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Proximal humeral fractures in Finland: regional differences in incidence and methods of treatment

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Background: Proximal humeral fractures (PHFs) are one of the most common fragility fractures and there is accumulating evidence that even displaced PHFs should be treated conservatively. The treatment should be as effective and standardized as possible regardless of the hospital district of the patient. The aim of this study was to describe possible regional variation in incidence and treatment methods of PHFs in Finland.

Methods: The study included all Finnish inhabitants aged 16 years and older with PHF diagnosis between 1997 and 2019. All records are based on data from 2 national registers. The fractures and operations were organized according to hospital district of the patient and annual incidences of PHFs, and different treatment methods were calculated for each hospital district.

Results: Between 1997 and 2019, 79,053 PHFs were identified. 64,117 of PHFs were treated conservatively and 14,936 operatively. The incidence of conservative treatment corresponded closely to the fracture incidence per hospital district. Internal fixation incidence generally increased toward the end of the first half of the study period and declined thereafter, and hemiarthroplasty was replaced by total shoulder arthroplasty as the most common type of arthroplasty by the end of the period. We found regional variation in the incidence of PHFs, with a low of 61.4 per 10⁵ in Åland, and a high of 97.7 per 10⁵ in East-Savo.

Conclusion: In Finland, the treatment of PHFs did not differ fundamentally between hospital districts and a general evidence-based shift in treatment practice was shown. We found regional variation in the incidence of PHFs, and it seems that the higher incidence of PHFs is concentrated in Eastern Finland.

Level of evidence: Level III; Retrospective Cohort Comparison; Descriptive Epidemiology Study

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Keywords: Proximal humeral fracture; regional variation; incidence; treatment methods; orif; reverse shoulder arthroplasty; Finnish National Discharge Register; register of Primary Health Care visits

Finland's National Institute for Health and Wellness (THL) approved this study (THL/2266/5.05.00/2019).

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Proximal humeral fractures (PHFs) are the third most common fragility fractures after hip and wrist fractures,^{5,20} and the incidence of PHFs has been increasing steadily in Finland between 1997 and 2019.¹⁴ Most of these fractures occur following a simple fall, and the most common patient group is elderly women.²⁰ PHFs are treated conservatively

or surgically,¹¹ mostly depending on the fracture pattern and various factors related to the patient. PHFs that are minimally displaced generally heal well when conservatively treated with good functional outcomes, especially in elderly patients. Surgical treatment options include internal fixation (IF) (e.g. minimally invasive osteosynthesis, open reduction and plate fixation, and intramedullary nailing), and primary arthroplasty.¹⁵ The choice of surgical treatment depends not only on the fracture and patient,¹⁷ but also on the experience and preferences of the surgeon, which can lead to geographical differences.¹ There is accumulating evidence promoting a more conservative approach to treatment even for displaced PHFs,^{8,18,19,22,23} which has led to a clear shift in treatment practices in our country.¹⁴ PHF treatments should be as effective and standardized as possible, especially in a country like Finland that has only 5.6 million inhabitants, a publicly funded healthcare system and a rapidly growing elderly population. In addition, the choice of treatment should always be based on the most recent evidence available. To date, no annual reports of possible regional variation in PHFs have been published. Thus, the aim of this study was to determine whether clear regional differences in PHF incidence and treatment methods exist, and how these have developed during recent decades in Finland. We hypothesized to find some regional differences in the treatment of PHFs and that the incidence would not differ significantly between hospital districts.

Materials and methods

This is an observational retrospective cohort study based on data from the Finnish National Hospital Discharge Register (NHDR) and the register of Primary Health Care Visits. These databases receive reports of all public and private hospital visits and all public primary health care visits, including diagnostic, procedural, and injury mechanism codes as well as data on patient age and type of health care service provided. The NHDR and Primary Health Care Visits were searched for all Finnish inhabitants aged 16 and older who had been treated for a PHF (ICD-10 code S42.2, International Classification of Diseases) between 1st January 1997 and 31st December 2019. The NHDR was also searched for surgical procedural codes (Nordic Classification of Surgical Procedures) for treatment of PHFs, including all IFs and arthroplasties. Through extensive exclusion of records, we identified and included only acute fractures and operations to treat them. A more detailed description and exclusion flow chart have been published in a previous study.¹⁴ The fractures and operations were organized according to hospital district of the patient and the incidences were calculated based on the annual adult population size of the hospital district in question, provided by the electronic national population register.²⁶ There are 5 University Hospitals in Finland: Helsinki University Hospital, Tampere University Hospital, Turku University Hospital, Kuopio University Hospital, and Oulu University Hospital. These together form 5 separate hospital catchment areas, which together with their population size on the 31st of December 2019, are shown in [Figure 1](#). The statistical

analysis was done using R software (version 4.2.2, R Core Team, Vienna, Austria) with packages ggplot2 (version 3.4.0, Springer-Verlag, New York, NY, USA) and mapsFinland (version 0.1.1, mapsFinland: Maps of Finland). Ethical approval and study permit were granted by Finland's National Institute for Health and Wellness¹⁶ (study permit number THL/2266/5.05.00/2019).

Results

We identified 79,053 PHFs of which 64,117 were treated conservatively and 14,936 operatively. A total of 12,521 IFs and 2415 arthroplasties were performed to treat PHFs. The mean age of PHF patients varied between 64.7 in Helsinki and Uusimaa and 69.6 in East-Savo. The proportion of patients aged 65 and older was lowest in Helsinki and Uusimaa with 54.5% and highest in Vaasa with 66.6%. During 1997-2019, the mean incidence of PHFs in all of Finland was 78.9 per 10⁵ varying between 61.4 per 10⁵ in Åland and 97.7 per 10⁵ in East-Savo. ([Fig. 2, A](#)). The incidence of conservative treatment corresponded closely to the fracture incidence per hospital district ([Fig. 2, B](#)). The incidence of operative treatment was highest in Central Ostrobothnia with an incidence of 20.2 per 10⁵ whereas the lowest incidence was in Åland with an incidence of 3.7 per 10⁵ ([Fig. 2, C](#)).

When observing the data in 10-year intervals, we see a clear trend toward more conservative treatment in 2018 compared to 1998 and 2008 ([Fig. 3](#) and [Supplementary Figure S1, A](#)). The use of IF was generally highest in 2008. In the beginning of the study period, the highest incidence of IF was in Central Ostrobothnia (26.1 per 10⁵, n = 16) but this declined thereafter. IF rates in East-Savo have on the other hand increased (from 4.8 to 30.4 per 10⁵, n = 2 & 11) between 1998-2018. ([Figs. 3](#) and [Supplementary Figure S1, B](#)). Nationally, hemiarthroplasty (HA) was the most common arthroplasty type in 2008 but was replaced by total shoulder arthroplasty (TSA) by 2018. The highest 2008 HA incidence was in Central Ostrobothnia (9.7 per 10⁵, n = 6) followed by Kymenlaakso (6.8 per 10⁵, n = 10). The highest 2018 incidences of TSA were in Vaasa (5.1 per 10⁵, n = 7) followed by Pirkanmaa (3.6 per 10⁵, n = 16) and Central Ostrobothnia (3.2 per 10⁵, n = 2). ([Fig. 3, Supplementary Figure S1, C and D](#)). In Southwest Finland, 10 TSAs were performed making it second largest in numbers but with an incidence of 2.5 per 10⁵.

Discussion

As previously published national results show, the incidence of PHFs in Finland is increasing steadily.¹⁴ Our study found regional variation in the incidence of PHFs, with a low of 61.4 per 10⁵ in Åland, and a high of 97.7 per 10⁵ in East-Savo. It seems that higher incidence of PHFs is

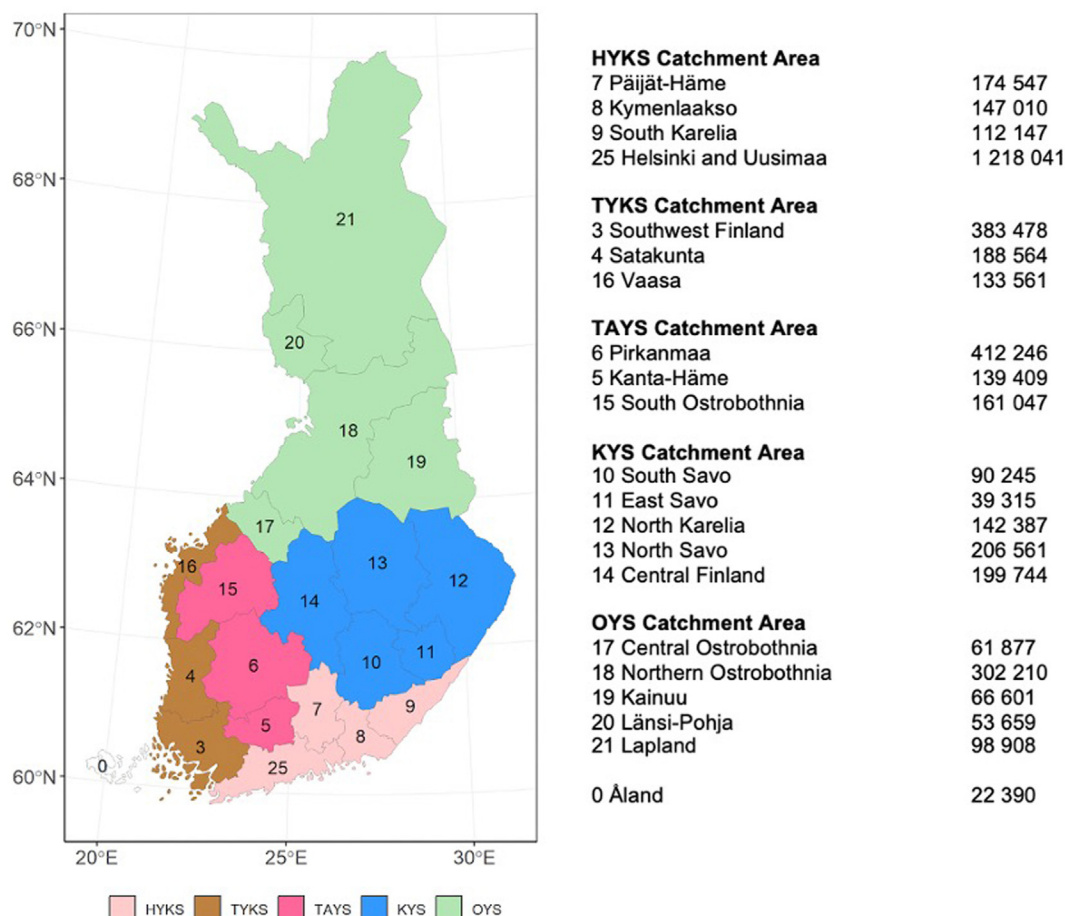


Figure 1 Hospital districts in Finland and their population on the 31st of December 2019. *HYKS*, Helsinki University Hospital; *TAYS*, Tampere University Hospital; *TYKS*, Turku University Hospital; *KYS*, Kuopio University Hospital; *OYS*, Oulu University Hospital.

concentrated in the Eastern Finland. The etiology of the regional variation of PHFs is unclear. Patient factors related to falls and bone fragility, such as age, overall health status, and polymedication, may be possible contributors.^{4,13} For example, there is comprehensive data that Northern-Eastern Finland bear greater morbidity burden compared to Southern-Western Finland.²¹

We found that despite some expected regional variation between hospital districts, there were no fundamental differences in the proportions of treatment methods. The results show that the trends in conservative treatment incidence for PHFs conform to the trends of PHF incidence in general, as both have increased in most of the hospital districts, mirroring previously published national results.¹⁴ As reported in this previous study, when observing the data between 10-year intervals, IF incidence generally increased toward the end of the first half of the study period and declined thereafter, and HA was replaced by TSA as the most common type of arthroplasty by the end of the period. As anatomical TSA and reverse shoulder arthroplasty (RSA) share the same Nordic Classification of

Surgical Procedures procedure code of NBB20, it is impossible to differentiate anatomical TSAs from RSAs based solely on NHDR data. However, based on data from the Finnish arthroplasty register, the rise in TSA incidence is in fact a rise in RSA incidence.^{9,14} In the 2010s, some authors found RSA to provide a better and a more predictable outcome than hemiarthroplasty, which explains the replacement as the most common type of arthroplasty found in our study.^{6,7,24}

The differences in IF incidence between hospital districts in these sampled years (ranging for instance in 1998 from zero in Åland to as high as 26.1 in Central Ostrobothnia), were in fact quite marginal when observing the differences in operation numbers. The population of the hospital district of Central Ostrobothnia is quite small, resulting in an IF incidence of 26.1 with only 16 operations. The hospital district of Helsinki and Uusimaa, with its considerably larger population size, had an osteosynthesis incidence of 12.5 with 135 operations that same year. The same applies to shoulder arthroplasty, where incidence and absolute operation numbers were even lesser. Because of

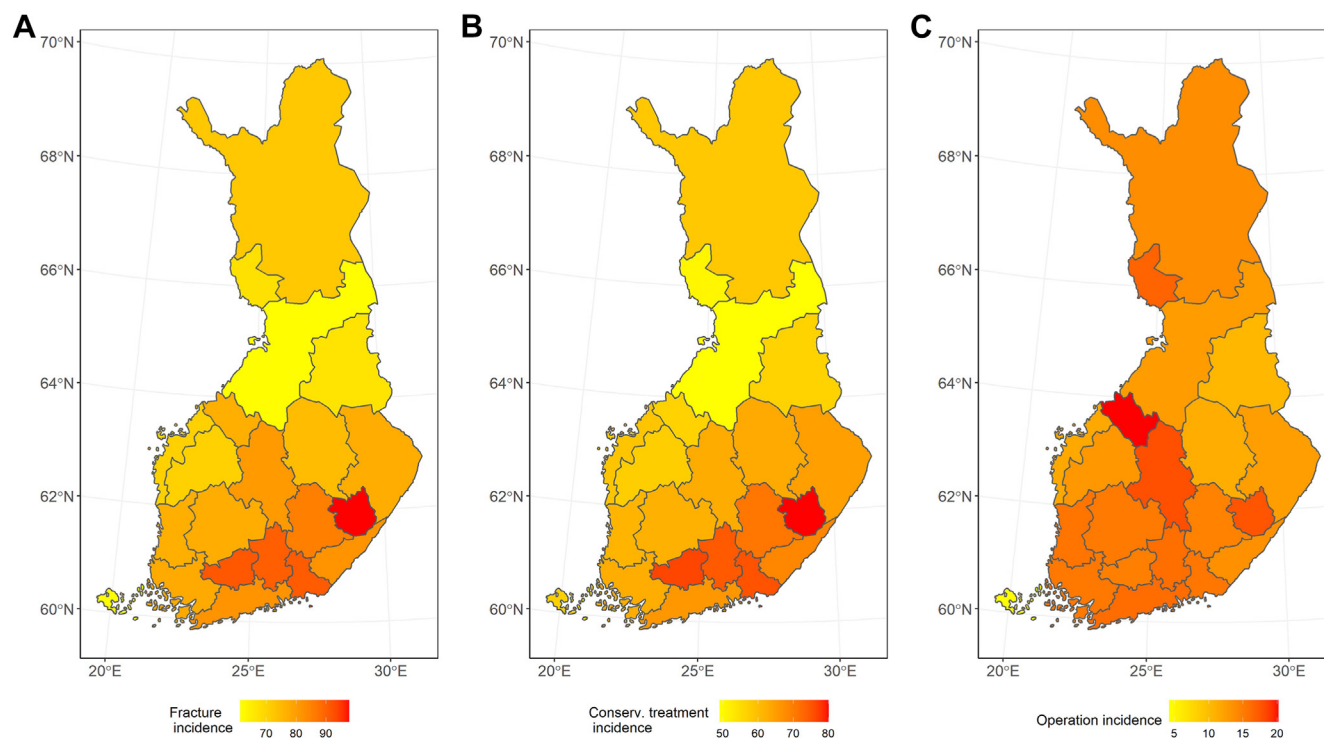


Figure 2 (A) Incidence by hospital district. (B) Conservative treatment by hospital district. (C) Operative treatment by hospital district.

the small operation numbers, it is not possible to draw conclusions about fundamental differences in practice, especially when data on exact fracture patterns and other patient-related factors aren't available. PHFs with their specific patterns and patient-related issues are random events, subject to some regional and temporal variation. According to the current data, the level of consensus among Finnish orthopedic surgeons seems better compared to previous similar work from the United States.^{2,5,24}

Of operative treatment methods, IF is the most common and it is used widely in most hospital districts whereas HA and TSA or RSA incidences vary more between districts. IF is generally available and in the hands of a large group of orthopedic surgeons, with less facility requirements and a shorter learning-curve compared to arthroplasty, whereas shoulder arthroplasty is performed by a limited number of surgeons and hospitals, therefore more dependent on the surgeon's preference, expertise, and beliefs.^{1,2} An interesting question is whether shoulder specialists, with the full repertoire and experience in treatment of PHFs and PHF sequelae, are more prone to the influence of current literature than other orthopedic and trauma surgeons who concentrate on osteosynthesis in general. For example, a considerable amount of research has been conducted on RSA, and one can only speculate whether shoulder specialists choose RSA over other treatment methods with broader indications, although according to the latest Cochrane review, the level of evidence in favor of RSA

remains low.⁸ The decision-making process of the treatment method of a PHF is complex, beside the radiographs ideally considering factors such as general health status, factors influencing compliance, ability to cope with possible complications, as well as the sex, demands and handedness of the patient. In addition to these, the patient's expectations and beliefs might also affect the choice of treatment.^{1,10}

In Helsinki and Uusimaa, the proportion of patients aged 65 and older was 54.5%, whereas in nearly all other hospital districts, it was more than 60%, even more than 65%. There was a statistically significant difference in the number of younger patients in Helsinki and Uusimaa compared with other hospital districts, except for Åland, where the number of patients was very small. Larger hospital districts often have a higher proportion of younger patients with high-energy injuries, as well as younger patients in poorer health with lower-energy injuries. According to our study, younger age did not significantly affect the choice of treatment.

An interesting note is that although the incidences used in this study, including those of arthroplasty, were reported according to the hospital district of the patient, we know that arthroplasty for PHFs is centralized to specialized institutions in Finland, especially in most recent times. For instance, in 2018, to our knowledge, no arthroplasties for PHFs were performed at Central Ostrobothnia Central hospital or at Lapland Central Hospital; these surgeries

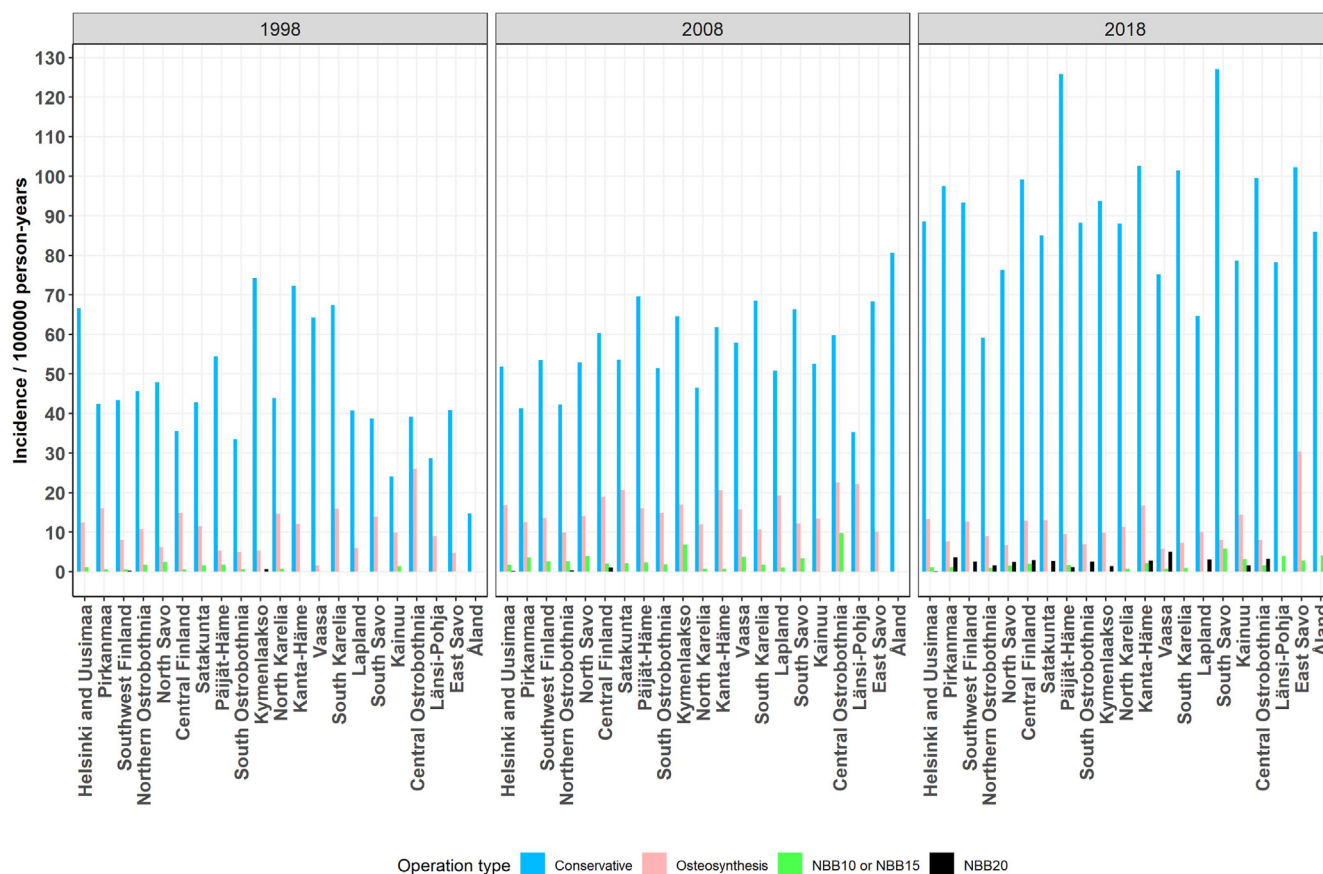


Figure 3 Incidence of treatment methods by hospital district in 1998, 2008, and 2018.

were performed at Oulu University Hospital despite being registered to the hospital districts of the patients. In these cases, the patients were referred to arthroplasty units for treatment evaluation. One might question, if patients referred from a smaller unit to a specialized unit for operative consultation might be more prone to end up treated operatively compared to patients treated in units where shoulder arthroplasty is readily available as an option. When a patient has travelled a long way and is already here, why not operate? Are all the patient related factors considered along with shared decision-making in such cases or is there a possibility for bias? – Perhaps, but again the numbers are too small to draw such conclusions. We made a listing of the hospitals for patients who had undergone arthroplasty in 1997-2019 for a PHF and most arthroplasties were performed in 5 University Clinics in Finland, and a smaller amount in larger Central hospitals (e.g. Jyväskylä in Central Finland, Lahti in Päijät-Häme, Vaasa in Vaasa hospital district and Seinäjoki in Southern-Pohjanmaa, in receding order by operation numbers). Only few cases were treated in smaller or private hospitals.

When considering arthroplasty for PHFs, the level of evidence is still scarce.⁸ Published studies report a better

range of motion and functional outcome scores for RSA compared to HA, but its role in the treatment of PHFs remains insufficient as literature offers only low-quality studies with low level of evidence.^{7,8,27} As Stig Brorsen said, we need less, but better research. Just because it seems that RSA is better than HA and IF, it does not mean it is better than conservative treatment for the largest bulk of patients in the long run.³ Results from more efficacy studies are needed to draw such conclusions and luckily, some are in the making such as the Deltacon-trial.¹² Later, it will be interesting to see if RSA for PHFs will act in the way of the Scott parabola²⁵ and rise to the skies before the following fall as has happened to IF for PHFs.

This is an observational study based on an administrative database. The analysis was performed based on diagnosis and surgical procedural codes. Specific data on fracture pattern or patient-related issues were not available, so it was not possible to determine the reasoning behind chosen treatment methods. We did not report complications or revision rates as this was not part of the study design. This study also demonstrates a limitation of register studies in general: When concentrating on smaller groups of patients, for instance patients treated with IF of arthroplasty

for PHFs in a single hospital district, the quantity of observations decreases, and data become more granular. However, a clear strength of this study is its size as it includes the population of an entire country, without selection bias. The purpose of this study was to try to determine what has actually happened in PHF treatment in Finland, not to give treatment recommendations or report treatment outcome.

Conclusion

The results of our study show that there is a general evidence-based shift in treatment practice and no fundamental difference in treatment of PHFs between hospital districts in Finland. Instead, we found regional variation in the incidence of PHFs, but its etiology remains unclear.

Disclaimers:

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Supplementary Data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jse.2024.08.027>.

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