**Supplementary Tables**

**Validating new coding algorithms to improve identification of alcohol- and non-alcohol-related cirrhosis hospital admissions in administrative databases.**

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Table 1S. Alcohol-related cirrhosis (AC) and non-alcohol-related cirrhosis (NAC) standard administrative database identification methods

|  |  |  |
| --- | --- | --- |
| Condition | Algorithm | References |
| Alcohol-related cirrhosis | AC ICD-10 code alone | Hayward, 2020; Bengtsson, 2020; Ramrakhiani, 2021; Khalifa, 2023; Kramer, 2008; Nehra, 2013; Gu, 2022; Laswi, 2022; Axley, 2019; Sandahl, 2011; Termeie, 2022; Yang, 2008 1-12 |
| Alcohol-related cirrhosis | AUD codes and non-specific cirrhosis codes  | Philip, 2020; Shirazi, 2021; Mellinger, 2018; Flemming, 2021; Dang, 2020; Beste, 2015; Ioannou, 2018; Pearson, 2021 13-20 |
| Non-alcohol-related cirrhosis etiologies | Viral, metabolic, and autoimmune etiology specific algorithms | Hayward, 2021; Husain, 2014; Philip, 2020; Myers, 2010; Molodecky, 2011; Niu, 2015; Kramer, 2008; Astrom, 2023; Pearson, 2021; Ioannou, 2018; Flemming, 2021 5, 13, 16, 19-26 |
| Non-alcohol-related cirrhosis as a group | NAC specific codes together | Mellinger, 2018; Ryu, 2022; Shaheen, 2022; Grønbaek, 2008; Nakitanda 2020 15, 27-30 |
| All cause cirrhosis  | Individual cirrhosis codes or combinations of cirrhosis and decompensated cirrhosis-related condition codes | Hayward, 2020; Nehra, 2013; Kramer, 2008; Shearer, 2022; Bengtsson, 2020; Lapointe-Shaw, 2018; Mapakshi, 2018; Khalifa, 2023; Dahiya, 2022; Driver, 2019; Goldberg, 2022; Ramrakhiani, 2021; Astrom, 2023; Ioannou, 2018; Pearson, 2021 1-6, 19, 20, 25, 31-36 |

Table 2S. Performance characteristics of previously validated individual ICD-9 and ICD-10 codes and algorithms for detection of cirrhosis and its complications.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Diagnostic Codes or Algorithms | **Diagnosis** | **PPV** | **NPV** | **Sensitivity** | **Specificity** | **Study** |
| ICD-9 Individual codes |  |  |  |  |  |  |
| * 571.2
 | Alcoholic cirrhosis of liver | 90%87.0% | 77%46.3% | 52% | 84% | Kramer 5Nehra 6 |
| * 571.5
 | Cirrhosis of liver without mention of alcohol | 90%79.8% | 87%52.5% | 72% | 68% | Kramer 5Nehra 6 |
| * 571.1
 | Alcoholic hepatitis+labs | 86% | NR | NR | NR | Shaheen 28 |
| * 789.5
 | Ascites | 63.3% | 29.6% | 44% | 48% | Nehra 6 |
| * 567.23
 | Spontaneous bacterial peritonitis | 84.1% | 33.3% | 3% | 99% | Nehra 6 |
| * 572.2
 | Hepatic encephalopathy | 91.5% | 36.1% | 52% | 84% | Nehra 6 |
| * 456.0
 | Esophageal varices with bleed | 92.3% | 32.8% | 3% | 100% | Nehra 6 |
| * 456.21
 | Secondary esophageal varices without bleed | 94.3% | 34.5% | 8% | 99% | Nehra 6 |
| * 456.2
 | Esophageal varices in diseases classified elsewhere | 79% | 33% | 1% | 100% | Nehra 6 |
| * 572.4
 | Hepatorenal syndrome | 92.1% | 33.2% | 2% | 100% | Nehra 6 |
| * 155.0
 | Hepatocellular carcinoma | NR | NR | 83-96% | 85-95% | Flemming 32 |
| * 456.1
 | Esophageal varices without bleed | 90.6% | 36.5% | 18% | 96% | Nehra 6 |
| * 572.3
 | Portal hypertension | 91.8% | 40.1% | 31% | 94% | Nehra 6 |
| Algorithms |  |  |  |  |  |  |
| 571.2, 571.5, 571.6 | All cause cirrhosis | 90% | 87% | NR | NR | Kramer 5 |
| 571.0x, 571.1x, 571.3x, 571.2 | ALD cirrhosis | 90% | 77% | NR | NR | Kramer 5 |
| ALD: 571.0x, 571.1x, 571.3x, 571.2 + HCV: 070.41, 070.51, 070.54, V02.62 | All cause cirrhosis | 93% | 77% |  |  | Kramer 5 |
| 572.4, 456.2, 456.0, 456.21, 567.23, 572.2, 456.1, 572.3, 571.2, 571.5 | All cause cirrhosis | 78% | 91% | 98% | 43% | Nehra 6 |
| At least one chronic liver disease and cirrhosis code (571.2, 571.5, 571.6; 070.20, 070.21, 020.22, 070.23, 070.3, 070.31, 070.32, 070.33 070.40, 070.49, 070.59, 070.60, 070.70, 070.71, 070.90, 573.1 070.41, 070.44, 070.51, 070.54, 070.70, 070.71 070.42, 070.52, 273.4, 275.0, 275.1, 453.0, 571.0, 571.1, 571.1, 571.40, 571.41, 571.8, 571.9, 573.0, 573.3, 573.8, 573.9, 517.42, 576.1, and ≥ 8 code for decompensation 456.0, 456.20, 456.1, 456.21, 789.5, 789.59, 572.2, 567.0, 567.2, 567.21, 567.21, 567.29, 567.8, 567.89, 567.9, 572.4  | All cause cirrhosis | 95% | NR | NR | NR | Goldberg 2012 36 |
| One cirrhosis and one decompensated code: 571.2, 572.5 and 456.0, 456.1, 456.20, 456.21, 789.5, 567.23, 572.2, 070.44, 572.4 | All cause cirrhosis  | 97% | NR | NR | NR | Ioannou 2018 19 |
| Hierarchical:1. HCV RNA positive | Hepatitis C  | 100% | 94-98% | 90-97% | 100% | Philip 2020 13 |
| 2. HBV surface antigen or HBV DNA positive | Hepatitis B | 86-96% | 99-100% | 92-96% | 99% | Philip 2020 13 |
| 3. 571.6, 576.1, 571.42 | Autoimmune | 90-91% | 96-98% | 56-83% | 99% | Philip 2020 13 |
| 4. 275.0 | hemochromatosis | 67% | 99% | 40% | 100% | Philip 2020 13 |
| 5. 305.0, 303, 291.0, 291, 571.0, 571.1, 571.2, 571.3, 535.3, 257.5, 425.5, 980.0, 980.9, 780.3, 760.71 | Alcohol-related cirrhosis | 40-82% | 98-100% | 80-90% | 96-97% | Philip 2020 13 |
| 6. None of the above | NAFLD/cryptogenic | 77-80% | 95% | 75-92% | 87-95% | Philip 2020 13 |
| ICD-10 Individual codes | **Diagnosis** | **PPV** | **NPV** | **Sensitivity** | **Specificity** | **Study** |
| * K70.3
 | Alcoholic-related cirrhosis  | 97%100%93%98% | 35%79%NR63% | 55%7%NR24% | 93%100%NR100% | Hayward 2020 1Ramrakhiani 2020 3Bengtsson 2020 2Khalifa 2023 4 |
| * K71.7
 | Toxic liver disease with cirrhosis | 100% | 78.1% | 0.3% | 100% | Ramrakhiani 2020 3 |
| * K74.6
 | Other and unspecified cirrhosis | 90%96%89%91%93%95% | NR33%89%NR81%NR | NR 59%NR71%NR | NR98%NR96%NR | Mapakshi 33Hayward 2020 1Ramrakhiani 2020 3Bengtsson 20202Khalifa 2023 4Hayward 2021 26 |
| * K74.69
 | Other cirrhosis of liver | 93%93% | 83%81% | 29%71% | 99%96% | Ramrakhiani 2020 3Khalifa 2023 4 |
| * K70.1
 | Alcoholic hepatitis+labs | 86% | NR | NR | NR | Shaheen 28 |
| * R18
 | Ascites | 93%97%92% | N/A76%68% | NRNR43% | NRNR97% | Bengtsson2Hayward 2020 1Khalifa 2023 4 |
| * K65.9
 | Peritonitis, unspecified  | 87% | 95% | NR | NR | Hayward 2020 1 |
| * G93.4
 | Hepatic encephalopathy | 75%71% | 89%77% | NRNR | NRNR | Tapper 37Hayward 2020 1 |
| * K72.9
 | Hepatic encephalopathy | 85-90% | 85-93% | NR | NR | Tapper 37 |
| * I85.0
 | Esophageal varices  | 90%96%91% | NRNR60% | NRNR18% | NRNR99% | Mapakshi 2018 33Bengtsson 2Khalifa 2023 4 |
| * I85.1/.11
 | Secondary esophageal varices | 90.2%92% | NR 57% | NR6% | NR100% | Mapakshi 2018 33Khalifa 2023 4 |
| * I85.9
 | Esophageal Varices without bleeding | 96% | NR | NR | NR | Bengtsson 2 |
| * I86.4
 | Gastric varices | 90.2% | NR | NR | NR | Mapakshi 2018 33 |
| * I98.2
 | Esophageal varices without bleeding in diseases classified elsewhere | 94% | 60% | NR | NR | Hayward 2020 1 |
| * I98.3
 | Esophageal varices with bleeding in diseases classified elsewhere | 100% | 60% | NR | NR | Hayward 1 |
| * K76.7
 | Hepatorenal syndrome | >80%100% | NR69% | NR12% | NR100% | Shearer 31Khalifa 2023 4 |
| * C22.0
 | Hepatocellular carcinoma | 84%97% | NR98% | NRNR | NRNR | Bengtsson2Hayward 2020 1 |
| * K76.6
 | Portal hypertension | 95%95% | 84%75% | 30%58% | 100%97% | Ramrakhiani 2020 3Khalifa 2023 4 |
| * K74.4
 | Secondary biliary cirrhosis | 100% | 24% | NR | NR | Hayward 2020 1 |
| * K74.5
 | Biliary cirrhosis unspecified | 67% | 23% | NR | NR | Hayward 2020 1 |
| * K76.0
 | NAFLD | 82% | NR | NR | NR | Astrom 2023 25 |
| * F10.1
 | Harmful use of alcohol | 95% | 63% | 59% | 95% | Hayward 202126 |
| * K70.1
 | Alcohol-related hepatitis | 100%54% | 44%NR | 5%NR | 100%NR | Hayward 202126Pang 2015 38 |
| * K70.4
 | Alcoholic hepatic failure  | 95% | 53% | 35% | 98% | Hayward 202126 |
|  |  |  |  |  |  |  |
| Algorithms | **Diagnosis** | **PPV** | **NPV** | **Sensitivity** | **Specificity** | **Study** |
| Grouped alcohol codes: F10.1, K70.1, K70.2, K70.3, K70.4, K70.9 | Alcohol-related liver disease | 94% | 81% | 84% | 92% | Hayward 202126 |
| #6: K70.3, K74.4 K74.5, K74.6, C22.0, K70.4, K72.9, K76.6, K76.7, I85.0, I85.9, I86.4, I98.2, I98.3, K76.6 | All cause cirrhosis | 88% | 76% | 94% | 56% | Hayward 2020 1 |
| #1: K70.3, K74.4, K74.5, K74.6 | All cause cirrhosis | 96% | 69% | 81 | 90 | Hayward 2020 1 |
| K70.3, K70.31, K74.60, K73.69, K74.3, K74.4, K74.5 | All cause cirrhosis | 93% | NR | NR | NR | Mapakshi 2018 33 |
| K74.6, K76.6, K74.69, K70.30, K70.31, K71.7 | All cause cirrhosis | 88% | 90% | 60% | 100% | Ramrakhiani 2020 3 |
| K74.6, K70.3, I85.0, I85.9, I98.2, I98.3, K76.6, K72.9, K76.7 | All cause cirrhosis | 83-89% | NR | 61-100 | NR | Shearer 2022 31 |
| K70.3, K71.7, K74.5, K74.6, or I85.9, I98.2 | All cause cirrhosis | 88% | 98% | 99% | 79% | Lapointe-Shaw 2018 32 |
| Hierarchical:1. HCV RNA positive | Hepatitis C  | 100% | 94-98% | 90-97% | 100% | Philip 2020 13 |
| 2. HBV surface antigen or HBV DNA positive | Hepatitis B | 86-96% | 99-100% | 92-96% | 99% | Philip 2020 13 |
| 3. K74.3, K83.0, K75.4 | Autoimmune | 90-91% | 96-98% | 56-83% | 99% | Philip 2020 13 |
| 4. E83.10 | hemochromatosis | 67% | 99% | 40% | 100% | Philip 2020 13 |
| 5. F100-F109, X45, Y15, X65, K700-K702, K704, K709, K292, G312, G721, I426, K852, K860, E244, R780, T510, T519, O354, Q860, P043, K70.3, K70.1 | Alcohol-related cirrhosis | 40-82% | 98-100% | 80-90% | 96-97% | Philip 2020 13 |
| 6. None of the above | NAFLD/cryptogenic | 77-80% | 95% | 75-92% | 87-95% | Philip 2020 13 |
| K76.0, excluding coding for AUD (F10.0-F10.7W) and other liver diseases (K70.0-K70.9, B18, K75.4, K74.3, K83.0A, and no HCV RNA and HBV surface antigen) | NAFLD  | 91% | NR | NR | NR | Astrom 2023 25 |
| K76.6, K70.31, K74.60, K74.69 | All cause cirrhosis | 92% | 93% | 90% | 94% | Khalifa 2023 4 |
| K70.3, K71.7, K72.1, K74.4, K74.5, K74.6, K76.6, K72.1, K72.9, I85.9, I86.4, I98.2, I85.0, I98.3 R18.X, J70.4, K70.9 | All cause cirrhosis | 99% | NR | 86% | 98% | Driver 2019 35 |

PPV: Positive predictive value

NPV: Negative predictive value

NR: Not reported

ICD: International classification of diseases

Table 3S. International classification of diseases tenth revision codes (ICD-10) used for case definitions and admission selection.

|  |  |
| --- | --- |
| Condition  | ICD-10 Codes |
| Alcohol-related cirrhosis | K70.3 |
| Non-alcohol-related cirrhosis: |  |
| * *Toxic liver disease with fibrosis and cirrhosis of liver*
 | K71.7 |
| * *Secondary biliary cirrhosis*
 | K74.4 |
| * *Biliary cirrhosis, unspecified*
 | K74.5 |
| * *Other and unspecified cirrhosis of liver*
 | K74.6 |
| Decompensated cirrhosis-related conditions |  |
| * *Ascites*
 | R18 |
| * *Unspecified encephalopathy*
 | G93.4 |
| * *Hepatic failure, unspecified*
 | K72.9 |
| * *Portal hypertension*
 | K76.6 |
| * *Esophageal varices*
 | I85.0 |
| * *Secondary esophageal varices*
 | I85.1  |
| * *Esophageal varices without bleeding*
 | I85.9 |
| * *Gastric varices*
 | I86.4 |
| * *Esophageal varices without bleeding in diseases classified elsewhere*
 | I98.2  |
| * *Esophageal varices with bleeding in diseases classified elsewhere*
 | I98.3 |
| * *Hepatorenal syndrome*
 | K76.7 |
| * *Hepatocellular carcinoma*
 | C22.0 |
| Additional decompensated cirrhosis-related conditions: |  |
| * *Acute/subacute hepatic failure*
 | K72.0 |
| * *Chronic hepatic failure*
 | K72.1 |
| * *Unspecified peritonitis*
 | K65.9 |
| Alcohol use disorder-related conditions: |  |
| * *Acute Intoxication*
 | F10.0 |
| * *Harmful Alcohol Use*
 | F10.1 |
| * *Alcohol dependence*
 | F10.2 |
| * *Alcohol withdrawal*
 | F10.3, F10.4 |
| * *Other alcohol-related psychoses*
 | F10.5-F10.9 |
| * *Accidental or intentional Alcohol Poisoning*
 | X45, Y15, X65 |
| * *Alcoholic fatty liver*
 | K70.0 |
| * *Alcohol-related hepatitis*
 | K70.1 |
| * *Alcoholic fibrosis and sclerosis of liver*
 | K70.2 |
| * *Alcohol-related cirrhosis*
 | K70.3 |
| * *Alcoholic hepatic failure*
 | K70.4 |
| * *Alcoholic liver disease, unspecified*
 | K70.9 |
| * *Alcoholic gastritis*
 | K29.2 |
| * *Degeneration of nervous system due to alcohol*
 | G31.2 |
| * *Alcoholic polyneuropathy*
 | G62.1 |
| * *Alcoholic myopathy*
 | G72.1 |
| * *Alcoholic cardiomyopathy*
 | I42.6 |
| * *Alcohol-induced pancreatitis*
 | K85.2, K86.0 |
| * *Alcohol-induced pseudo Crushing’s syndrome*
 | E24.4 |
| * *Maternal care for (suspected) damage to fetus from alcohol*
 | O35.4, Q86.0, P04.3 |
| * *Alcohol in blood*
 | R78.0 |
| * *Toxic effect of alcohol*
 | T51.0, T51.9 |

ICD-10: International classification of diseases 10th revision

Table 4S. Non-alcohol-related cirrhosis (NAC) identification performance characteristics of individual decompensated cirrhosis-related condition ICD-10 codes in any diagnostic position.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Condition  | ICD-10  | PPV %(95% CI) (n/n) | NPV %(95% CI) (n/n) | Sensitivity %(95% CI) (n/n) | Specificity % (95% CI) (n/n) | AUROC (95% CI)  |
| * *Ascites*
 | R18 | 25.8 (19.7-32.7) (48/186) | 69.7 (65.4-73.8) (338/485) | 24.6 (18.7-31.3)(48/195) | 71.0 (66.7-75.0)(338/485) | 0.48 (0.44-0.51) |
| * *Unspecified encephalopathy*
 | G93.4 | 21.1 (6.1-45.6)(4/19) | 70.7 (67.0-74.2)(461/652) | 2.1 (0.6-5.2)(4/195) | 96.8 (94.9-98.2)(461/476) | 0.49 (0.48-0.51) |
| * *Hepatic failure, unspecified*
 | K72.9 | 44.2 (35.1-53.5) (53/120) | 74.2 (70.4-77.8)(409/551) | 27.2 (21.1-34.0)(53/195) | 85.9 (82.5-88.9)(409/476) | 0.57 (0.53-0.60) |
| * *Portal hypertension*
 | K76.6 | 41.5 (26.3-57.9)(17/41) | 71.7 (68.1-75.2)(452/630) | 8.7 (5.2-13.6)(17/195) | 95.0 (92.6-96.7)(452/476) | 0.52 (0.50-0.54) |
| * *Esophageal varices*
 | I85.0 | 46.7 (21.3-73.4)(7/15) | 71.3 (67.7-74.8)(468/656) | 3.6 (1.5-7.3)(7/195) | 98.3 (96.7-99.3)(468/476) | 0.51 (0.50-0.52) |
| * *Secondary esophageal varices*
 | I85.1  | 0 | 70.9 (67.3-74.4)(476/671) | 0 | 100% | 0.50 |
| * *Esophageal varices without bleeding*
 | I85.9 | 33.3 (4.3-77.7)(2/6) | 71.0 (67.4-74.4)(472/665) | 1.0 (0.1-3.7)(2/195) | 99.2 (97.9-99.8)(472/476) | 0.50 (0.49-0.51) |
| * *Gastric varices*
 | I86.4 | 5.0 (0.1-24.9)(1/20) | 70.2 (66.5-73.7)(457/651) | 0.5 (0.0-2.8)(1/195) | 96.0 (93.8-97.6)(457/476) | 0.48 (0.47-0.49) |
| * *Esophageal varices without bleeding in diseases classified elsewhere*
 | I98.2  | 23.7 (11.4-40.2)(9/38) | 70.6 (66.9-74.1)(447/633) | 4.6 (2.1-8.6)(9/195) | 93.9 (91.4-95.9)(447/476) | 0.49 (0.47-0.51) |
| * *Esophageal varices with bleeding in diseases classified elsewhere*
 | I98.3 | 21.2 (12.1-33.0)(14/66) | 70.1 (66.3-73.7)(424/605) | 7.2 (4.0-11.8)(14/195) | 89.1 (85.9-91.7)(424/476) | 0.48 (0.46-0.50) |
| * *Hepatorenal syndrome*
 | K76.7 | 36.8 (16.3-61.6)(7/19) | 71.2 (67.5-74.6)(464/652) | 3.6 (1.5-7.3)(7/195) | 97.5 (95.6-98.7)(464/476) | 0.51 (0.49-0.52) |
| * *Hepatocellular carcinoma*
 | C22.0 | 51.8 (43.1-60.4)(71/137) | 76.8 (73.0-80.3)(410/534) | 36.4 (29.7-43.6)(71/195) | 86.1 (82.7-89.1)(410/476) | 0.61 (0.58-0.65) |
| * *Acute/subacute hepatic failure*
 | K72.0 | 14.0 (5.8-26.7)(7/50) | 69.7 (65.9-73.3)(433/621) | 3.6 (1.5-7.3)(7/195) | 91.0 (88.0-93.4)(433/476) | 0.47 (0.45-0.49) |
| * *Chronic hepatic failure*
 | K72.1 | 48.8 (33.3-64.5)(21/43) | 72.6 (69.0-76.1)(454/625) | 10.9 (6.9-16.2)(21/195) | 95.4 (93.1-97.1)(454/476) | 0.53 (0.51-0.56) |
| * *Unspecified peritonitis*
 | K65.9 | 14.6 (6.1-27.8)(7/48) | 69.8 (66.1-73.4)(435/623) | 3.6 (1.5-7.3)(7/195) | 91.4 (88.5-93.7)(435/476) | 0.47 (0.46-0.49) |

PPV: Positive predictive value

NPV: Negative predictive value

AUROC: Area under receiver operating characteristic curve

95% CI: 95% confidence intervals

n/n: Estimate ratio

ICD-10: International classification of diseases 10th revision

Table 5S: Calculation of true and false positives and negatives for AC and NAC algorithms using electronic medical record review as reference standard.

|  |  |
| --- | --- |
|  | Reference standard: EMR validation |
| Validated condition\* | No validated condition |
| AC ICD-10 coding algorithm | Meets AC algorithm | AC True positive | AC False positive |
| Does not meet AC algorithm | AC False negative | AC True negative |
| NAC ICD-10 coding algorithm | Meets NAC algorithm | NAC True positive | NAC False positive |
| Does not meet NAC algorithm | NAC False negative | NAC True negative |

\* Validated condition is AC for AC ICD-10 coding algorithms and NAC for NAC ICD-10 coding algorithms

AC: alcohol-related cirrhosis

NAC: non-alcohol-related cirrhosis

EMR: electronic medical record

ICD-10: International Classification of Diseases 10th revision

Table 6S. Calculation of positive negative predictive value (PPV), negative predictive value (NPV), sensitivity, and specificity.

|  |  |
| --- | --- |
| Estimate | \*Calculation |
| PPV | True positive / (true positive + false positive) |
| NPV | True negative / (true negative + false negative |
| Sensitivity | True positive / (true positive + false negative) |
| Specificity | True negative / (true negative + false positive) |

\*Calculation is specific to AC or NAC. For example, PPV for AC would be AC true positive / (AC true positive + AC false positive).

PPV: positive predictive value

NPV: negative predictive value

Table 7S. Characteristics of patients with missing laboratory data compared to admissions who successfully linked to laboratory data.

|  |  |  |  |
| --- | --- | --- | --- |
| Characteristics | Linked to lab dataN=426 | Not linked to lab dataN=245 | p-value |
| Age, median (IQR) | 61 (52-70) | 58 (50-69) | p=0.018 |
| Hospitalization year, median (IQR) | 2017 (2014-2019) | 2011 (2009-2015) | p<0.001 |
| Sex, n (%) |  |  |  |
| 1. Male
 |  259 (60.7%) |  (64.5%%) | p=0.90 |

IQR: Interquartile range

Table 8S. Demographic and clinical characteristics of patients with missing EMRs compared to patients with available EMRs.

|  |  |  |  |
| --- | --- | --- | --- |
| Characteristics | Linked to EMR N=671 | Not linked to EMRN=29 | p-value |
| Age, median (IQR) | 60 (51-70) | 64 (55-72) | p=0.23 |
| Hospitalization year, median (IQR) | 2015 (2011-2019) | 2011 (2009-2014) | p=0.07 |
| Sex, n (%) |  |  |  |
| 1. Male
 | 417 (62.2%) | 21 (72.4%) | p=0.33 |
| 1. Female
 | 254 (37.9%) | 8 (27.4%) |  |
| AST (U/L), median (IQR) | 65.5 (40-117) | 82 (51-133) | p=0.55 |
| ALT (U/L), median (IQR) | 31 (19-65) | 43 (36-49) | p=0.19 |
| Albumin (g/L), median (IQR) | 25 (21-30) | 26 (25-35) | p=0.42 |
| Total bilirubin (µmol/L), median (IQR) | 28 (13-81) | 23 (17-36) | p=0.71 |
| Creatinine (µmol/L), median (IQR) | 84 (62-132.5) | 101.5 (77-126) | p=0.34 |
| INR, median (IQR) | 1.4 (1.2-1.7) | 1.2 (1.1-1.3) | p=0.18 |
| Sodium (mEq/L), median (IQR) | 136 (132-137) | 137 (135-137) | p=0.49 |
| MELD, median (IQR) | 15.4 (10.0-21.2) | 11.7 (10.0-16.9) | p=0.37 |
| MELD sodium, median (IQR) | 17.4 (11.6-24.6) | 13.2 (11.0-18.8) | P=0.25 |
| Has AC ICD-10 code any position, n (%) | 167 (24.9%) | 4 (13.8%) | p=0.27 |
| Has NAC ICD-10 code any position, n (%) | 142 (21.2%) | 6 (20.7%) | p=1.00 |
| Has AUD ICD-10 code in any position, n (%) | 194 (29.9%) | 4 (13.8%) | p=0.09 |
| Has decompensated cirrhosis code in any position, n (%) | 511 (76.2%) | 22 (75.9) | p=1.00 |

Note: only 10 of the individuals missing EMR have available lab data.

AC: Alcohol-related cirrhosis

NAC: Non-alcohol-related cirrhosis

AUD: Alcohol use disorder

EMR: Electronic medical records

AST: Aspartate transaminase

ALT: Alanine transaminase

INR: International Normalized Ratio

MELD: Model-for-End-Stage Liver Disease

IQR: Interquartile range

Table 9S. Performance characteristics of alcohol-related cirrhosis (AC) admission identification algorithms in the cohort of 671 hospitalized patients.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| AC identification number and ICD-10 algorithm: | PPV %(95% CI) (n/n) | NPV %(95% CI) (n/n) | Sensitivity %(95% CI) (n/n) | Specificity % (95% CI) (n/n) | AUROC (95% CI)  |
| AC algorithm 1 derivations: AC code in different diagnostic positions |
| AC#1: *K70.3 primary position*  | 99.0 (94.6-100) (100/101) | 73.3 (69.5-76.9) (418/570) | 39.7 (33.6-46.0) (100/252) | 99.8 (98.7-100) (418/419) | 0.70 (0.67-0.73) |
| AC #1.1*: K70.3 secondary position*  | 89.4 (79.4-95.6) (59/66) | 68.1 (64.2-71.8) (412/605) | 23.4 (18.3-29.1) (59/252) | 98.3 (96.6-99.3) (412/419) | 0.61 (0.58-0.64) |
| AC #1.2: *K70.3 any position*  | 95.2 (90.8-97.9) (159/167) | 81.5 (77.9-84.8) (411/504) | 63.1 (56.8-69.1) (159/252) | 98.1 (96.3-99.2) (411/419) | 0.81 (0.78-0.84) |
| AC algorithm 2 derivations: NAC + AUD codes together |
| AC #2*: Primary K71.7, K74.6, K74.4, or K74.5 + secondary AUD code* | 100 (29.2-100) (3/3) | 62.7 (58.9-66.4) (419/668) | 1.2 (0.2.1-3.4) (3/252) | 100 (99.1-100) (419/419) | 0.51 (0.50-0.51) |
| AC #2.1*: Primary AUD code + secondary K71.7, K74.6, K74.4, or K74.5* | 0 (0/0) | 62.4 (58.7-66.1) (419/671) | 0 (0/252) | 100 (99.1-100) (419/419) | 0.50 (0.50-0.50) |
| AC #2.2*: AUD code + K71.7, K74.6, K74.4, or K74.5 in any position* | 90 (55.5-99.7) (9/10) | 63.2 (59.4-66.9) (418/661) | 3.6 (1.6-6.7) (9/252) | 99.8 (98.7-100) (418/419) | 0.52 (0.50-0.53) |
| AC algorithm 3 derivations: AUD + decompensation codes together |
| AC #3: *Primary decompensation code + secondary AUD code* | 94.4 (81.3-99.3)(34/36) | 65.7 (61.8-69.4)(417/635) | 13.5 (9.5-18.3) (34/252) | 99.5 (98.3-99.9) (417/419) | 0.57 (0.54-0.59) |
| AC #3.1*: Primary AUD code + secondary decompensation code* | 94.8 (89.0-98.1) (109/115) | 74.3 (70.4-77.9) (413/556) | 43.3 (37.1-49.6) (109/252) | 98.6 (96.9-99.5) (413/419) | 0.71 (0.68-0.74) |
| AC #3.2: *AUD code + decompensation code in any position* | 92.3 (87.4-95.7) (167/181) | 82.7 (79.0-85.9) (405/490) | 66.3 (60.1-72.1) (167/252) | 96.7 (94.5-98.2) (405/419) | 0.81 (0.78-0.85) |
| AC algorithm 4 derivations: AC + decompensation + AUD + NAC codes |
| AC #4: *AC #1.2 or AC #3.2* | 92.8 (88.4-95.9) (194/209) | 87.4 (84.1-90.3) (404/462) | 77.0 (71.3-82.0) (194/252) | 96.4 (94.2-98.0) (404/419) | 0.87 (0.84-0.89) |
| AC #4.1: *AC #4 or AC #2.2* | 92.9 (88.6-96.0)(197/212) | 88.0 (84.7-90.8)(404/459) | 78.2 (72.6-83.1)(197/252) | 96.4 (94.2-98.0)(404/459) | 0.87 (0.85-0.90) |
| AC #4.2*: AC #4.1 and K72.0 + AUD code together* | 91.7 (87.1-95.0)(198/216) | 88.1 (84.8-91.0)(401/455) | 78.6 (73.0-83.5)(198/216) | 95.7 (93.3-97.4)(401/419) | 0.87 (0.84-0.90) |
| AC #4.3: *AC #4.2 and K72.1 + AUD code together*  | 91.7 (87.1-95.0)(198/216) | 88.1 (84.8-91.0)(401/455) | 78.6 (73.0-83.5)(198/252) | 95.7 (93.3-97.4)(401/419) | 0.87 (0.84-0.90) |
| AC #4.4: *AC #4.3 and K65.9 + AUD code together*  | 91.7 (87.1-95.0)(198/216) | 88.1 (84.8-91.0)(401/455) | 78.6 (73.0-83.5)(198/252) | 95.7 (93.3-97.4)(401/419) | 0.87 (0.84-0.90) |
| AC algorithm 5 derivations: AC #4.1 + alcohol-related hepatic failure and unspecified alcohol-related liver disease codes |
| AC #5: *AC #4.1 + K70.4 in any position* | 91.1 (86.5-94.5)(204/224) | 89.3 (86.0-92.0)(399/447) | 81.0 (75.6-85.6)(204/252) | 95.2 (92.7-97.1)(399/419) | 0.88 (0.85-0.91) |
| AC #5.1: *AC #5 + K70.9 in any position* | 81.8 (76.5-86.3)(211/258) | 90.1 (86.8-92.8)(372/413) | 83.7 (78.6-88.1)(211/252) | 88.8 (85.4-91.6)(372/419) | 0.86 (0.84-0.89) |

Note: Table 3S shows all used ICD-10 codes

AC: Alcohol-related cirrhosis

PPV: Positive predictive value

NPV: Negative predictive value

AUROC: Area under receiver operating characteristic curve

95% CI: 95% confidence interval

n/n: Estimate ratio

ICD-10: International classification of diseases 10th revision

NAC: Non-alcohol-associated cirrhosis

AUD: Alcohol use disorder

Table 10S. Performance characteristics of non-alcohol-related cirrhosis (NAC) admission identification algorithms in the cohort of 671 hospitalized patients.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NAC identification number and ICD-10 algorithm: | PPV % (95% CI) (n/n) | NPV % (95% CI) (n/n) | Sensitivity (95% CI) (n/n) | Specificity (95% CI) (n/n) | AUROC (95% CI)  |
| NAC algorithm 1 derivations: NAC ICD-10 codes alone |
| NAC #1: *K71.7, K74.6, K74.4, or K74.5 in any position (not excluding AUD codes)* | 78.9 (71.2-85.3) (112/142) | 84.3 (80.9-87.3)(446/529) | 57.4 (50.2- 64.5)(112/195) | 93.7 (91.1-95.7)(446/476) | 0.76 (0.72-0.79 |
| NAC #1.1*: K71.7, K74.6, K74.4, or K74.5 in primary position (not excluding AUD codes)* | 76.1 (61.2-87.4)(35/46) | 74.4 (70.8-77.8)(465/625) | 17.9 (12.8-24.1)(35/195) | 97.7 (95.9-98.8)(465/476) | 0.58 (0.55-0.61) |
| NAC #1.2: *K71.7, K74.6, K74.4, or K74.5 in secondary position (not excluding AUD codes)* | 80.2 (70.8-87.6)(77/96) | 79.5 (75.9-82.7)(457/575) | 39.5 (32.6-46.7)(77/195) | 96.0 (93.8-97.6)(457/575) | 0.68 (0.64-0.71) |
| NAC algorithm 2: NAC ICD-10 codes alone, excluding AUD codes |
| NAC #2: NAC #1 + excluding all AUD codes | 84.1 (76.7-89.9) (111/132) | 84.4 (81.1-87.4) (455/538) | 56.9 (49.7-64.0) (111/195) | 95.6 (93.3-97.2) (455/476) | 0.76 (0.73-0.80) |
| NAC algorithms 3-17 derivations: Stepwise inclusion of decompensation codes to NAC coding algorithms |
| NAC #3: *NAC #2 + C22.0 in any diagnostic position* | 69.2 (62.5-75.4)(144/208) | 89.0 (85.8-91.7)(412/463) | 73.8 (67.1-79.9)(144/195) | 86.6 (83.2-89.5)(412/476) | 0.80 (0.77-0.84) |
| NAC #3.1: *NAC #2 + C22.0 in primary position* | 69.8 (63.0-76.0) (143/205) | 88.8 (85.6-91.6)(414/466) | 73.3 (66.5-79.4)(143/195) | 87.0 (83.6-89.9)(414/476) | 0.80 (0.77-0.84) |
| NAC #4: *NAC #3 + K72.9 in any position* | 63.4 (57.3-69.2)(168/265) | 93.3 (90.5-95.6)(379/406) | 86.2 (80.5-90.7)(168/195) | 79.6 (75.7-83.2)(379/476) | 0.83 (0.80-0.86) |
| NAC #4.1: *NAC #3.1 + K72.9 in primary position* | 67.6 (61.3-73.5)(163/241) | 92.6 (89.7-94.9)(398/430) | 83.6 (77.6-88.5)(163/195) | 83.6 (80.0-86.8)(398/476) | 0.84 (0.81-0.87) |
| NAC #5: *NAC #4 + K72.1 in any position* | 62.8 (56.9-68.4)(179/285) | 95.9 (93.4-97.6)(370/386) | 91.8 (87.0-95.2)(179/195) | 77.7 (73.7-81.4)(370/476) | 0.85 (0.82-0.87) |
| NAC #5.1: *NAC #4.1 + K72.1 in primary position* | 68.3 (62.1-74.0) (172/250) | 94.5 (91.9-96.5)(396/419) | 88.2 (82.8-92.4) (172/195) | 83.2 (79.5-86.4)(396/476) | 0.86 (0.83-0.89) |
| NAC #6: *NAC #5 + K76.6 in any position* | 62.6 (56.8-68.2)(181/289) | 96.3 (93.9-98.0)(368/382) | 92.8 (88.2-96.0)(181/195) | 77.3 (73.3-81.0)(368/476) | 0.85 (0.82-0.88) |
| \*NAC #6.1: *NAC #5.1 + K76.6 in primary position* | 68.3 (62.1-74.0)(172/252) | 94.5 (91.9-96.5)(396/419) | 88.2 (82.8-92.4)(172/195) | 83.2 (79.5-86.4)(396/476) | 0.86 (0.83-0.89) |
| NAC #7: *NAC #6 + I85.0 in any position*  | 62.6 (56.8-68.1)(184/294) | 97.1 (94.8-98.5)(366/377) | 94.4 (90.1-97.2)(184/195) | 76.9 (72.8-80.6)(366/476) | 0.86 (0.83-0.88) |
| NAC #7.1: *NAC #5.1 + I85.0 in primary position*  | 68.1 (62.0-73.7)(177/260) | 95.6 (93.2-97.4)(393/411) | 90.8 (85.8-94.4)(177/195) | 82.6 (78.8-85.9)(393/476) | 0.87 (0.84-0.89) |
| NAC #8: *NAC #7 + K76.7 in any position* | 62.3 (56.5-67.8)(185/297) | 97.3 (95.1-98.7)(364/374) | 94.9 (90.8-97.5)(185/195) | 76.5 (72.4-80.2)(364/476) | 0.86 (0.83-0.88) |
| NAC #8.1: *NAC #7.1 + K76.7 in primary position* | 68.2 (62.2-73.8)(178/261) | 95.9 (93.4-97.6)(393/410) | 91.3 (86.4-94.8)(178/195) | 82.6 (78.8-85.9)(393/476) | 0.87 (0.84-0.90) |
| \*NAC #9: *NAC #8 + I85.9 in any position* | 62.1 (56.3-67.6)(185/298) | 97.3 (95.1-98.7)(363/373) | 94.9 (90.8-97.5)(185/195) | 76.3 (72.2-80.0)(363/476) | 0.86 (0.83-0.88) |
| NAC #9.1: NAC #8.1 + I85.9 in primary position | 68.1 (62.1-73.7)(179/263) | 96.1 (93.7-97.7)(392/408) | 91.8 (87.0-95.2)(179/195) | 82.4 (78.6-85.7)(392/476) | 0.87 (0.84-0.90) |
| \*NAC #10: *NAC #8 + I98.2 in any position* | 62.3 (56.5-67.8)(185/297) | 97.3 (95.1-98.7)(364/374) | 94.9 (90.8-97.5)(185/195) | 76.5 (72.4-80.2)(364/476) | 0.86 (0.83-0.88) |
| \*NAC #10.1: *NAC #9.1 + I98.2 in primary position* | 68.1 (62.1-73.7)(179/263) | 96.1 (93.7-97.7)(392/408) | 91.8 (87.0-95.2)(179/195) | 82.4 (78.6-85.7)(392/476) | 0.87 (0.84-0.90) |
| ^NAC #11: *NAC #8 + G93.4 in any position* | 59.9 (54.2-65.4)(185/309) | 97.2 (95.0-98.7)(352/362) | 94.9 (90.8-97.5)(185/195) | 73.9 (69.8-77.8)(352/476) | 0.84 (0.82-0.87) |
| ^NAC #11.1: *NAC #9.1 + G93.4 in primary* *position* | 65.5 (59.5 71.1)(180/275) | 96.2 (93.8-97.9)(381/396) | 92.3 (87.6-95.6)(180/195) | 80.0 (76.2-83.5)(381/476) | 0.86 (0.84-0.89) |
| ^NAC #12: *NAC #8 + R18 in any position* | 56.8 (51.3-62.2)(188/331) | 97.9 (95.8-99.2)(333/340) | 96.4 (92.7-98.5)(188/195) | 70.0 (65.6-74.0)(333/476) | 0.83 (0.81-0.86) |
| ^NAC #12.1: *NAC #9.1 + R18 in primary position* | 61.4 (55.6-67.0)(183/298) | 96.8 (94.4-98.3)(361/373) | 93.8 (89.5-96.8)(183/195) | 75.8 (71.7-79.6)(361/476) | 0.85 (0.82-0.87) |
| \*NAC #13: *NAC #8 + I98.3 in any position* | 62.3 (56.5-67.8)(185/297) | 97.3 (95.1-98.7)(364/374) | 94.9 (90.8-97.5)(185/195) | 76.5 (72.4-80.2)(364/476) | 0.86 (0.83-0.88) |
| \*NAC #13.1:  *NAC #9.1 + I98.3 in primary position* | 68.1 (62.1-73.7)(179/263) | 96.1 (93.7-97.7)(392/408) | 91.8 (87.0-95.2)(179/195) | 82.4 (78.6-85.7)(392/476) | 0.87 (0.84-0.90) |
| ^NAC #14: *NAC #8 + K65.9 in any position* | 56.6 (51.1-62.0)(188/332) | 97.9 (95.8-99.2)(332/339) | 96.4 (92.7-98.5)(188/195) | 69.7 (65.4-73.8)(332/476) | 0.83 (0.81-0.86) |
| \*NAC #14.1: *NAC #9.1 + K65.9 in primary position* | 64.5 (58.6-70.1)(182/282) | 96.7 (94.4-98.2)(376/389) | 93.3 (88.9-96.4)(182/195) | 79.0 (75.1-82.6)(376/476) | 0.86 (0.84-0.89) |
| ^NAC #15: *NAC #8 + K72.0 in any position* | 57.1 (51.5-62.6)(185/324) | 97.1 (94.8-98.6) (337/347) | 94.9 (90.8-97.5)(185/195) | 70.8 (66.5-74.8)(337/476) | 0.83 (0.80-0.85) |
| ^NAC #15.1: *NAC #9.1 + K72.0 in primary position* | 65.1 (59.1-70.7)(179/275) | 96.0 (93.5-97.7)(380/396) | 91.8 (87.0-95.2)(179/195) | 79.8 (75.9-83.3)(380/476) | 0.86 (0.83-0.88) |
| ^NAC #16: *NAC #8 + I86.4 in any position* | 60.9 (55.1-66.4)(185/304) | 97.3 (95.0-98.7)(357/367) | 94.9 (90.8-97.5)(185/195) | 75.0 (70.9-78.8)(357/476) | 0.85 (0.82-0.87) |
| ^NAC #16.1: *NAC #9.1 + I86.4 in primary position* | 66.1 (60.1-71.7)(179/271) | 96.0 (93.6-97.7)(384/400) | 91.8 (87.0-95.2)(179/195) | 80.7 (76.8-84.1)(384/476) | 0.86 (0.84-0.89) |
| ^NAC #17: *NAC #2 + any decompensation code in any position* | 46.7 (41.8-51.7)(191/409) | 98.5 (96.1-99.6)(258/262) | 97.9 (94.8-99.4)(191/195) | 54.2 (49.6-58.7)(258/476) | 0.76 (0.74-0.79) |
| ^NAC #17.1: *NAC #2 + any decompensation code in primary position* | 53.6 (48.2-58.9)(187/349) | 97.5 (95.2-98.9)(314/322) | 95.9 (92.1-98.2)(187/195) | 66.0 (61.5-70.2)(314/476) | 0.81 (0.78-0.83) |

\* Addition of code produced lower or the exact same performance characteristics; therefore, the code was excluded in subsequent algorithms

^ Addition of code significantly decreased AUROC; therefore, the code was excluded in subsequent algorithms

Table 3S has all ICD-10 codes used

PPV: Positive predictive value

NPV: Negative predictive value

AUROC: Area under receiver operating characteristic curve

95% CI: 95% confidence intervals

n/n: Estimate ratio

ICD-10: International classification of diseases 10th revision

NAC: Non-alcohol-associated cirrhosis

AUD: Alcohol use disorder (includes AC and AH)

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