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Management of Home Parenteral Nutrition: Complications and Survival

Emilie Reber[a] Kaspar Staub[b] Katja A. Schönenberger[a] Anastasia Stanga[a] Michèle Leuenberger[c] Claude Pichard[d] Philipp Schuetz[e] Stefan Mühlebach[f] Zeno Stanga[a]

[a]Department of Diabetes, Endocrinology, Nutritional Medicine and Metabolism, Inselspital, Bern University Hospital, and University of Bern, Bern, Switzerland; [b]Institute for Evolutionary Medicine, University of Zürich, Zürich, Switzerland; [c]Department of Visceral Surgery and Medicine, Inselspital, Bern University Hospital, University of Bern, Bern, Switzerland; [d]Clinical Nutrition, Geneva University Hospital, Geneva, Switzerland; [e]Division of General Internal and Emergency Medicine, Medical University Department, Kantonsspital Aarau, Aarau, Switzerland; [f]Department of Clinical Pharmacy and Epidemiology, University of Basel, Basel, Switzerland

Keywords
Parenteral nutrition · Home parenteral nutrition · Central venous catheter · Complication

Abstract
Background and Aims: Parenteral nutrition (PN) has become an efficient, safe, and convenient treatment over years for patients suffering from intestinal failure. Home PN (HPN) enables the patients to have a high quality of life in their own environment. The therapy management however implies many restrictions and potentially severe lethal complications. Prevention and therapy of the latter are therefore of utmost importance. This study aims to assess and characterize the situation of patients with HPN focusing on prevalence of catheter-related complications and mortality. ***Methods:*** Swiss multicentre prospective observational study collecting demographic, anthropometric, and catheter-related data by means of questionnaires every sixth month from 2017 to 2019 (24 months), focusing on survival and complications. Data were analysed using descriptive statistics. Logistic regression models were fitted to investigate association between infection and potential co-factors. ***Results:*** Seventy adult patients (50% women) on HPN were included (≈5 patients/million adult inhabitants/year). The most common underlying diseases were cancer (23%), bariatric surgery (11%), and Crohn's disease (10%). The most prevalent indication was short bowel syndrome (30%). During the study period, 47% of the patients were weaned off PN; mortality rate reached 7% for a median treatment duration of 1.31 years. The rate of catheter-related infection was 0.66/1,000 catheter-days (0.28/catheter-year) while the rate of central venous thrombosis was 0.13/1,000 catheter-days (0.05/catheter-year). ***Conclusion:*** This prospective study gives a comprehensive overview of the adult Swiss HPN patient population. The collected data are prerequisite for evaluation, comparison, and improvement of recommendations to ensure best treatment quality and safety.

Introduction

The European Society for Clinical Nutrition and Metabolism (ESPEN) defines parenteral nutrition (PN) as "a type of nutrition therapy provided through intravenous

karger@karger.com
www.karger.com/anm

Correspondence to:
Emilie Reber, emilie.reber@insel.ch

Table 1. Overview of the complications related to the HPN [12]

Medical/metabolic complications	Over/underfeeding, hyperglycaemia, refeeding syndrome, hypertriglyceridemia, cholestasis, intestinal failure-associated liver disease and non-alcoholic steatohepatitis, intestinal and renal complications, osteopathy, reduced immune competency
Hygienic complications	Complex catheter care, infection, sepsis
Technic/mechanic complications	Complex handling (attaching and removing parenteral admixtures and installing infusion pump), occlusion, central venous thrombosis, displacement, breaking, incompatibility, instability, and contamination of parenteral admixtures
Psychologic complications	Fear of complications, depression
Somatic complications	Physical problems, fatigue, diarrhoea, polyuria, pain

HPN, home parenteral nutrition.

administration of nutrients such as amino acids, glucose, lipids, electrolytes, vitamins, and trace elements" [1]. According to the ESPEN guidelines, home PN (HPN) is indicated in those patients who are unable to meet their nutritional requirements via the oral and/or enteral route and who can be safely managed outside the hospital [2]. Furthermore, HPN should be prescribed as the primary and life-saving therapy for patients with transient-reversible or permanent-irreversible chronic intestinal failure due to non-malignant or malignant disease [2, 3].

Owing to pharmaceutical and technical progress, this complex and multifaceted treatment has become efficient, effective, safe, and convenient [2]. In the long-term care, it may be used in an ambulatory setting, for example, at home, where patients practice better their daily life activities and have good or reasonably good quality of life in their usual environment. HPN additionally contributes to prevent prolonged hospital stays and readmissions resulting in reduced healthcare costs [4–7]. High-quality equipment and outstanding medical as well as logistic support contribute to minimize risks and to improve HPN patients' outcome, since safety and quality assurance are of central relevance [4, 8, 9]. Complications related to HPN treatment are manifold, rather frequent and potentially life threatening (Table 1). Adequate prevention and rapid management of these complications are therefore of paramount importance.

In Switzerland as in many other countries, very few studies on patients with HPN have been conducted. Data on these patients rarely exist owing to the rarity of the treatment (rare disease frequency 1:2,000) and to the high heterogeneity of the patient population [10, 11]. Further, there is no national registry allowing representative observation of developments in this population, as well as international comparability and benchmarking of standards of care.

This study aims to assess and characterize the situation of adult patients with HPN in Switzerland regarding clinical aspects and focusing on the prevalence of catheter-related complications and mortality. Further, the objective is to identify factors, which are potentially associated with treatment outcome, to evaluate and optimize the treatment quality and to ensure patients' safety and better address their problems. It additionally may contribute to define evidence-based measures to optimize treatment and care in the HPN population.

Methods

Study Design and Data Collection

This prospective multicentre observational study was conducted in Switzerland over 24 months, from January 1, 2017, until January 1, 2019. Data were collected using questionnaires distributed to the patients and their treating physicians in charge of PN (i.e., general practitioner or hospital physician depending on the local setting). These questionnaires (available as supplementary material) were created by an international group of experts and previously validated in a pilot trial and focused on catheters and related complications (mechanic and metabolic). They contained items on patient demographics (sex, age, nationality, and living/working situation), medical history, medication, detailed nutritional regimen, anthropometric changes (body weight and BMI), and technical-related aspects of catheters (type, aseptic handling, and care). These questionnaires were filled in at baseline and follow-up questionnaires every 6 months.

Patient Selection and Inclusion Criteria

Adult patients (≥18 years old) with HPN for an estimated period >3 weeks, started at least 7 days prior to the study inclusion, not critically ill, not in a terminal phase (estimated life expectancy >30 days), and without severe psychological problems,

addiction, or dementia were included in the study. To this end, community and hospital physicians whose names were accessible through the official Swiss Association for Common Tasks of Health Insurers (SVK) taking care of HPN patients were contacted. Patients were subsequently contacted, screened for inclusion and exclusion criteria, and included in the study. This procedure was always conducted by the same single investigator, experienced in PN and in clinical study conduction. Patients were additionally asked for their further consent, allowing the investigator to collect medical data from the treating physician. Inquiry was regularly repeated to include all new patients on HPN during the study period.

Included patients filled the questionnaire alone or in a personal interview with the local investigator (mean duration 40 min) at home, during a hospital stay, or an outpatient visit. The questionnaires were available in German, French, Italian, and English. Deaths occurring during the study period were reported by family members and confirmed by the treating physician. The questionnaires completed by the patient prior to death were included in the final analysis and the PN duration accordingly adjusted.

Statistics

Statistical analysis was performed with Stata 14.0 (StataCorp. 2015. Stata Statistical Software: Release 14: StataCorp LP; College Station, TX, USA). Results are presented as mean ± standard deviation (MV±SD), or as number (*n*) and percentage (%). The Fisher's exact test for categorical variables was used for data analysis. Logistic regression models were fitted to investigate the association between the infections occurred during the entire study period and potential co-factors at baseline. No data were excluded from statistical calculations. As the sample size ($n = 70$) and the number of events ($n = 20$) were rather small, we did not calculate multivariable models but single models for each of the co-factors and infection. The p values <0.05 were considered as statistically significant.

Ethical Statement

This study was conducted in accordance with the ethical guidelines of the 1957 Declaration of Helsinki and the current national laws. The Bernese Cantonal Ethics Committee approved this study (KEK Bern, Study No. 2016-00669). Patients gave their written informed consent.

Results

In total, 70 patients were included in the study, representing 39,514 catheter-days (92 catheter-years). The mean follow-up duration was 11.3 months. Roughly 63% ($n = 44$) were cared and medically supervised at the Bern University Hospital. The prevalence of HPN in the adult Swiss population (6,835,622 million in 2019) amounts 5/million adult inhabitants per year. The incidence of PN is 3/million inhabitants per year. Figure 1 shows the detailed study flowchart. Table 2 shows the baseline characteristics of the study population.

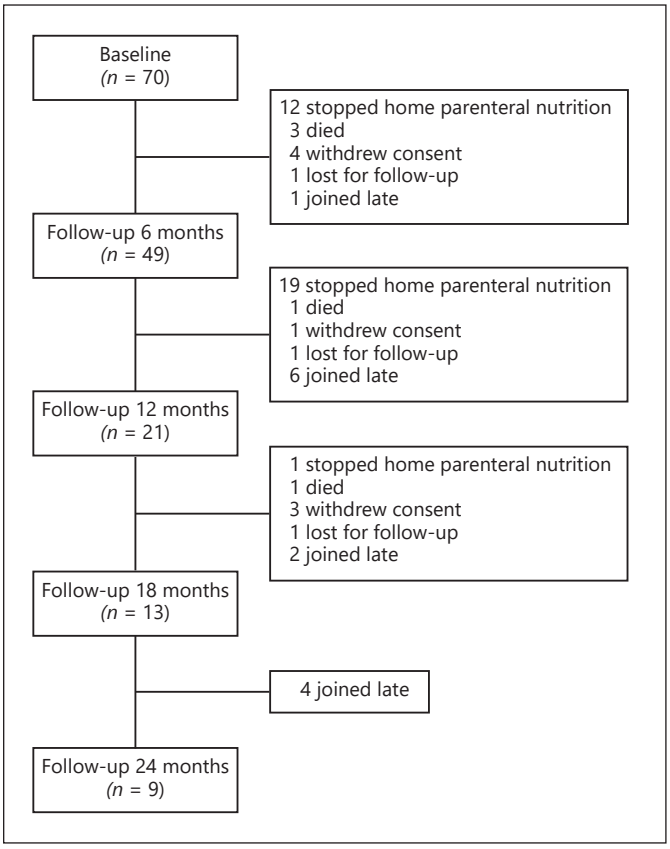

Fig. 1. Study flowchart. Joined late means patients were included after the study start and were therefore not able to complete more follow-up questionnaires; withdrew consent means that the patients did not want to fill the questionnaire anymore. HPN, home parenteral nutrition.

Indication for HPN and Underlying Disease

Table 3 shows the indications for prescribing HPN and the most common underlying diseases of the included patients. Of this population, 75% suffer from benign and 25% from malignant diseases. Further, 40% ($n = 28$) had a stoma, of which 28% ($n = 7$) with related problems (e.g., stoma fluid/bag leakage).

HPN Regimen and Medication

Half of the patients ($n = 35$) were started on HPN during the course of the study. Overall, 5 (7%) patients had total PN and 4 patients (6%) made the transition from total PN to supplemental PN during the study period. Table 4 shows the HPN regimen characteristics of the patients. The median duration of HPN was 1.31 years (range 25 days–37 years). In total, 47% of the patients ($n = 33$) were weaned off HPN: 26 resumed oral nutrition (thereof 7 had colostomy reversal) and 7 were in a termi-

Table 2. Population's baseline characteristics

Baseline characteristics	*N* (%)
Study population	70 (100)
Gender	
Female	35 (50)
Male	35 (50)
Age	59.2±16.2
Nationality	
Swiss	56 (80)
Others	14 (20)
Civil status	
Single	14 (20)
Married	36 (52)
Divorced	15 (21)
Widowed	5 (7)
Living situation	
Alone	22 (31)
With partner	36 (52)
With children <18 years	6 (9)
With parents	2 (3)
Others	3 (4)
n/a	1 (1)
Education	
Unskilled	7 (10)
Apprenticeship	40 (57)
Vocational certificate	3 (4)
University/technical school	16 (23)
n/a	4 (6)
Working status	
Full time	5 (7)
Part time	9 (13)
Housework	2 (3)
Not possible any more	24 (34)
Retired	28 (40)
n/a	2 (3)

Table 3. Indication for HPN and underlying disease, according to the pathophysiological classification of intestinal failure [3]

	N (%)
Indication for PN	
Short bowel syndrome	21 (30)
Motility disorder	13 (19)
Severe malnutrition	12 (17)
Fistula	11 (16)
Mucosal disease	6 (9)
Mechanical obstruction	4 (6)
Others	3 (4)
Underlying disease	
Cancer	16 (23)
Bariatric surgery	8 (11)
Crohn's disease	7 (10)
Mesenteric infarction	5 (7)
Surgical complications (chyle leak, leaking anastomosis, etc.)	4 (6)
Pancreatic disease	4 (6)
CIPO	4 (6)
Radiation enteritis	3 (4)
Others (polymyositis, protein losing enteropathy, common variable immunodeficiency, M. Hirschprung, FAP Gardner syndrome, etc.)	16 (23)

HPN, home parenteral nutrition; CIPO, chronic intestinal pseudo-obstruction.

nal condition (mean 14.5 days). Thirteen percent ($n = 9$) of the patients were diabetics and received insulin therapy. Commonly used drugs were gastric acid inhibitors (70%, $n = 49$), analgesics (43%, $n = 30$), enzyme replacement therapy (27%, $n = 19$), motility activators (20%, $n = 14$), antidepressants (17%, $n = 12$), and diuretics (10%, $n = 7$).

Central Venous Catheters, Catheter Care, and Related Complications

Table 5 shows CVC characteristics. Port-a-cath needle change occurred in average every 9.1 ± 3.2 days (range: 4–14 days). Dressing mostly consisted of films 84% ($n = 59$), mulls 7% ($n = 5$), or a mix of both 8% ($n = 6$). Dressing change occurred in average every 5.9 ± 2.7 days.

Fifty-six percent ($n = 39$) of the patients took care of themselves or with the help of a family member of the PN (aseptic handling, attach and depend the admixture, and add the micronutrients) while 44% ($n = 31$) required support from home nurses. The training for the catheter handling usually took place before leaving the hospital through the nursing staff (41%, $n = 29$). In most cases (74%, $n = 52$), initial training was described as too short, while 10% ($n = 7$) of the patients reported no specific training. Patients commonly received written information, mainly from the treating medical hospital staff ($n = 16$).

Most patients (80%, $n = 56$) reported to have an explicit setting up of the PN, in a specific place in the house (78%, $n = 55$): 23% ($n = 16$) in the living room, 20% ($n = 14$) in the bedroom, 17% ($n = 12$) in the kitchen/eating room, while 18% ($n = 13$) had separate dedicated places. Surface disinfection was reported by 94% ($n = 66$) of the patients, of which 17% ($n = 12$) used sterile towels. The most widely used skin disinfectant was chlorhexidine 31% ($n = 22$), and the most widely used surface disinfectant was alcohol. The aseptic handling occurred after a hand washing procedure in 88% ($n = 62$), hand disinfec-

Table 4. HPN regimen

Total PN, *n* (%)	5 (7)
Combination of EN (ONS or tube feeding) and PN, *n* (%)	4 (6)
Combination of oral nutrition and PN, *n* (%)	61 (87)
Standard industrial all-in-one admixture, *n* (%)	68 (97)
Nocturnal administration, *n* (%)	65 (93)
Average administration duration, h	13.2±3.3
Administration days per week, d	5.4±1.8
Mean total energy per applied bag, kcal	1,520±442
Mean total energy per kg body weight, kcal	24.1±8.1
Additional fluid requirements, *n* (%)	25 (36)
Isotonic sodium chloride 0.9% solution, *n* (%)	17 (24)
Ringer's solution, *n* (%)	5 (7)
Bicarbonate 8.4% solution, *n* (%)	2 (3)
Administration days per week, d	5.5±2.2
Vitamins and trace elements addition to PN admixture, *n* (%)	67 (96)
Supplemental electrolytes added to PN admixture, *n* (%)	10 (14)
Potassium, *n* (%)	6 (8)
Magnesium, *n* (%)	5 (7)

HPN, home parenteral nutrition.

tion in 98% (n = 69), with one-way gloves in 64% (n = 45), and with hygiene masks in 54% (n = 38) of the patients.

A large majority of the patients (88%, n = 62) were hospitalized in the half year prior to the study inclusion, 40% (n = 28) in relation to HPN. The hospital stay average was 27.8 ± 33.3 days (median: 13.5 days). During the study, the hospital stay averaged 26.1 ± 32.4 days (median: 13.5 days). Catheter-related problems caused not elective hospitalization in 57% of the cases. The number of PN and catheter-related incidents amounts 0.98/1,000 catheter-days (0.42/catheter-year). Table 6 shows the complication that occurred since the start of HPN (baseline) and during the course of the study (2 years).

Most common signs of infection were fever 73% (n = 19), shivering 69% (n = 18), redness of the skin at the catheter site 38% (n = 10), pus 31% (n = 8), feeling unwell 23% (n = 6), and hypertonia 7% (n = 2). Table 7 shows the odds ratios (OR) for infection during the course of the study according to observed co-factors. Of all observed co-factors, only handling of the PN/CVC revealed a significant association, when handling by a home nurse resulted in a significantly reduced OR for infection as compared with the self-carers (OR = 0.31, 95% CI: 0.10–0.98, p = 0.045).

Death occurred in 7% (n = 5) of the patients during the 2-year study period. Mortality was due to the underlying disease and not related to any complication of the HPN in all cases.

Table 5. CVC characteristics

Type	
Hickmann	37 (53)
Port	21 (30)
PICC	12 (17)
Lumen	
Single-lumen catheters	66 (94)
Placement side	
Right side	35 (50)
Insertion vein	
Subclavian vein	22 (31)
Cephalic vein	17 (24)
Jugular vein	16 (23)
Use	
Exclusively PN	22 (31)
Blood	16 (23)
Drug	4 (6)
All	28 (40)
Lock	
Isotonic saline solutions	35 (50)
Heparin block (500 IU)	15 (22)
Taurolidine block (taurolidine citrate 4%)	18 (26)
Taurolidine-heparin block (taurolidine citrate 4% and heparin 100 IU)	2 (3)

Values are given as *n* (%).

Table 6. Occurrence of catheter-related complications

	During study period, *n* (%)
Mechanic complications	8 (11)
Obstruction	5 (7) 0.13/1,000 catheter-days 0.05/catheter-year
Leak/break	2 (3) 0.05/1,000 catheter-days 0.02/catheter-year
Dislocation	1 (1) 0.02/1,000 catheter-days 0.01/catheter-year
Central venous thrombosis	5 (7) 0.13/1,000 catheter-days 0.05/catheter-year
Infections	20 (28) 0.66/1,000 catheter-days 0.28/catheter-year
One infection	15 (21)
Two infections	4 (6)
More than 2 infections	1 (1)

Discussion/Conclusion

This is the first prospective study investigating a Swiss adult cohort of patients on HPN [10, 11]. Despite its rather small sample size, this study is representative of this population. The incidence and prevalence of HPN (3 and 5/million adult inhabitants, respectively) reported in this study are comparable to previous studies. In Europe, the incidence of HPN reaches about 4–6 per million per year, and in Switzerland 4 per 1 million adult inhabitants per year were previously reported, while the prevalence of HPN reaches 2–40 per million adult inhabitants in Europe and 4–6 per million adult inhabitants in Switzerland [4, 10, 11].

Crohn's disease, mesenteric infarction, and cancer are amongst the most common underlying diseases for HPN in Europe [4]. While cancer remains the most common underlying disease in the present study, we also included several patients after bariatric surgery [4]. This increasingly becomes a new indication for HPN due the high frequency of this surgical intervention and associated complications [13, 14]. Regarding the indications, short bowel syndrome remains the most common one [2, 8, 9, 15, 16].

The overall survival rate after the 2-year study period was 93%. This is comparable to other studies after 1 year [5, 8]. Similar to other studies, the cause of death was the underlying disease rather than PN-related complications [6, 7, 17]. Weaning off rates of HPN in our cohort was 47%, similar to the rates reported in the literature (20–50%) [2, 14, 18, 19]. Our weaning data are high considering the greater proportion of malignant diseases compared to published data, despite the low number of very long-term HPN patients. We grouped patients with malignant and benign diseases regarding the small overall sample size what may represent a bias given the intrinsic difference in prognosis, rate of complications such as infections and thrombosis, etc.

We found overall a high compliance of the HPN management with the current ESPEN guidelines on HPN [2]. The catheter features were mainly in line with the guidelines regarding type of catheters, insertion site, dressing, and care. The loss of venous access (e.g., catheter displacement and site shift) is the main problem in HPN treatment [7]. Catheter-related infections are the most common as well as dangerous complications with an overall infection rate of 0.66 per 1,000 catheter-days in our study, defined as proposed in the ESPEN guidelines on PN [20]. Other studies reported rates between 0.38 and 4.58/1,000 catheter-days [7, 21, 22]. Around 80% of the infections are catheter-related bloodstream, 17% are exit site, and 2% are tunnel infections [7]. Due to the nature of the study, we could only record the infections for which catheter had to be removed and were not able to differentiate between the different types of infections. Other infections may have been missed, for example, infections where catheters were saved. Restricting only to catheter-related bloodstream infections would result in lower rates (presuming that catheter-related bloodstream infections account for 80% of the total infections: 0.52/1,000 catheter-days). However, the terminology to define these infections is still a matter of debate, and it makes it difficult to compare trials [23]. We were not able to detect any significant specific pattern influencing infection rates in our study. This is probably mainly due to the limited sample size of our study, which did not allow us to calculate multivariable and thus adjusted regressions. With larger samples at hand, observed trends and associations would become clearer. Since infections are largely caused by skin pathogens (50%), hygiene and aseptic training remain the key to reduce infection rates and thus morbidity and mortality rates and costs [2,

Table 7. Odds ratios for infection

	OR	95% CI	*p* value
Demographic parameters			
Age			
<50 yr	1.00		
50–65 yr	0.20	0.05–0.82	0.026
>65 yr	0.33	0.09–1.17	0.087
Educational level			
Others	1.00		
Higher education	0.58	0.11–3.02	0.521
Living status			
Others	1.00		
Live alone	0.44	0.13–1.53	0.199
Disease-related parameters			
Presence of a stoma			
No	1.00		
Yes	2.33	0.80–6.77	0.119
Underlying disease			
Cancer	1.00		
Inflammatory disease	0.50	0.08–3.29	0.471
Obstructive disease	1.00	0.17–5.77	1.000
Others	1.08	0.26–4.42	0.918
Surgical complications	0.46	0.09–2.41	0.359
PN-related parameters			
Care centre			
Practicing physician	0.33	0.04–2.95	0.323
Canton hospital	1.17	0.30–4.47	0.822
University hospital	1.00		
Handling of the PN/CVC			
Self-carer	1.00		
Home nurse	0.31	0.10–0.98	0.045
Duration of PN			
≤1 yr	1.00		
2–5 yr	1.05	0.33–3.39	0.932
>5 yr	1.02	0.25–4.11	0.975
Type of CVC			
Hickmann catheter	1.00		
Port-a-cath	0.58	0.17–1.93	0.373
PICC	0.37	0.07–1.94	0.240
Lock of CVC			
NaCl	1.00		
Heparin	2.06	0.52–8.16	0.302
Tauro lock	1.98	0.60–6.56	0.263
Use of CVC			
Blood withdrawal	1.00		
No blood withdrawal	1.56	0.51–4.73	0.436
Hand washing procedure before disinfection			
No	1.00		
Yes	3.09	0.36–26.92	0.306
Use of gloves for aseptic handling			
No	1.00		
Yes	1.04	0.35–3.09	0.937
Complications			
Occurrence of CVT			
No	1.00		
Yes	2.63	0.76–9.15	0.128
Occurrence of mechanic complication			
No	1.00		
Yes	1.45	0.51–4.17	0.486

OR, odds ratio; CI, confidence interval; PN, parenteral nutrition; CVC, central venous catheter; CVT, central venous thrombosis.

23]. The use of a taurolidine lock was not associated with reduced infection rates in our cohort. However, from our clinical practice in the hospital as well as long-term expertise in the field, we noted subjectively a trend of less catheter-related infections since the implementation of taurolidine lock. The efficacy of taurolidine has been demonstrated as well in the primary prevention of catheter-related infections as in the secondary prophylaxis; however, most of the trials present methodological weakness [24–26]. A further important aspect for the investigated quality and safety of HPN was thrombosis, which might closely be related to infections. We found very low rates of CVC-associated thrombosis (0.05/catheter-year) compared to the literature (0.08/catheter-year) despite the 25% of our cohort suffering from malignancies (higher risk of thromboembolism: 25 vs. 10%) [6, 8, 27, 28].

In our study, the overall complication rate amounts 0.98/1,000 catheter-days, affecting 28% of the patients. While similar percentages were found in other studies, the rates were higher with 1.06–5.06 events per 1,000 catheter-days [21, 27, 29]. According to a recent meta-analysis of prospective trials, the current evidence is insufficient to show differences in infection rates between tunnelled catheters and peripherally inserted central catheters while the latter shows lower infection rates compared to port systems [30]. Furthermore, there were no differences in the rates of mechanical complications and catheter-related thrombosis. Vashi et al. [31] also could not show any difference between catheter types and postulated that the incidence of infections in patients receiving HPN might be related to the care protocol used rather than to the type of catheter. Catheter-related infection rates effectively reflect the quality of training and the adherence of patients to the given instructions. Our results are in line with these findings, as we could not show any difference between the types of catheters by overall low complication rates.

We found discrepancies with the current ESPEN HPN guidelines in 2 points: blood drawing from the catheter and lowering of the infusion rates in the last hour of administration [2]. In our cohort, the routine drawing of blood samples occurs via the catheters in 63%, which should be avoided as far as possible due to a higher complication risk. Further, none of the patients reduced the infusion rate at the end of the mostly overnight PN administration, meant to avoid rebound hypoglycaemia due to the high insulin stimulation by the important glucose dosing by PN [2]. Only one patient in our study reported hypoglycaemia, what she could manage by eating small portions of carbohydrate-rich food. Since PN was supplemental in the large majority of the patients, they may have eaten after the administration, thus avoiding rebound hypoglycaemia. To give evidence, this statement should be investigated by appropriate blood sugar monitoring in an appropriately powered group of HPN patients.

The current guidelines and standards recommend the prescription, implementation, and monitoring of PN by multi-professional nutritional support teams in dedicated competence centres with expertise in management of HPN, including physicians, specialized nurses, dieticians, and pharmacists [2, 32]. Patients cared by such centres show better clinical outcomes [2]. Evidence-based standards and well-documented complication reports are therefore mandatory for a quality-assured HPN provision. Our study showed that HPN programs are not implemented in all hospitals and that the management of the patients varies to a large extent offering important potential for improvement, for example, implementing standardized protocols, conducting educational meetings, networking, and expert opinion exchange between hospitals and competence centres [18]. Our results also underline the importance of education and training for aseptic handling, since self-caring patients showed higher risk for infection compared to the nurses. Further, there is urgency for a nationwide registry for PN to characterize and assess quality of care in HPN and for international comparability and benchmarking. Our results show low complication rates, which do not influence mortality rates. Even if the management of HPN largely varies throughout the country, the compliance with the current ESPEN guidelines is high and validates their clinical value, contributing to high standard of care and low complication rates.

Best practices for HPN remain to be defined, as they are mostly based on expert opinion, expertise, experience, and local/national/international guidelines [16]. Therefore and in order to offer all patients the best therapy, there is a clear need to define competence centres and adequately staff trained and experienced for (H)PN with personnel with PN.

This study also has limitations. First, results are subjected to reporting and recall bias since we used questionnaires to collect data. Second, it is mostly difficult for patients to keep apart the complications or issues related to underlying disease and specifically related to HPN. In conclusion, this study underlines that when administered according to the actual standards, the HPN therapy is safe, efficient, and enables patients to live at home in familiar and good life conditions.

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Statement of Ethics

This study was conducted in accordance with the ethical guidelines of the 1957 Declaration of Helsinki and the current national laws. The Bernese Cantonal Ethics Committee approved this study (KEK Bern, Study No. 2016-00669). Patients gave their written informed consent.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Emilie Reber: conceptualization, methodology, investigation, data curation, formal analysis, and writing – original draft. Kaspar Staub: data curation, formal analysis, and writing – review and editing. Katja Schönenberger: writing – review and editing. Anastasia Stanga: writing – review and editing. Michèle Leuenberger: investigation and writing – review and editing. Claude Pichard: investigation and writing – review and editing. Stefan Mühlebach: conceptualization, methodology, supervision, and writing – review and editing. Zeno Stanga: conceptualization, methodology, supervision, and writing – review and editing.

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