Development and Validation of a Risk Prediction Model of linezolid-induced thrombocytopenia in Vietnamese patients

Sunday, February 4, 2024

## Objectives

1. Investigating risk factors of linezolid-induced thrombocytopenia (LI-TP)
2. Developing and validating a logistics regression model to predict LI-TP in Vietnamese patients

## Data cleaning

Source: [Article Notebook](https://AnTangQuoc.github.io/LZD-TP-pred-model/index.qmd.html)

Rows: 780  
Columns: 58  
$ patient\_age <dbl> 90, 80, 79, 71, 72, 61, 60, 64, 92, 75, 86, 93, 6…  
$ patient\_sex <lgl> TRUE, TRUE, FALSE, FALSE, TRUE, FALSE, FALSE, TRU…  
$ LZD\_dose\_per\_weight <dbl> 25.00000, 30.00000, 30.00000, 13.33333, 17.14286,…  
$ baseline\_CLCR <dbl> 27.22860, 63.15805, 29.93031, 50.89929, 10.87932,…  
$ dept\_ER <lgl> TRUE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, T…  
$ dept\_ICU <lgl> FALSE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, FALSE,…  
$ baseline\_HGB <dbl> 96, 101, 86, 94, 86, 99, 98, 119, 60, 118, 99, 10…  
$ baseline\_WBC <dbl> 6.75, 11.91, 14.05, 14.61, 7.92, 21.79, 13.27, 6.…  
$ baseline\_PLT <dbl> 244, 180, 259, 179, 236, 113, 196, 154, 147, 101,…  
$ LZD\_duration <dbl> 6, 8, 15, 3, 7, 8, 22, 4, 3, 16, 14, 7, 13, 20, 6…  
$ invasive\_ETI <lgl> FALSE, FALSE, FALSE, TRUE, TRUE, FALSE, TRUE, FAL…  
$ invasive\_CVC <lgl> FALSE, FALSE, TRUE, FALSE, TRUE, FALSE, TRUE, FAL…  
$ invasive\_IHD <lgl> FALSE, FALSE, FALSE, FALSE, TRUE, FALSE, FALSE, F…  
$ invasive\_CRRT <lgl> FALSE, FALSE, FALSE, TRUE, FALSE, FALSE, FALSE, F…  
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$ comorb\_HF <lgl> FALSE, TRUE, TRUE, TRUE, TRUE, FALSE, FALSE, TRUE…  
$ comorb\_angina <lgl> FALSE, TRUE, TRUE, FALSE, FALSE, FALSE, FALSE, FA…  
$ comorb\_cirr <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, TRUE, FALSE, F…  
$ comorb\_COPD <lgl> FALSE, FALSE, FALSE, TRUE, FALSE, FALSE, FALSE, F…  
$ comorb\_CVA <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, …  
$ comorb\_MI <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, …  
$ comorb\_K <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, TRUE, F…  
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$ comorb\_hema <lgl> FALSE, FALSE, FALSE, TRUE, FALSE, FALSE, FALSE, F…  
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$ infect\_CAP <lgl> FALSE, FALSE, TRUE, FALSE, FALSE, FALSE, FALSE, F…  
$ infect\_HAP <lgl> TRUE, FALSE, FALSE, TRUE, TRUE, FALSE, FALSE, TRU…  
$ infect\_SSTI <lgl> FALSE, FALSE, FALSE, FALSE, TRUE, FALSE, FALSE, T…  
$ infect\_CNS <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, TRUE, FALSE, F…  
$ infect\_IAI <lgl> FALSE, TRUE, FALSE, FALSE, FALSE, TRUE, TRUE, FAL…  
$ infect\_UTI <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, …  
$ infect\_BJI <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, …  
$ infect\_septicemia <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, …  
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$ comed\_rifampin <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, …  
$ comed\_heparin <lgl> FALSE, FALSE, FALSE, TRUE, TRUE, FALSE, FALSE, FA…  
$ comed\_clopidogrel <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, …  
$ comed\_enoxaparin <lgl> FALSE, FALSE, TRUE, TRUE, FALSE, TRUE, TRUE, FALS…  
$ comed\_dexamethason <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, TRUE, FALSE, F…  
$ comed\_amiodaron <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, …  
$ comed\_furosemid <lgl> FALSE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, FALSE,…  
$ comed\_haloperidol <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, …  
$ comed\_valproic <lgl> FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, …  
$ flag\_ADR\_TP\_ID <lgl> FALSE, FALSE, FALSE, FALSE, TRUE, TRUE, TRUE, FAL…  
$ site <chr> "TN1", "TN1", "TN1", "TN1", "TN1", "TN1", "TN1", …

Source: [Article Notebook](https://AnTangQuoc.github.io/LZD-TP-pred-model/index.qmd.html)

## Descriptive statistics

Source: [Article Notebook](https://AnTangQuoc.github.io/LZD-TP-pred-model/index.qmd.html)

|  | **Thrombocytopenia Status** | | | **Univariate Regression** | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Characteristic** | **Overall**, N = 7801 | **FALSE**, N = 5201 | **TRUE**, N = 2601 | **OR**2 | **95% CI**2 | **p-value** |
| **patient\_age** | 62 (50 - 73) | 61 (48 - 72) | 64 (53 - 74) | 1.02 | 1.01, 1.02 | **<0.001** |
| **patient\_sex** | 292 (37%) | 194 (37%) | 98 (38%) | 1.02 | 0.75, 1.38 | >0.9 |
| **LZD\_dose\_per\_weight** | 21.8 (20.0 - 24.0) | 21.8 (20.0 - 24.0) | 21.8 (19.4 - 24.5) | 0.99 | 0.95, 1.03 | 0.5 |
| **baseline\_CLCR** | 46 (21 - 83) | 55 (26 - 88) | 32 (15 - 64) | 0.99 | 0.99, 0.99 | **<0.001** |
| **dept\_ER** | 133 (17%) | 89 (17%) | 44 (17%) | 0.99 | 0.66, 1.46 | >0.9 |
| **dept\_ICU** | 368 (47%) | 221 (43%) | 147 (57%) | 1.76 | 1.30, 2.38 | **<0.001** |
| **baseline\_HGB** | 102 (89 - 119) | 105 (91 - 121) | 97 (85 - 117) | 0.99 | 0.98, 1.0 | **<0.001** |
| **baseline\_WBC** | 12 (8 - 17) | 12 (8 - 17) | 12 (8 - 18) | 1.01 | 0.99, 1.03 | 0.3 |
| **baseline\_PLT** | 203 (141 - 286) | 233 (165 - 310) | 151 (102 - 208) | 0.99 | 0.99, 0.99 | **<0.001** |
| **LZD\_duration** | 9.0 (6.0 - 14.0) | 9.0 (6.0 - 13.0) | 10.0 (6.0 - 14.0) | 1.03 | 1.01, 1.06 | **0.016** |
| **invasive\_ETI** | 363 (47%) | 210 (40%) | 153 (59%) | 2.11 | 1.56, 2.86 | **<0.001** |
| **invasive\_CVC** | 399 (51%) | 226 (43%) | 173 (67%) | 2.59 | 1.90, 3.54 | **<0.001** |
| **invasive\_IHD** | 105 (13%) | 60 (12%) | 45 (17%) | 1.60 | 1.05, 2.44 | **0.027** |
| **invasive\_CRRT** | 133 (17%) | 53 (10%) | 80 (31%) | 3.92 | 2.67, 5.79 | **<0.001** |
| **comorb\_HTN** | 321 (41%) | 208 (40%) | 113 (43%) | 1.15 | 0.85, 1.56 | 0.4 |
| **comorb\_DM** | 214 (27%) | 142 (27%) | 72 (28%) | 1.02 | 0.73, 1.42 | >0.9 |
| **comorb\_HF** | 218 (28%) | 126 (24%) | 92 (35%) | 1.71 | 1.24, 2.37 | **0.001** |
| **comorb\_angina** | 31 (4.0%) | 19 (3.7%) | 12 (4.6%) | 1.28 | 0.59, 2.64 | 0.5 |
| **comorb\_cirr** | 48 (6.2%) | 20 (3.8%) | 28 (11%) | 3.02 | 1.67, 5.54 | **<0.001** |
| **comorb\_COPD** | 38 (4.9%) | 24 (4.6%) | 14 (5.4%) | 1.18 | 0.58, 2.28 | 0.6 |
| **comorb\_CVA** | 90 (12%) | 64 (12%) | 26 (10%) | 0.79 | 0.48, 1.27 | 0.3 |
| **comorb\_MI** | 20 (2.6%) | 15 (2.9%) | 5 (1.9%) | 0.66 | 0.21, 1.73 | 0.4 |
| **comorb\_K** | 64 (8.2%) | 41 (7.9%) | 23 (8.8%) | 1.13 | 0.66, 1.92 | 0.6 |
| **comorb\_hematological** | 46 (5.9%) | 27 (5.2%) | 19 (7.3%) | 1.44 | 0.77, 2.63 | 0.2 |
| **comorb\_hema** | 60 (7.7%) | 36 (6.9%) | 24 (9.2%) | 1.37 | 0.79, 2.33 | 0.3 |
| **infect\_sepsis** | 130 (17%) | 62 (12%) | 68 (26%) | 2.62 | 1.78, 3.84 | **<0.001** |
| **infect\_CAP** | 112 (14%) | 66 (13%) | 46 (18%) | 1.48 | 0.98, 2.22 | 0.062 |
| **infect\_HAP** | 352 (45%) | 236 (45%) | 116 (45%) | 0.97 | 0.72, 1.31 | 0.8 |
| **infect\_SSTI** | 128 (16%) | 95 (18%) | 33 (13%) | 0.65 | 0.42, 0.99 | **0.049** |
| **infect\_CNS** | 68 (8.7%) | 45 (8.7%) | 23 (8.8%) | 1.02 | 0.60, 1.72 | >0.9 |
| **infect\_IAI** | 49 (6.3%) | 33 (6.3%) | 16 (6.2%) | 0.97 | 0.51, 1.77 | >0.9 |
| **infect\_UTI** | 53 (6.8%) | 37 (7.1%) | 16 (6.2%) | 0.86 | 0.46, 1.54 | 0.6 |
| **infect\_BJI** | 10 (1.3%) | 9 (1.7%) | 1 (0.4%) | 0.22 | 0.01, 1.18 | 0.2 |
| **infect\_septicemia** | 231 (30%) | 143 (28%) | 88 (34%) | 1.35 | 0.98, 1.86 | 0.068 |
| **comed\_aspirin** | 46 (5.9%) | 29 (5.6%) | 17 (6.5%) | 1.18 | 0.63, 2.17 | 0.6 |
| **comed\_diclofenac** | 27 (3.5%) | 20 (3.8%) | 7 (2.7%) | 0.69 | 0.27, 1.58 | 0.4 |
| **comed\_ibuprofen** | 25 (3.2%) | 14 (2.7%) | 11 (4.2%) | 1.60 | 0.70, 3.56 | 0.3 |
| **comed\_paracetamol** | 338 (43%) | 230 (44%) | 108 (42%) | 0.90 | 0.66, 1.21 | 0.5 |
| **comed\_penicillin** | 114 (15%) | 71 (14%) | 43 (17%) | 1.25 | 0.83, 1.88 | 0.3 |
| **comed\_cepha** | 197 (25%) | 141 (27%) | 56 (22%) | 0.74 | 0.52, 1.05 | 0.092 |
| **comed\_carbapenem** | 554 (71%) | 355 (68%) | 199 (77%) | 1.52 | 1.08, 2.14 | **0.017** |
| **comed\_cotrimoxazol** | 63 (8.1%) | 36 (6.9%) | 27 (10%) | 1.56 | 0.92, 2.62 | 0.10 |
| **comed\_vancomycin** | 67 (8.6%) | 40 (7.7%) | 27 (10%) | 1.39 | 0.83, 2.31 | 0.2 |
| **comed\_levofloxacin** | 230 (29%) | 144 (28%) | 86 (33%) | 1.29 | 0.93, 1.78 | 0.12 |
| **comed\_teicoplanin** | 26 (3.3%) | 13 (2.5%) | 13 (5.0%) | 2.05 | 0.93, 4.54 | 0.072 |
| **comed\_ethambutol** | 8 (1.0%) | 5 (1.0%) | 3 (1.2%) | 1.20 | 0.25, 4.94 | 0.8 |
| **comed\_pyrazinamid** | 12 (1.5%) | 6 (1.2%) | 6 (2.3%) | 2.02 | 0.63, 6.53 | 0.2 |
| **comed\_rifampin** | 17 (2.2%) | 10 (1.9%) | 7 (2.7%) | 1.41 | 0.51, 3.72 | 0.5 |
| **comed\_heparin** | 189 (24%) | 94 (18%) | 95 (37%) | 2.61 | 1.86, 3.66 | **<0.001** |
| **comed\_clopidogrel** | 38 (4.9%) | 28 (5.4%) | 10 (3.8%) | 0.70 | 0.32, 1.42 | 0.3 |
| **comed\_enoxaparin** | 327 (42%) | 213 (41%) | 114 (44%) | 1.13 | 0.83, 1.52 | 0.4 |
| **comed\_dexamethason** | 92 (12%) | 60 (12%) | 32 (12%) | 1.08 | 0.67, 1.69 | 0.8 |
| **comed\_amiodaron** | 33 (4.2%) | 15 (2.9%) | 18 (6.9%) | 2.50 | 1.24, 5.12 | **0.010** |
| **comed\_furosemid** | 417 (53%) | 244 (47%) | 173 (67%) | 2.25 | 1.65, 3.08 | **<0.001** |
| **comed\_haloperidol** | 45 (5.8%) | 28 (5.4%) | 17 (6.5%) | 1.23 | 0.65, 2.27 | 0.5 |
| **comed\_valproic** | 29 (3.7%) | 21 (4.0%) | 8 (3.1%) | 0.75 | 0.31, 1.66 | 0.5 |
| **comed\_aceclofenac** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_naproxen** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_daptomycin** | 1 (0.1%) | 0 (0%) | 1 (0.4%) |  |  |  |
| **comed\_cetirizin** | 6 (0.8%) | 5 (1.0%) | 1 (0.4%) |  |  |  |
| **comed\_simvas** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_bisoprolol** | 6 (0.8%) | 4 (0.8%) | 2 (0.8%) |  |  |  |
| **comed\_diltiazem** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_eptifibatid** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_quinidin** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_carbamazepin** | 7 (0.9%) | 7 (1.3%) | 0 (0%) |  |  |  |
| **comed\_phenytoin** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_mirtazapin** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_quetiapin** | 3 (0.4%) | 3 (0.6%) | 0 (0%) |  |  |  |
| **comed\_ondansetron** | 6 (0.8%) | 4 (0.8%) | 2 (0.8%) |  |  |  |
| **comed\_palonosetron** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_oseltamivir** | 3 (0.4%) | 1 (0.2%) | 2 (0.8%) |  |  |  |
| **comed\_quinin** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_pembrolizumab** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_trastuzumab** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_atezolizumab** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_durvalumab** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_IVIG** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_tacrolimus** | 1 (0.1%) | 0 (0%) | 1 (0.4%) |  |  |  |
| **comed\_fluorouracil** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_irinotecan** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_leucovorin** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| **comed\_oxaliplatin** | 0 (0%) | 0 (0%) | 0 (0%) |  |  |  |
| 1Median (IQR); n (%) | | | | | | |
| 2OR = Odds Ratio, CI = Confidence Interval | | | | | | |

Source: [Article Notebook](https://AnTangQuoc.github.io/LZD-TP-pred-model/index.qmd.html)

## Model Performance

| performance\_type | C\_index | calibration\_intercept | calibration\_slope |
| --- | --- | --- | --- |
| Apparent | 0.7779549 | 0.0000000 | 1.0000000 |
| Bootstrap | 0.7456938 | -0.0001972 | 0.8176676 |
| Fold | 0.7641578 | -0.0084625 | 0.9584548 |

Source: [Article Notebook](https://AnTangQuoc.github.io/LZD-TP-pred-model/index.qmd.html)