



Diagnostic and Prognostic Utility of Monocyte Cell Population Data in Emergency Department Patients With Suspected Sepsis

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Background

- Cell population data (CPD) may characterize each white blood cell (WBC) population and has been suggested to be an useful hematologic biomarker for sepsis.
- We evaluated the utility of monocyte CPD on DxH 900 analyzer (Beckman Coulter, Miami, FL, USA) for the diagnosis and prognosis prediction in sepsis.

Methods

- A total of 485 (non-sepsis, N = 315; sepsis, N = 170) patients with suspected sepsis were recruited at the emergency department of Konkuk University Medical Center from May 2020 to July 2021 (**Table 1**).
- Using Mann–Whitney test, receiver operating characteristic (ROC) curve analysis and logistic regression analysis, we selected monocyte CPD with the best performance among the 14 monocyte CPD (**Table 2 & 3**).
- Using the ROC curve analysis, we compared the selected monocyte CPD with quick sequential organ failure assessment (qSOFA) score for diagnosing sepsis and SOFA score for predicting 30-day mortality.
- Using Kaplan–Meier survival analysis, we obtained hazard ratio (HR) for 30-day mortality prediction.

Table 1. Characteristics of the study population

	All patients (N = 485)	Non-sepsis (N = 315)	Sepsis (N = 170)	P
Age	74 (63–83)	65 (54–76.8)	68 (57–78.3)	< 0.01
Males	272 (56.1)	167 (53.0)	105 (61.8)	0.08
Comorbidities				
Hypertension	213 (43.9)	130 (41.3)	83 (48.8)	0.110
Diabetes mellitus	212 (43.7)	125 (64.9)	87 (51.2)	0.015
Solid cancer	177 (36.5)	106 (33.7)	71 (41.8)	0.077
Gastrointestinal diseases	84 (17.3)	44(14.0)	40 (23.5)	0.008
Cerebrovascular accidents	69 (14.2)	29 (9.2)	40(23.5)	< 0.001
Chronic kidney diseases	68 (14.0)	26 (8.3)	42 (24.7)	< 0.001
Gastrointestinal	84 (17.3)	44(14.0)	40 (23.5)	0.008
qSOFA score	1 (1 – 2)	1 (1 – 1)	2 (1 – 2)	< 0.01
SOFA score	2 (0 – 4)	1 (0 – 2)	4 (3 – 6)	< 0.01
Laboratory parameters				
CRP (mg/L)	15.5 (12.4 – 20.8)	15.1 (12.4 – 20.1)	16.1 (12.4 – 20.9)	0.055
Lactate (mmol/L)	1.8 (1.3 – 2.5)	1.7 (1.3 – 2.3)	1.9 (1.4 – 2.8)	0.013
Procalcitonin (ng/mL)	0.4 (0.2 – 2.0)	0.3 (0.1 – 1.2)	0.7 (0.3 – 3.9)	< 0.001
Hb (g/L)	105 (93 – 123)	110 (98 – 129)	99 (87 – 111)	< 0.001
WBC (× 10 ⁹ /L)	10.7 (7.8 – 15.6)	10.2 (7.8 – 14.0)	11.4 (8.2 – 15.6)	0.036
PLT (× 10 ⁹ /L)	223 (160 – 291)	237 (117 – 313)	187 (125 – 257)	< 0.001
MDW	25.0 (22.6 – 28.8)	24.4 (22.5 – 28.0)	26.3 (23.4 – 30.8)	< 0.001
CRP (mg/L)	15.5 (12.4 – 20.8)	15.1 (12.4 – 20.1)	16.1 (12.4 – 20.9)	0.055
Monocyte CPD				
MN–AL2–MO	119.0 (115.0 – 122.0)	119.0 (115.0 – 122.0)	119.0 (114.0 – 122.0)	0.446
MN–C–MO	121.0 (119.0 – 124.0)	121.0 (119.0 – 123.0)	121.5 (119.0 – 124.0)	0.039
MN–LALS–MO	75.0 (68.0 – 81.0)	74.0 (66.3 – 80.0)	78.0 (69.0 – 82.0)	0.003
MN–LMALS–MO	77.0 (75.0 – 80.0)	77.0 (75.0 – 80.0)	78.0 (75.0 – 81.0)	0.137
MN–MALS–MO	91.0 (88.0 – 93.0)	91.0 (88.0 – 93.0)	91.0 (88.0 – 93.0)	0.212
MN–UMALS–MO	100.0 (97.0 – 104.0)	100.0 (97.0 – 104.0)	101.0 (98.0 – 104.0)	0.437
MN–V–MO	182.0 (176.8 – 190.0)	182.0 (176.0 – 190.0)	183.0 (177.0 – 192.0)	0.212
SD–AL2–MO	17.4 (16.3 – 18.9)	17.0 (16.2 – 18.6)	17.8 (16.4 – 20.2)	0.001
SD–C–MO	6.0 (5.3 – 6.9)	5.9 (5.3 – 6.6)	6.1 (5.4 – 7.3)	0.018
SD–LALS–MO	25.2 (22.9 – 27.5)	25.1 (22.8 – 27.1)	25.5 (23.1 – 28.1)	0.070
SD–LMALS–MO	14.2 (13.2 – 15.0)	14.2 (13.1 – 14.9)	14.2 (13.3 – 15.2)	0.328
SD–MALS–MO	10.2 (9.4 – 11.0)	10.0 (9.2 – 10.7)	10. 8(9.8 – 11.5)	< 0.001
SD–UMALS–MO	11.9 (10.2 – 14.5)	11.4 (10.0 – 13.9)	12.7 (11.0 – 15.4)	< 0.001
SD–V–MO	23.6 (21.9 – 25.9)	23.2 (21.6 – 25.3)	24.3 (22.6 – 27.2)	< 0.001
Clinical outcome				
ICU admission	122 (25.2)	54 (17.1)	68 (40.2)	< 0.001
ICU stay (day)	3 (2 – 17)	3 (1 – 18)	4 (2 – 18)	0.562
Hospital stay (day)	15 (7 – 34)	12 (6 – 25)	28 (13 – 53)	< 0.001
In-hospital mortality	63 (13.0)	17 (5.4)	46 (27.1)	< 0.001
30-day mortality	52 (10.7)	14 (4.4)	38 (22.4)	< 0.001

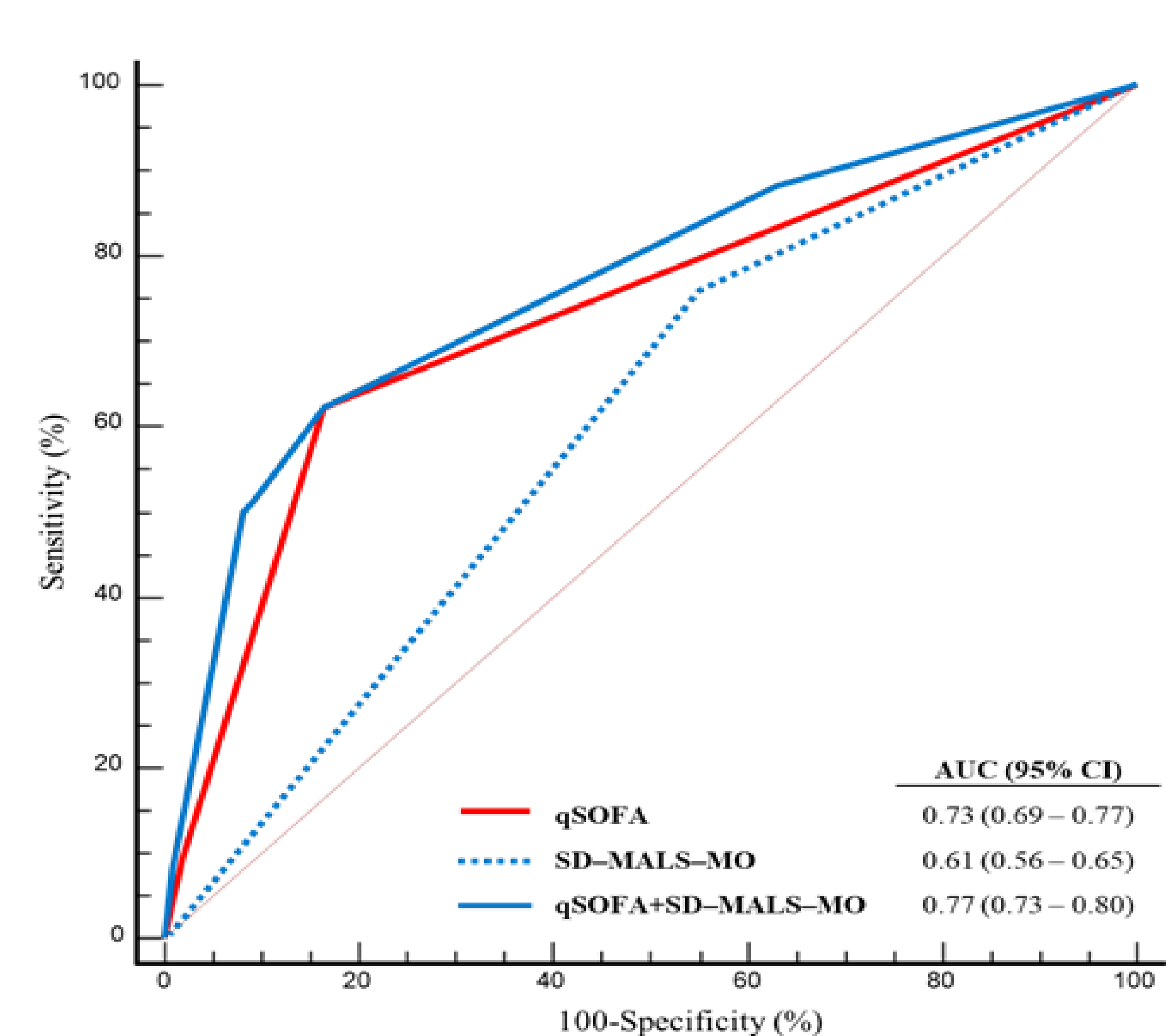


Fig. 1. ROC curve analysis for diagnosing sepsis using monocyte CPD and qSOFA score.

Results

- Standard deviation of monocyte median angle light scatter (SD–MALS–MO) were selected for diagnosing sepsis, and both mean of monocyte conductivity (MN–C–MO) and SD–MALS–MO were selected for predicting 30-day mortality (**Table 2 & 3**).
- SD–MALS–MO significantly enhanced qSOFA score for sepsis diagnosis (area under the curve [AUC], 0.77 vs. 0.73; $P < 0.009$) (**Fig. 1**).
- The combination of the MN–C–MO and SD–MALS–MO demonstrated comparable performance to SOFA score (AUC, 0.70 vs. 0.75; $P = 0.321$) (**Fig. 2A**) and showed higher risk of 30-day mortality than SOFA score (HR: 7.5 vs. 5.8, $P < 0.001$) (**Fig. 2B**).

Conclusions

- Monocyte CPD offered an add-on value to qSOFA score for sepsis diagnosis, and the combination was as effective as SOFA score for predicting 30-day mortality in patients with suspected sepsis.
- Monocyte CPD can be a valuable hematologic biomarker for the early diagnosis and prognosis prediction in sepsis.

Table 2. ROC curve and logistic regression analyses of monocyte CPD for diagnosing sepsis

Variable	Cut-off	ROC curve analysis			Logistic regression analysis			
		Sensitivity (%)	Specificity (%)	AUC (95% CI)	OR (95% CI)	P	OR (95% CI)	P
MN–AL2–MO	≤ 110.0	13.5	94.3	0.52 (0.48 – 0.57)	0.99 (0.96 – 1.02)	0.412		
MN–C–MO	> 120.0	67.1	46.4	0.56 (0.51 – 0.60)	1.06 (1.00 – 1.12)	0.060		
MN–LALS–MO	> 75.0	57.1	59.7	0.58 (0.54 – 0.63)	1.02 (1.00 – 1.04)	0.072		
MN–LMALS–MO	> 77.0	54.1	54.6	0.54 (0.50 – 0.59)	1.03 (0.98 – 1.08)	0.249		
MN–MALS–MO	> 92.0	35.3	70.8	0.53 (0.49 – 0.58)	1.02 (0.98 – 1.07)	0.319		
MN–UMALS–MO	> 100.0	52.4	53.3	0.52 (0.48 – 0.57)	1.01 (0.98 – 1.04)	0.450		
MN–V–MO	> 186.0	40.6	67.6	0.53 (0.49 – 0.58)	1.01 (1.00 – 1.03)	0.151		
SD–AL2–MO	> 19.8	28.2	88.6	0.59 (0.55 – 0.63)	1.17 (1.09 – 1.26)	< 0.001	1.03 (0.92 – 1.16)	0.612
SD–C–MO	> 6.7	38.2	76.8	0.56 (0.52 – 0.61)	1.12 (1.04 – 1.21)	0.002	0.94 (0.84 – 1.05)	0.286
SD–LALS–MO	> 27.1	36.5	75.9	0.55 (0.50 – 0.60)	1.05 (1.00 – 1.11)	0.062		
SD–LMALS–MO	> 15.2	27.1	81.0	0.53 (0.48 – 0.57)	1.10 (0.98 – 1.23)	0.113		
SD–MALS–MO	> 9.8	75.9	45.7	0.63 (0.59 – 0.67)	1.38 (1.20 – 1.59)	< 0.001	1.29 (1.08 – 1.55)	0.006
SD–UMALS–MO	> 11.2	72.4	47.6	0.62 (0.57 – 0.66)	1.14 (1.07 – 1.21)	< 0.001	1.05 (0.96 – 1.13)	0.289
SD–V–MO	> 23.1	69.4	49.5	0.61 (0.56 – 0.65)	1.13 (1.07 – 1.20)	< 0.001	1.08 (1.00 – 1.17)	0.062

Table 3. ROC curve and logistic regression analyses of monocyte CPD for predicting 30-day mortality

Variable	Cut-off	ROC curve analysis			Logistic regression analysis			
		Sensitivity (%)	Specificity (%)	AUC (95% CI)	OR (95% CI)	P	OR (95% CI)	P
MN–AL2–MO	≤ 119.0	76.9	46.4	0.64 (0.60 – 0.68)	0.91 (0.86 – 0.95)	< 0.001		
MN–C–MO	> 122.0	55.8	68.6	0.62 (0.58 – 0.66)	1.15 (1.05 – 1.25)	0.002	1.20 (1.09 – 1.31)	< 0.001
MN–LALS–MO	> 79.0	46.2	70.2	0.58 (0.54 – 0.63)	1.03 (1.00 – 1.06)	0.080		
MN–LMALS–MO	> 76.0	69.2	42.5	0.55 (0.50 – 0.59)	1.03 (0.96 – 1.10)	0.495		
MN–MALS–MO	> 88.0	75.0	30.3	0.50 (0.46 – 0.55)	0.98 (0.91 – 1.05)	0.603		
MN–UMALS–MO	≤ 96.0	28.6	81.5	0.55 (0.51 – 0.60)	0.99 (0.95 – 1.02)	0.391		
MN–V–MO	≤ 173.0	21.2	87.5	0.54 (0.49 – 0.58)	0.98 (0.95 – 1.01)	0.146		
SD–AL2–MO	> 18.0	57.7	62.4	0.60 (0.56 – 0.65)	1.16 (1.06 – 1.26)	0.003	1.01 (0.84 – 1.22)	0.889
SD–C–MO	> 7.0	38.5	78.8	0.59 (0.54 – 0.63)	1.11 (1.03 – 1.20)	0.012	0.84 (0.71 – 1.00)	0.047
SD–LALS–MO	> 28.0	34.6	81.3	0.56 (0.52 – 0.61)	1.06 (0.98 – 1.15)	0.172		
SD–LMALS–MO	> 15.1	36.5	78.1	0.59 (0.55 – 0.64)	1.28 (1.09 – 1.51)	0.003	0.82 (0.62 – 1.09)	0.178
SD–MALS–MO	> 10.2	76.9	54.5	0.69 (0.65 – 0.73)	1.50 (1.26 – 1.80)	< 0.001	2.02 (1.38 – 2.94)	< 0.001
SD–UMALS–MO	> 13.3	61.5	67.2	0.65 (0.61 – 0.69)	1.18 (1.08 – 1.28)	< 0.001	1.03 (0.90 – 1.18)	0.665
SD–V–MO	> 26.2	44.2	79.9	0.62 (0.57 – 0.66)	1.15 (1.07 – 1.24)	< 0.001	1.10 (0.97 – 1.26)	0.137

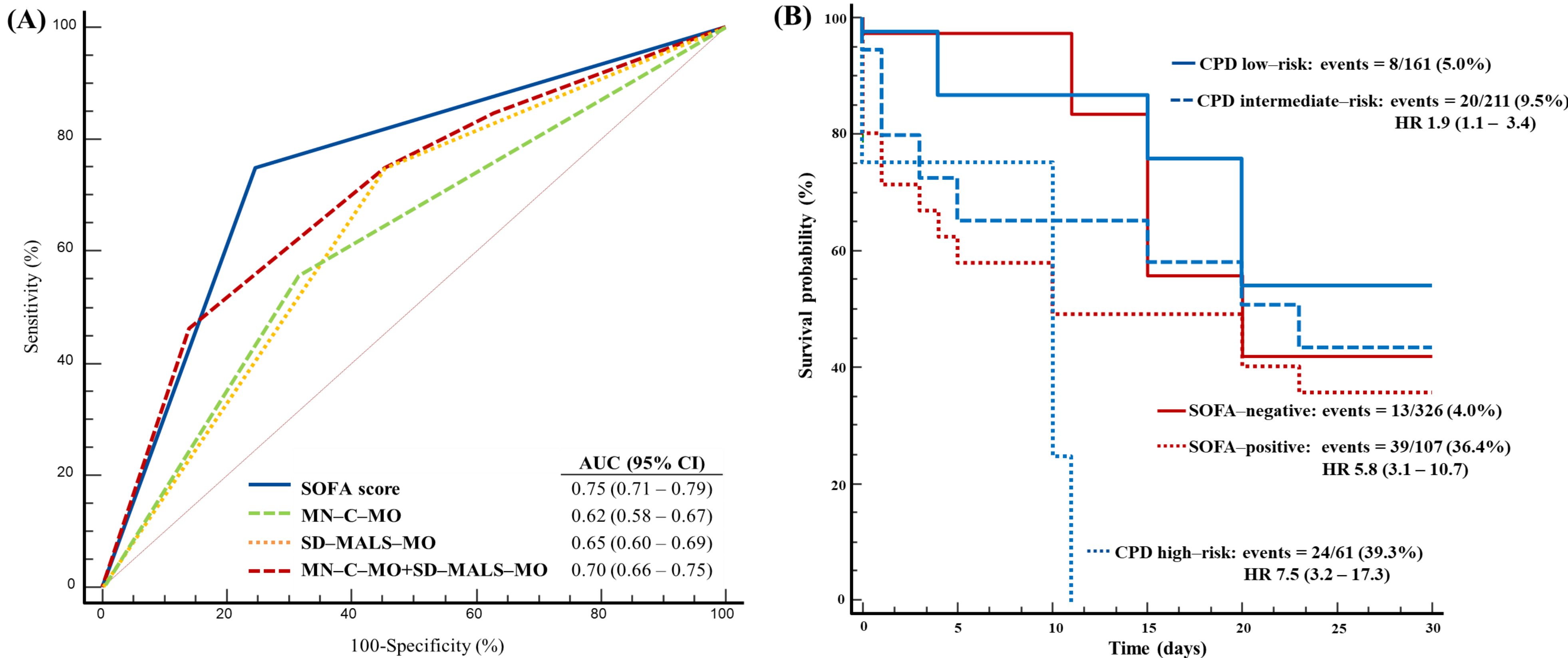


Fig. 2. ROC curve analysis (A) and Kaplan-Meier survival analysis (B) for predicting 30-day mortality using monocyte CPD and SOFA score.