM, iMDsoft, Tel Aviv, Israel): gut motility parameters, dose of drugs for analgosedation and circulatory-support (mean total dose during ICU treatment), ICP-levels (mean daily values), duration of mechanical ventilation and length of ICU stay.

Nutritional support was given according to the guidelines of the German Society for Nutrition (DGEM 2007, www.dgem.de) and the European Society for Clinical Nutrition and Metabolism (ESPEN 2005; www.espen.org). To improve defecation pattern physical therapy and pro motility drugs (mainly bisacodyl, lactulose, clyster, enteral given naloxone, sodium picosulfate, rhizine oil and neostigmine) were given following clinical assessment and the attending physician's estimation.

The defecation pattern was recorded separately for each day of ICU stay (0.00 am to 11.59 pm). Stool volume was measured using a fecal collector (FlexiSeal TM, ConvaTec, Munich, Germany) when patients had liquid or soft, mushy stool. In patients who had formed stool the classification in being enough or too few for a day was done corresponding to the assessment by the attending nurse. A cumulative stool volume of more than 150 ml per day or enough formed stool for a day as documented in the PDMS was regarded to be a sufficient defecation. According to this, patients were initially divided into two groups: patients who had not shown a period of more than three consecutive days without sufficient bowel movement were classified into group "adequate defecation", patients with periods of more than three consecutive days with constipation into group "inadequate defecation". In addition, patients with episodes of insufficient bowel movement on at least seven consecutive days were classified into group "long period with inadequate defecation" and recorded separately.

Statistical analysis was performed using IBM SPSS Statistics TM Version 22 (IBM, Armonk, USA). Categorical data were displayed according to the distribution frequency. Statistical significance was calculated using chi-square test. Metric data were analyzed using Student's t-test when data were normally distributed or Mann-Whitney U test when not. Significance was supposed when p-value was <0.05. As not otherwise indicated data are presented as mean ± standard deviation.

## Results

A total of 73 patients (29 female, 44 male, average age 48.2 years, ± 16.9 years) met inclusion criteria and were enrolled. 28 patients (38.3%, 20 female, 8 male) suffered from SAH, 25 patients (34.3%, 3 female, 22 male) from TBI, 13 patients (17.8%, 4 female, 9 male) from other types of ICH and finally 7 patients (9.6%, 2 female, 5 male) from cerebral ischemia.

11 patients (15.1%) showed adequate defecation according to the definition given above (group "adequate defecation"). 4 patients in this group were female (13.8% of all female patients), 7 male (15.9% of all male patients). 62 patients (84.9%) were assigned to group "inadequate defecation". A period of insufficient bowel movement on at least seven consecutive days (group "long period with inadequate defecation") was detected in 28 patients (46.8% of the patients of group "inadequate defecation, 38.4% of all patients respectively). 8 patients in this group were female (27.6% of all female patients), 20 male (45.5% of all male patients).

## Defecation and ICP

The initially established ICP probe was removed as soon as possible after reaching a stable situation regarding ICP values to prevent infectious complications. Therefore, a continuous recording of ICP values during the first ten days of ICU stay was available in only 56 patients. During this period, inadequate defecation for more than three consecutive days occurred in 49 of these patients. 7 patients showed a normal defecation pattern. Within the patients with inadequate defecation pattern two patients showed extremely elevated mean daily ICP values on day 9 (56.31 mmHg and 36.46 mmHg) and 10 (106.84 mmHg and 85.07 mmHg) due to multiple infarction as a consequence of severe cerebral vasospasm following SAH and an intracerebral bleeding after installing an external ventricular drainage respectively with deleterious prognosis. Therefore, both patients were excluded from the calculations. Table 1 shows the development of the mean daily ICP value over the time comparing both groups. A significant difference of mean daily ICP values was not seen throughout the whole observation period.

	Mean Group "Inadequate defecation" (mmHg)	Mean Group "Adequate defecation" (mmHg)	MD (mmHg)	95%-CI	p-value
Day 1	10.43	8.35	2.08	-2.67; 6.84	0.327
Day 2	11.73	12.47	-0.74	-3.77; 2.29	0.598
Day 3	11.63	11.92	-0.29	-3.02; 2.44	0.815
Day 4	10.86	11.44	-0.58	-3.91; 2.73	0.694
Day 5	11.10	11.02	0.08	-2.98; 3.14	0.954
Day 6	11.43	11.02	0.41	-1.56; 2.37	0.663
Day 7	10.95	10.66	0.29	-1.72; 2.30	0.760
Day 8	11.68	10.50	1.18	-0.76; 3.11	0.212
Day 9	11.08	10.56	0.52	-1.87; 2.90	0.644
Day 10	11.32	9.29	2.03	-0.50; 4.56	0.109

**Table 1:** Mean daily ICP values until day 10 after admission to the ICU. MD: Mean Difference; CI: Confidence Interval.

## Defecation and ICU therapy

Patients classified into group "adequate defecation" had to be ventilated mechanically for an average of 8.8 days, whereas "inadequate defecation" group patients were ventilator-dependent for 15.9 days. This was a statistically significant mean difference of 7.1 days (95%-CI 4.4; 9.7). The shortest ventilation period was 5 days in group "adequate defecation" and 3 days in group "inadequate defecation", the longest period 13 days vs. 42 days respectively. The mean length of ICU stay was 16.5 days in group "adequate defecation" and 24.8 days in group "inadequate defecation". This was also a statistically significant mean difference of 8.4 days (95%-CI 4.7; 12.0).

## Defecation and analgosedation

Propofol, midazolam, ketamine and if necessary methohexital on top were given for sedation and sufentanil was used for analgesia. The

mean cumulative dose was significantly higher in the group “inadequate defecation” for all drugs (Table 2).

	Cumulative dose Group “inadequate defecation” (g)	Cumulative dose Group “adequate defecation” (g)	MD (g)	95% CI	p-value
Propofol	24.06	12.91	11.15	2.59; 19.73	0.012
Midazolam	3.81	1.12	2.69	1.48; 3.89	<0.001
Ketamine	30.26	7.72	22.54	10.68; 34.40	<0.001
Methohexital	4.98	0	4.98	2.15; 7.82	0.001
Sufentanil	0.020	0.008	0.012	0.007; 0.017	<0.001

**Table 2:** Cumulative dose of drugs used for analgesedation. MD: Mean Difference; CI: Confidence Interval.

### Defecation and circulatory support

For circulatory support norepinephrine, dobutamine or epinephrine were given if necessary. The mean cumulative dose was significantly

higher in group “inadequate defecation” for norepinephrine but not for dobutamine or epinephrine despite a tendency towards higher doses for both agents in this group (Table 3).

### Long period of obstipation and ICP

A noticeable number of 28 patients showed at least once an episode of insufficient bowel movement for at least seven consecutive days (group “long period with inadequate defecation”).

	Group “inadequate defecation” Cumulative dose (mg)	Group “adequate defecation” Cumulative dose (mg)	MD (mg)	95% CI	p-value
Norepinephrine	192.2	106.2	86.0	13.7; 158.3	0.021
Dobutamine	105.8	72.7	33.1	-104.1; 170.5	0.615
Epinephrine	10.4	0.2	10.2	5.3; -0.4	0.058

**Table 3:** Cumulative dose of catecholamines. MD: Mean Difference; CI: Confidence Interval.

Patient number	Mean daily ICP (mmHg)												
	Day 1	2	3	4	5	6	7	8	9	10	11	12	13
3	12.4	15.4	15.7	14.1	13.2	13.8	12.4	12.1					
6	3.7	6.8	7.5	7.1	9.9	7.2	7.6						
9	11.6	9.9	9.1	10.3	10.9	12.9	13.1	16.1	24.6				
25	12.8	12.1	10.4	10.9	11.9	11.0	12.5						
26	8.6	17.1	17.1	20.4	16.9	17.3	15.6	17.7					
27	1.0	7.0	7.7	6.3	5.0	2.9	3.1						
35	14.0	13.6	11.6	9.4	9.8	11.4	11.3	12.1	11.4	12.5	10.5	11.3	10.1
37	18.4	16.1	17.0	17.0	15.8	15.1	18.5	15.1					
39	11.4	8.4	11.0	11.0	9.2	8.9	9.9	11.6					
40	18.6	16.2	13.0	12.0	12.6	12.6	11.9	12.2	10.1	13.2			
42	29.0	10.8	13.5	14.7	16.3	14.9	13.6	14.8	20.9				
46	20.1	21.1	23.8	24.2	25.4	24.4	23.1						
51	16.0	19.4	15.0	8.9	7.3	6.0	9.0	12.6	8.2	9.9	4.5	5.3	5.2
53	11.5	14.9	13.9	14.1	14.5	16.1	17.3	22.3	20.8	17.8			
59	3.9	5.0	7.1	10.2	12.4	9.3	6.3	7.8	6.0				
70	9.6	9.6	9.0	5.0	6.6	6.6	9.5						
73	3.1	5.5	8.8	6.1	7.6	15.6	14.0						

**Table 4:** Mean daily ICP in patients with a long period without adequate defecation. Day 1 is the first day of this period starting one day after last sufficient defecation.

A continuous recording of the ICP values during these episodes existed in 19 patients out of this group. Again two patients were excluded due to deleterious prognosis. Thus 17 patients remained in which the development of the mean daily ICP values during this long period without adequate defecation could be compared (Table 4). We only saw a slight increase of 1.07 mmHg (12.10 mmHg,  $\pm$  7.13 mmHg on day 1 vs. 13.17 mmHg,  $\pm$  6.18 mmHg on the last day) in mean daily ICP. Two patients (number 35 and 51) had a remarkably long period of 13 consecutive days without adequate defecation. In these two patients the mean daily ICP even declined and was lower on the last day of this episode than at the beginning.

## Discussion

The present study shows that an insufficient defecation pattern is a common problem in critically ill neurosurgical patients as only 15.1% of all patients showed adequate defecation at least every third day during the observation period. Interestingly even longer periods without adequate defecation were not associated with elevated mean daily ICP values compared to patients showing an adequate defecation pattern. However, patients with regular bowel movement had to be ventilated and treated significantly shorter on ICU.

In literature the incidence of constipation varies from 16% to 84% in critically ill patients [8-10,12-15]. Main reasons for this variance might be the inhomogeneity of the study populations and the lack of a general definition of regular bowel movement. We recently examined the defecation pattern within the first 5 days after ICU admission in neurosurgical intensive care patients comparing a group where laxatives and physical measures had been applied in a standardized manner after implementation of a SOP to a group where the pro motility measures had been ordered without any schedule merely according to the attending physician's estimation. In this study the number of patients showing adequate defecation was over all low with 24% in the intervention group and 8.3% in the control group respectively [11]. In concordance to these previous findings the percentage of patients with regular defecation was 15.1% in the present study.

It might be assumed that the absence of defecation leads to elevated IAP levels over time. The association between an elevated IAP and rising ICP values has been described repeatedly [1-3, 16-19]. However, it is difficult to predict the development of IAP in the individual critically ill patient [20-23]. In our previous study we had not seen higher ICP levels in the group showing an inadequate defecation pattern. However, in the preceding study we only observed the first five days after admission to the ICU. We supposed that this short period of time was not long enough to find a detectable effect of inadequate defecation pattern on the ICP levels as probably this period was too short to develop a relevant increase in IAP due to lack of defecation. This was the main reason for initiating the present study, now examining the whole time of intensive care treatment. Although the initially established ICP probes were removed as soon as possible in order to prevent infectious complications we were able to analyze data of 56 patients who had a continuous ICP measurement during the first ten days of ICU stay. Once again no difference was seen between the mean ICP values in the patients showing an adequate defecation pattern compared to those whose bowel movement was insufficient. Even in patients with a remarkably long period of at least seven consecutive days without adequate defecation no relevant increase of ICP was detected. These findings seem to be surprising, but probably only a manifest abdominal compartment syndrome can induce a

relevant ICP elevation as several case reports and a small patient series suggest. Unfortunately, the IAP values were not recorded regularly in the study population what in fact is a limitation of our present study. Therefore, it is impossible to rule out that even in cases with an extremely long period without defecation an increase in ICP was not seen simply because there was no relevant elevation in IAP.

However, another result of the current study may provide a different interpretation approach. The mean cumulative dose of all sedatives and sufentanil was significantly higher in the group "inadequate defecation". Correspondingly norepinephrine that was used as first line vasopressor also had to be given in higher dosage when defecation pattern was inadequate. These findings are in concordance to literature where an association between sedatives, analgesics (especially opioids) and vasopressors and constipation is described [5,7,24-26]. All these drugs are well-known to impair gut motility in a dose-dependent manner. Therefore, the higher dosage of the applied drugs might be the reason for the disturbed defecation pattern. On the other hand, however, the situation could be interpreted inversely as well so that a deeper analgosedation could have been necessary to control borderline ICP levels in patients with inadequate defecation pattern. Deep analgosedation is an elementary aspect of conservative treatment of elevated ICP. Thus higher dosages of vasopressors could have been necessary due to deeper analgosedation. The observed prolonged ventilator dependency and duration of ICU therapy in patients with disturbed bowel movements seems also to be in line with this interpretation. In this context prolonged respirator therapy could have been necessary because of longer and deeper analgosedation. Furthermore, the weaning phase from the respirator is often associated with a moderate hypercapnia. It is likely that a reduction of the respirator therapy invasivity allowing spontaneous breathing was not possible in those patients with inadequate defecation pattern as the resulting moderate hypercapnia would have led to an excess of ICP thresholds.

In summary, the present study can lead to different interpretation approaches and is not able to draw a chain of causation free of doubt. Seen from a pure clinical standpoint efforts for optimizing bowel movements in critically ill patients with acute severe cerebral disorders seem to be justified as we have seen a correlation between an insufficient defecation pattern and a longer duration of ventilator dependency and ICU treatment. To be able to answer the open questions we are in need of larger prospective studies with regular measurement of IAP and inclusion of protocol-based strategies for optimizing bowel movement and defecation in critically ill neurosurgical patients.

## Conclusion

Critically ill patients with an acute severe cerebral disorder often show an inadequate defecation pattern. This, however, seems not to be associated with elevated ICP levels even if patients do not show an adequate bowel movement for seven consecutive days or even longer. On the other hand, higher doses of drugs for analgosedation and circulatory support are necessary in these patients. In addition, compared to patients with an adequate defecation pattern those patients show a prolonged ventilator dependency and are in need of a longer ICU treatment.

## Conflict of Interest Statement

Martin Kieninger, Tobias Finzel, Nina Zech, Milena Seemann, Sylvia Bele and Holger Künzig declare that they have no conflict of interest.

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