Clinical Epidemiology Dovepress

Open Access Full Text Article ORIGINAL RESEARCH

# A Validation Study of the Danish ICD-10 Diagnosis Code K75.0 for Pyogenic Liver Abscess

Margarita Dudina[1,2], Kirstine Kobberøe Søgaard[1,3], Søren Schou Olesen[3,4], Hans Linde Nielsen[1,3]

[1]Department of Clinical Microbiology, Aalborg University Hospital, Aalborg, 9000, Denmark; [2]Department of Clinical Microbiology, Aarhus University Hospital, Aarhus N, 8200, Denmark; [3]Department of Clinical Medicine, Aalborg University, Aalborg, 9000, Denmark; [4]Centre for Pancreatic Diseases, Department of Gastroenterology and Hepatology, Aalborg University Hospital, Aalborg, 9000, Denmark

Correspondence: Margarita Dudina, Department of Clinical Microbiology, Aarhus University Hospital, Palle Juul-Jensens Boulevard 99, Aarhus N, 8200, Denmark, Email mardud@rm.dk

**Purpose:** Routinely collected clinical data are a valuable resource for epidemiological research in infectious diseases. We examined the validity of the ICD-10 diagnosis code K75.0 for pyogenic liver abscess (PLA) from hospital discharge registries.

**Patients and Methods:** This validation study was conducted in the North Denmark Region, using data from Aalborg University Hospital and the North Denmark Regional Hospital, along with their smaller regional satellite hospitals. The study period extended from January 1, 2010, to June 30, 2022, covering a catchment population of approximately 590,000 inhabitants. We identified patients with a first diagnosis (primary or secondary) of PLA (ICD-10 code K75.0) recorded in the Danish National Patient Registry and estimated the positive predictive value (PPV) of the PLA diagnosis using medical records as the reference standard. Subanalyses of PPV were conducted based on the department setting (emergency, medical, or surgical).

**Results:** A total of 297 patients received an ICD-10 diagnosis code of K75.0 during the study period. Five (2.0%) patients were excluded due to initial hospitalization outside the North Denmark Region, and 67 (23%) were misclassified. The overall PPV for the K75.0 diagnosis code during the study period was 77% (95% CI: 72–82%). The highest PPV, 88% (95% CI: 81–93%), was observed in patients diagnosed in medical departments, while the lowest PPV, 56% (95% CI: 30–80%), was observed in patients diagnosed in emergency wards. The PPV for surgical departments was 69% (95% CI: 61–77%).

**Conclusion:** The overall PPV of the ICD-10 diagnosis code K75.0 for PLA was 77%. Variability in PPVs across departments suggested differences in diagnostic accuracy, with medical departments demonstrating the highest PPV.

**Keywords:** pyogenic liver abscess, hepatic abscess, epidemiology, validation, positive predictive value

## Introduction

Pyogenic liver abscess (PLA) is a severe bacterial infection characterized by nonspecific symptoms such as fever, right upper quadrant pain, and weight loss, and is often associated with considerable morbidity and mortality.[1] The understanding of PLA has evolved significantly in recent decades, but it remains a challenge for physicians due to its diverse aetiology and complexities in management. The nonspecific presentation of PLA often leads to misdiagnosis in the initial phase, making it difficult to distinguish PLA from other liver diseases.[2]

The 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) provides a standardized coding system for various medical conditions, with code K75.0 specifically designated for PLA. In Denmark, the Danish National Patient Registry (DNPR) serves as a comprehensive database of routinely collected clinical data registered with ICD-10 codes since 1994. Such real-world data are a valuable resource for tracking disease prevalence and healthcare outcomes. However, validation of diagnosis codes is essential to ensure the reliability of epidemiological data and general principles for performing such validation studies were recently published.[3]

Despite the widespread use of the DNPR, there has been limited research focused on the validation of the specific ICD-10 code for PLA. Ensuring the accuracy of this code is particularly important given the serious nature of PLA and

Received: 9 July 2024
Accepted: 14 October 2024
Published: 21 November 2024

the potential consequences of diagnostic errors. Previous studies have highlighted the importance of validating ICD-10 codes to improve data quality and enhance the credibility of research findings.[4]

We therefore aimed to validate and assess the data quality of the PLA diagnosis code ICD-10 K75.0 in the DNPR. We evaluated all cases using medical records as the reference standard and calculated the positive predictive value (PPV) of the diagnosis code for PLA.

# Materials and Methods

## Study Design and Setting

This validation study was conducted in the North Denmark Region, using data from Aalborg University Hospital (UH) and the North Denmark Regional Hospital, along with their smaller regional satellite hospitals. Together, these hospitals have a total of approximately 1,000 beds. Aalborg UH serves as the reference hospital and handles highly specialized regional functions, whereas the North Denmark Regional Hospital and other regional hospitals cover the remaining healthcare needs in the region. The study period extended from January 1, 2010, to June 30, 2022, covering a catchment population of around 590.000 inhabitants,[5] representing approximately 10% of the Danish population. In Denmark, free healthcare is accessible to all residents, funded through taxes and administered by public hospitals. All Danish citizens are assigned a unique 10-digit civil registration number (CPR), which integrates their date of birth and sex, allowing seamless linkage across various administrative registries.[6]

## Data Sources

The Business Intelligence and Analysis Unit in the North Denmark Region provided CPR numbers for all patients, regardless of age, who received a primary or secondary discharge diagnosis of PLA using the ICD-10 code K75.0 (Abscess of liver) during the study period. For patients diagnosed with PLA episodes more than once during the study period, only the first episode was included in the validation. If patients had multiple discharging PLA diagnosis codes from different departments during the same hospitalization episode, such as an initial diagnosis in the emergency ward followed by a transfer to another department (eg, department of surgery or internal medicine), the final department of discharge was recorded.

Microbiological data, including positive specimens from abscess material and/or blood culture, were retrieved from the microbiological database (WWBakt, Autonik AB, Nyköping, Sweden) at the Department of Clinical Microbiology, Aalborg UH. The department provides microbiological services for the entire North Denmark Region. Additionally, the patients' medical records were reviewed to extract information on clinical presentation, medical history, and radiological findings.

## Validation of ICD-10 Diagnosis Code K75.0

PLA diagnosis code K75.0 was validated through a comprehensive review of the microbiology data, medical records, and radiological and histopathological findings. The diagnosis was considered confirmed if any of the following criteria were met:

i. Imaging confirmation with culture-positive abscess material: Imaging modalities such as abdominal ultrasonography, Computed tomography (CT) scan, Magnetic resonance imaging (MRI) scan, or Positron emission tomography (PET) scan confirmed the presence of PLA, and percutaneous needle aspiration, percutaneous drainage, or surgical exploration yielded positive cultures and/or PCR results for pathogenic bacteria or yeast.
ii. Imaging confirmation with positive blood culture: Imaging modalities such as abdominal ultrasonography, CT scan, MRI scan, or PET scan confirmed the presence of PLA, and patients concurrently had a positive blood culture (without abscess material or with culture-negative abscess material).
iii. Imaging confirmation with clinical response: Imaging modalities such as abdominal ultrasonography, CT scan, MRI scan, or PET scan confirmed the presence of PLA, and patients demonstrated a clear clinical, biochemical, and radiological response to antimicrobial therapy (without culture-positive samples).
iv. Histopathological confirmation: Histopathological examination revealed the presence of pus and/or bacteria, even in cases where blood culture and diagnostic imaging were negative, and no abscess material was sent to the microbiological laboratory.

Misclassification was defined as any case that did not meet the above criteria, or where another diagnosis explained the clinical presentation (eg, malignancy).

## Microbiological Sample Cultivation

Pus material underwent cultivation on solid agar media, incubated under both a $CO_2$-enriched atmosphere and anaerobic conditions. Blood cultures were processed using the Bact/ALERT system (BioMérieux, Marcy-L'Etoile, France) from 2010 to 2015, and subsequently with the BACTEC FX instrument (Becton, Dickinson and Company, Franklin Lakes, US) for the remaining study period, with a seven-day incubation period for both systems. For bacterial identification, conventional biochemical diagnostic methods were used, supplemented with MALDI-TOF (Bruker, Bremen, Germany). Additionally, upon request, pus material was sent to standard microbiome 16S/18S rRNA targeted next-generation sequencing analysis performed at the national reference laboratory Statens Serum Institut.[7]

## Statistical Analysis

Data was collected using the Research Electronic Data Capture (REDCap) system (Vanderbilt University, Nashville, Tennessee). The study population was characterized according to gender and age. Continuous variables were presented as medians with interquartile ranges ($25^{th}$ and $75^{th}$ percentiles, IQRs), while categorical variables were expressed as numbers with proportions (%). The PPV of the ICD-10 code K75.0 was calculated as the proportion of patients with a confirmed PLA diagnosis among those identified with the code. Corresponding 95% confidence intervals (CIs) for the PPV were calculated using the Clopper–Pearson method for binomial proportions.[8] Differences in PPV between departments were analysed to identify variability in diagnostic accuracy. For the analysis of misclassified patients, the types of incorrect diagnoses were categorized and presented as proportions.

## Ethics

This study was approved by the North Denmark Region (Record no. 2022–025705). Due to the retrospective nature of the study, no patient consent or permission from an ethics committee was required. We confirm that the data accessed complied with relevant data protection and privacy regulations.

# Results

A total of 297 patients were identified with the ICD-10 diagnosis code K75.0 during the study period. Five patients (2%) were excluded due to initial hospitalization outside the North Denmark Region, resulting in insufficient information to validate the PLA diagnosis code. Consequently, 292 patients underwent the validation process, see Figure 1.

Among the 292 patients with the PLA diagnosis code, 221 (76%) were diagnosed at Aalborg UH, whereas 71 (24%) were diagnosed at one of the regional hospitals. The Department of Gastrointestinal Surgery, Aalborg UH treated most patients (n=108, 37%), followed by the medical department, Aalborg UH with 106 (36%), where 61 (21%) patients were diagnosed at the Department of Gastroenterology and Hepatology, Aalborg UH, and 34 (12%) at the Department of Infectious Diseases, Aalborg UH, see Table 1.

Sixty-seven patients (23%) were misclassified (see below), resulting in 225 (77%) patients with a confirmed PLA diagnosis code included in the study. The distribution according to validation criteria was as follows: i) 119 patients had imaging confirmation with culture-positive abscess material; ii) 29 had imaging confirmation with positive blood culture; iii) 72 had imaging confirmation with clinical response; iv) and five had histopathological confirmation.

The median age of the 225 confirmed PLA patients was 68 years (IQR: 59–77), and 124 (56%) were men. Similar demographics were observed in the misclassified group, with a median age of 69 years (IQR: 58–77) and 39 (53%) men.

## Positive Predictive Values

The overall PPV of the ICD-10 code K75.0 among the 292 patients was 77% (95% CI: 72–82%) (see Table 1). Specifically, medical departments exhibited the highest PPV at 88% (95% CI: 81–93%), indicating more precise identification of PLA cases. Emergency departments showed a PPV of 56% (95% CI: 29–80%), reflecting increased false positives and variability. Surgical departments demonstrated a PPV of 69% (95% CI: 61–77%), suggesting

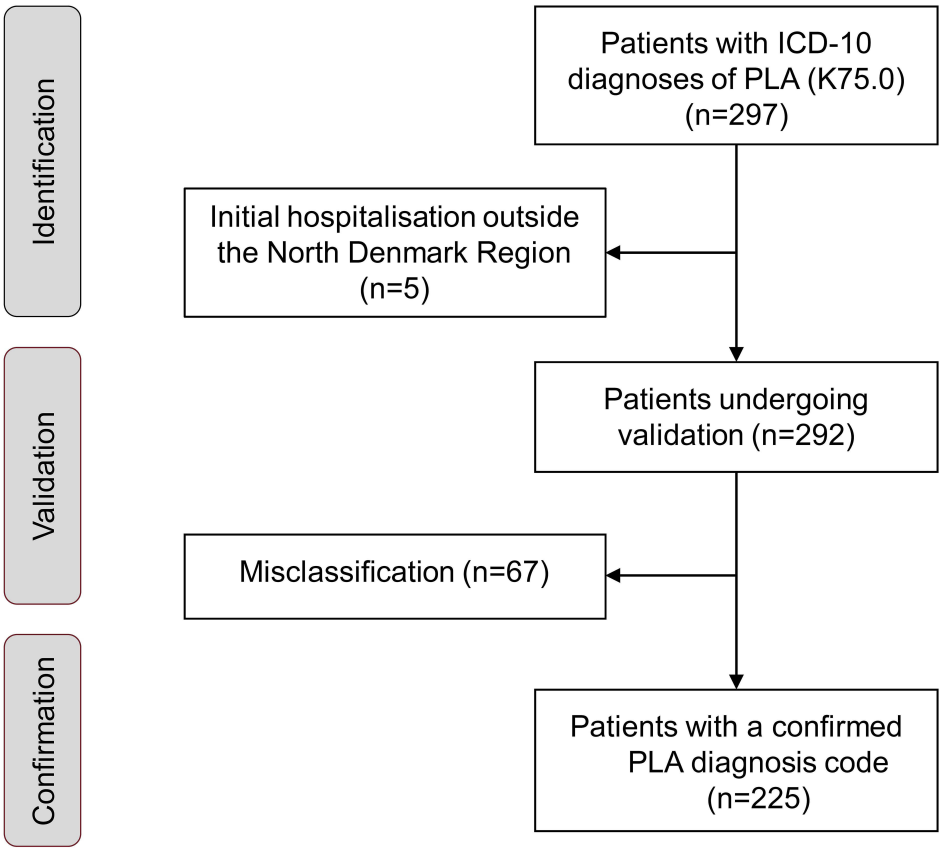


**Figure 1** Flowchart of identified, validated and confirmed PLA diagnosis code patients.

consistent but slightly less accurate identification compared to medical departments. Notably, the Department of Gastrointestinal Diseases and Hepatology at Aalborg UH achieved a PPV of 92% (95% CI: 82–97%), second only to the Department of Infectious Diseases at Aalborg UH, which had the highest PPV at 97% (95% CI: 85–100%).

**Table 1** Validity of the ICD-10 Diagnosis Codes for Pyogenic Liver Abscess (K75.0) Among 292 Patients in the North Denmark Region from January 1, 2010, to June 30, 2022. The Table Shows the Numbers of Correctly and Misclassified Diagnoses, as Well as the Positive Predictive Values (PPV) by Hospitals and Departments

| | Patients, n | Correct, n | Misclassified, n | PPV, % (95% CI) |
|---|---|---|---|---|
| All patients | 292 | 225 | 67 | 77 (72–82) |
| Emergency ward | 16 | 9 | 7 | 56 (30–80) |
| Surgical department | 139 | 96 | 43 | 69 (61–77) |
| Medical department | 137 | 120 | 17 | 88 (81–93) |
| Aalborg University hospital | 221 | 178 | 43 | 81 (75–86) |
| Emergency ward | 7 | 4 | 3 | 57 (18–90) |
| Surgical department | 108 | 76 | 32 | 70 (61–79) |
| Medical department | 106 | 98 | 8 | 93 (86–97) |

(*Continued*)

**Table 1** (Continued).

| | Patients, n | Correct, n | Misclassified, n | PPV, % (95% CI) |
|---|---|---|---|---|
| The Regional hospitals | 71 | 47 | 24 | 66 (54–77) |
| Emergency ward | 9 | 5 | 4 | 56 (21–86) |
| Surgical department | 31 | 20 | 11 | 65 (45–81) |
| Medical department | 31 | 42 | 9 | 71 (52–86) |

## Imaging results Among Confirmed PLA Cases

A total of 215 patients (96%) underwent a CT scan, with 51 cases (23%) presenting radiological descriptions challenging to distinguish from non-infectious liver abnormalities. Supplementary imaging involved MRI scan for 32 patients (15%) and PET scan for 16 patients (7%). Abdominal ultrasound was performed in 190 patients (84%), with 95 (51%) undergoing ultrasound after CT for drainage purposes. In 33 cases (17%), an ultrasound provided the conclusive diagnosis of liver abscess. Diagnostic liver biopsy was performed in eight patients (4%) when imaging failed to diagnose PLA and to exclude potential underlying malignancy.

## Microbiological Findings Among Confirmed PLA Cases

A culture-confirmed diagnosis was made in a total of 148 (66%) patients. The most frequently isolated pathogens were *Escherichia coli* and *Streptococcus anginosus* group found in both blood cultures (n=31 (36%) and n=17 (20%)) and abscess material (n=41 (34%) and n=23 (19%)), respectively. Blood cultures were collected from 213 patients (95%), with 87 (41%) yielding positive results. Pus material was collected from 157 patients (70%), with 119 cases (76%) yielding positive cultures. Microbiome sequencing (16S/18S) directly from pus aspirate was conducted in 24 patients (11%), yielding positive results in 20 cases (83%).

## Misclassification Analysis

Of the 67 misclassified patients, 37 (55%) were diagnosed with other forms of intra-abdominal infections, predominantly abscesses near the liver parenchyma (n=25, 68%), see Table 2. Twenty-one patients (31%) presented with non-infectious conditions lacking signs of infection at the time of diagnosis, most commonly liver metastasis without abscess (n=5, 24%). Nine patients (13%) were categorized under non-specific causes for PLA diagnosis, including cases missing hospital records (n=4, 6%), unexplained liver processes (n=4, 6%), and a single case showing vascular liver disease.

**Table 2** The Causes of Misclassification in the PLA Diagnosis Code (ICD-10: K75.0). Data from the 67 Misclassified Patients are Reported and Categorised into Infectious, Non-Infectious, and Unknown Causes. The Specific Conditions That Led to Incorrect Coding are Detailed for Each Group

| Cause | Patients. n (%) |
|---|---|
| **Infectious:** | 37 (55) |
| Abscess near liver | 25 (37) |
| Acute cholecystitis without liver abscess | 12 (18) |

(*Continued*)

**Table 2** (Continued).

| Cause | Patients. n (%) |
|---|---|
| **Non-infectious:** | 21 (31) |
| Liver metastasis without infection | 5 (7) |
| Cholangiocarcinoma | 3 (4) |
| Decompensated liver cirrhosis without liver abscess | 4 (6) |
| Hepatocellular carcinoma without infection | 2 (3) |
| Liver hematoma without infection | 2 (3) |
| Granulomatous hepatitis | 1 (1) |
| Simple liver cyst without infection | 1 (1) |
| Hepatic biloma after radiofrequency ablation | 1 (1) |
| Perihepatic hematoma | 2 (3) |
| **Unknown:** | 9 (13) |
| No hospital records found at the time of diagnosis | 4 (6) |
| Process in liver without known cause, not treated as liver abscess | 4 (6) |
| Vascular liver disease | 1 (1) |

## Discussion

Our study aimed to validate the ICD-10 diagnosis code K75.0 registered as "Abscess of liver" in the DNPR and to determine the PPV through medical chart examination. Overall, our findings indicate that the PLA diagnosis code accurately identifies PLA patients in 77% of cases, reflecting moderate diagnostic accuracy. The variability in PPVs across different departments underscores differences in diagnostic precision and expertise. Medical departments demonstrated the highest PPV, suggesting superior identification of PLA cases, while emergency and surgical departments exhibited lower PPVs and greater variability. These disparities may stem from variations in clinical training, diagnostic resources, and patient demographics.

To our knowledge, no previous studies have specifically validated the diagnosis code for PLA using ICD-10 codes, and thus the PPV of the K75.0 diagnosis code has not been established. However, recent studies from Europe, Asia and the United States have utilized ICD-codes in their research on PLA.[9–12] Notably, a 2023 study from Sweden, which included 434 patients, did not report the PPV for their diagnostic code directly. Nevertheless, based on their data, we can infer an approximate PPV of 84%, which is closely aligned with our findings.[9]

As no exact diagnostic criteria for diagnosis of pyogenic liver abscess exists, we established four validation criteria based on existing literature.[2,13] Our analysis revealed that misclassification primarily occurred due to other intra-abdominal infections and non-infectious conditions such as liver metastases without abscess. These findings underscore the complexity involved in differentiating PLA from other hepatic and abdominal conditions. Implementing more specific diagnostic criteria could potentially reduce misclassification rates. Improving diagnostic protocols and offering targeted training for healthcare providers, especially in emergency and surgical settings, may enhance the accuracy of PLA diagnosis.

Imaging played a critical role in PLA diagnosis, with most patients undergoing CT scans. However, a subset of cases posed challenges in distinguishing PLA from other non-infectious liver abnormalities. Supplementary imaging modalities such as MRI and PET were employed in 17% of cases, highlighting the need for advanced imaging techniques in

complex cases. Furthermore, our study demonstrated high rates of positive cultures from both blood and abscess material, emphasizing the critical role of microbiological testing in PLA diagnosis.

A major strength of our study lies in its comprehensive analysis of a large patient population, integrating clinical, imaging and microbiological data to validate PLA diagnoses. However, there are limitations, including potential selection bias due to the exclusion of patients initially hospitalized outside the North Denmark Region. Variability in the completeness of clinical information in routine data collection also posed a challenge. Moreover, differences in diagnostic practices and available resources between centres and countries may limit the generalizability of our findings as they may not apply to all settings or healthcare systems. Lastly, our setup did not allow us to determine the sensitivity and completeness of pyogenic liver abscess diagnoses in the register. Thus, the diagnosis code K75.0 may serve as a valuable tool for epidemiological studies investigating the risk and prognosis in patients with PLA.

In conclusion, our study confirms that the diagnosis code K75.0 accurately classifies 77% of PLA cases among 297 patients in our cohort, with medical departments achieving the highest PPV of 88%. While the diagnosis code is beneficial for epidemiological research, ongoing enhancements in diagnostic criteria and clinical training are essential for optimizing the accuracy of PLA diagnoses.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

## Disclosure

The authors report no conflicts of interest in this work.

## References


1. Jepsen P, Vilstrup H, Schønheyder HC, Sørensen HT. A nationwide study of the incidence and 30-day mortality rate of pyogenic liver abscess in Denmark, 1977–2002. *Aliment Pharmacol Ther*. 2005;21(10):1185–1188. doi:10.1111/j.1365-2036.2005.02487.x
2. Lardière-Deguelte S, Ragot E, Amroun K, et al. Hepatic abscess: diagnosis and management. *J Visc Surg*. 2015;152(4):231–243. doi:10.1016/j.jviscsurg.2015.01.013
3. Ehrenstein V, Hellfritzsch M, Kahlert J, et al. Validation of algorithms in studies based on routinely collected health data: general principles. *Am J Epidemiol*. 2024;193:1612–1624. doi:10.1093/aje/kwae071
4. Thygesen SK, Christiansen CF, Christensen S, Lash TL, Sørensen HT. The predictive value of ICD-10 diagnostic coding used to assess Charlson comorbidity index conditions in the population-based Danish national registry of patients. *BMC Med Res Methodol*. 2011;11:83. doi:10.1186/1471-2288-11-83
5. Danmarks Statistik. Folketal den 1. kvartalet efter område, køn, alder og civilstand (2008K1–2023K4) [Population in the 1st quarter by area, gender, age, and marital status (2008Q1–2023Q4)]. Available from: https://www.statistikbanken.dk/statbank5a/SelectVarVal/Define.asp?MainTable=FOLK1A&PLanguage=0&PXSId=0&wsid=cftree. Accessed November 12, 2024.
6. Schmidt M, Pedersen L, Sørensen HT. The Danish civil registration system as a tool in epidemiology. *Eur J Epidemiol*. 2014;29(8):541–549. doi:10.1007/s10654-014-9930-3
7. Poulsen SH, Søgaard KK, Fuursted K, Nielsen HL. Evaluating the diagnostic accuracy and clinical utility of 16S and 18S rRNA gene targeted next-generation sequencing based on five years of clinical experience. *Infect Dis*. 2023;55(11):767–775. doi:10.1080/23744235.2023.2241550
8. Clopper CJ, Pearson ES. The use of confidence or fiducial limits illustrated in the case of the binomial. *Biometrika*. 1934;26(4):404–413. doi:10.1093/biomet/26.4.404
9. Svensson EJA, Bläckberg A, Sunnerhagen T, Kiasat A, Ljungquist O. Increasing incidence of pyogenic liver abscess in Southern Sweden: a population-based study from 2011 to 2020. *Infect Dis*. 2023;55(6):375–383. doi:10.1080/23744235.2023.2190813
10. Zimmermann L, Wendt S, Lübbert C, Karlas T. Epidemiology of pyogenic liver abscesses in Germany: analysis of incidence, risk factors and mortality rate based on routine data from statutory health insurance. *United Eur Gastroenterol J*. 2021;9(9):1039–1047. doi:10.1002/ueg2.12132
11. Losie JA, Lam JC, Gregson DB, Parkins MD. Epidemiology and risk factors for pyogenic liver abscess in the Calgary Health Zone revisited: a population-based study. *BMC Infect Dis*. 2021;21(1):939. doi:10.1186/s12879-021-06649-9
12. Yoo JJ, Lee TK, Kyoung DS, Park MA, Kim SG, Kim YS. A population-based study of pyogenic liver abscess in Korea: incidence, mortality and temporal trends during 2007–2017. *Liver Int*. 2021;41(11):2747–2758. doi:10.1111/liv.15034
13. Roediger R, Lisker-Melman M. Pyogenic and amebic infections of the liver. *Gastroenterol Clin North Am*. 2020;49(2):361–377. doi:10.1016/j.gtc.2020.01.013