OBSERVATIONAL STUDY

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Social Determinants of Health and Delirium Occurrence and Duration in Critically Ill Adults

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OBJECTIVES: Social determinants of health may affect ICU outcome, but the association between social determinants of health and delirium remains unclear. We evaluated the association between three social determinants of health and delirium occurrence and duration in critically ill adults.

DESIGN: Secondary, subgroup analysis of a cohort study.

SETTING: Single, 36-bed mixed medical-surgical ICU in the Netherlands.

PATIENTS: Nine hundred fifty-six adults consecutively admitted from July 2016 to February 2020. Patients admitted after elective surgery, residing in a nursing home, or not expected to survive greater than or equal to 48 hours were excluded.

INTERVENTION: None.

MEASUREMENTS AND MAIN RESULTS: Four factors related to three Center for Disease Control social determinants of health domains (social/community context [ethnicity], education access/quality [educational level], and economic stability [employment status and monthly income]) were collected at ICU admission from patients (or families). Well-trained ICU nurses evaluated patients without coma (Richmond Agitation Sedation Scale, −4, −5) and with the Confusion Assessment Method-ICU and/or a delirium day was defined by greater than or equal to 1 + Confusion Assessment Method-ICU and/or scheduled antipsychotic use. Multivariable logistic regression models controlling for ICU days and 10 delirium risk variables (before-ICU: age, Charlson, cognitive impairment, any antidepressant, antipsychotic, or benzodiazepine use; ICU baseline: Acute Physiology and Chronic Health Evaluation IV and admission type; daily ICU: Sequential Organ Failure Assessment, restraint use, coma, benzodiazepine, or opioid use) evaluated associations between each social determinant of health factor and both ICU delirium occurrence and duration. Delirium occurred in 393/956 patients (45.4%) for 2 days (1–5 d). Patients with low (vs high) income had more ICU delirium ($p = 0.05$). Multivariate analyses revealed no social determinants of health to be significantly associated with increased delirium occurrence or duration. Low (vs high) income was weakly associated with increased delirium occurrence (adjusted odds ratio, 1.83; 95% CI, 0.91–3.89). Low (vs high) education (adjusted relative risk, 1.21; 95% CI, 0.97–1.53) was weakly associated with a longer delirium duration.

CONCLUSIONS: Social determinants of health did not affect ICU delirium in one Dutch region. Additional research across different countries/regions and where additional social determinants of health are considered is needed to define the association between social determinants of health and ICU delirium.

KEY WORDS: delirium; intensive care; social determinants of health; socioeconomic factors

Social determinants of health (SDOH) are categorized by the Centers for Disease Control into five domains: social/community context, education access/quality, economic stability, neighborhood/built environment, and healthcare access/quality (1). The first three domains are often grouped as socioeconomic factors. There is great interest in determining the influence of SDOH

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on ICU outcomes given social policy changes may sometimes help improve SDOH (2). The results of published studies investigating this question are mixed in terms of whether a relationship between SDOH and critical care outcomes exists (2–5). One investigation in the Nashville, TN, area found that patients who are non-White and have a lower education are more likely to experience greater post-ICU, long-term cognitive impairment (3). However, in one Australian state, a relationship between socioeconomic status and ICU mortality was not demonstrated (4). A French study found no relationship between socioeconomic status and mortality or psychologic health 1 year after ICU discharge (5).

Delirium, a common sequela of critical illness, is associated with poor outcomes (6, 7). Multiple predisposing and precipitating factors increase ICU delirium risk (7, 8). A longer ICU delirium duration increases mortality and worsens long-term cognitive impairment (7,9). Although African Americans (vs Caucasians) have a similar risk for delirium in the ICU (10), the association between other SDOH and delirium has not been evaluated. Ecosocial theory integrates social and biologic characteristics and suggests that adults who have been chronically exposed to the disadvantages conferred by SDOH may have prolonged immune activation resulting in physiologic dysregulation and excessive inflammatory response (11). With delirium being an acute neuroinflammatory condition (6), we hypothesized critically ill adults having chronically poor SDOH are at greater risk for ICU delirium. We evaluated the associations between three SDOH domains and the occurrence and duration of delirium in critically ill adults.

MATERIALS AND METHODS

This retrospective cohort study is a secondary, subgroup analysis of the Monitoring cOnsequeNces of InTensive care fOR Intensive Care patients (MONITOR-IC) study (ClinicalTrials.gov NCT03246334) (12, 13). The multicenter, MONITOR-IC cohort study prospectively compared patient self-reported cognitive, psychologic, and physical health statuses before- and 1-year after ICU admission in 2,345 critically ill adults in the Netherlands (12, 13). Consecutive patients enrolled in the MONITOR-IC study between July 2016 and February 2020 who were admitted to the 36-bed mixed medical-surgical ICU at Radboud University Medical Center (RadboudUMC), an academic medical center in Nijmegen, NL, were included in this study. Patients admitted after elective surgery, who were currently residing in a long-term care facility, or not expected to survive greater than or equal to 48 hours were excluded. This study was approved by the ethics committee of the RadboudUMC (2016-2724). Each participant, or their legal representative, provided written informed consent.

Baseline demographic and SDOH data were obtained from the MONITOR-IC database (12, 13); all remaining patient data were extracted from the RadboudUMC EPIC (Verona, WI) electronic health record. Data on four SDOH were collected via questionnaires filled in by patients (or families) at the time of ICU admission: 1) social/community context (ethnicity: non-Dutch vs Dutch [patient and both parents NL-born]), 2) education access/quality (highest educational attainment: low [≤ secondary school graduate] vs high [postsecondary graduate]), and 3) economic stability (employment status: part-time employed/unemployed vs fully employed and individual monthly income: low [≤ $USD 2,075] vs high [> $3,052]) (1, 12). The monthly income levels chosen were consistent with the income levels (in EUROS) used in the MONITOR-IC trial (12). Patients greater than or equal to 65 years were assumed not to be part of the active workforce and were excluded from the employment status analysis.

Bedside ICU nurses evaluated patients without coma (Richmond Agitation Sedation Scale [RASS], –4 or –5) (14) every 8 hours with the Confusion Assessment Method-ICU (CAM-ICU) when they were maximally awake (e.g., after a spontaneous awakening trial) (15, 16). Both RASS and CAM-ICU assessment are longstanding standards of care in the study ICU; nurses undergo regular training updates. A delirium day was defined by greater than or equal to 1 + CAM-ICU and/or scheduled antipsychotic use (16). Data on ICU days and 10 variables previously shown to be associated with increased ICU delirium or duration (7, 8) were collected: before-ICU: age, modified Charlson comorbidity index (mCCI) (17), cognitive impairment (Cognitive Failures Questionnaire Score ≥ 43) (18), antidepressant, antipsychotic, or benzodiazepine use (indicative of a preexisting mental illness); ICU baseline: admission type and Acute Physiology and Chronic Health Evaluation IV score (19); and Daily ICU (until

delirium occurrence or discharge): average Sequential Organ Failure Assessment score (20), restraint use, coma occurrence, daily ICU benzodiazepine (≥ 5-mg midazolam equivalent) (21), and opioid (≥ 10-mg IV morphine equivalents) use (22).

Logistic regression models were created to measure the association between each of the four SDOH and ICU delirium occurrences. Quasi-Poisson regression models were created to measure the association between each of the four SDOH and ICU delirium durations. Patients with random missing data (SDOH [ethnicity 6.6%, education 3.3%, employment status 4.7%, and income 14.7%] and covariates [mCCI 4.8%]) were excluded from analyses. All models were adjusted for all pre-ICU, ICU baseline, and daily ICU covariates. Significance was defined as a two-sided *p* value of less than 0.05. All analyses were performed using R version 4.0.3 (R Foundation for Statistical Computing).

RESULTS

Among 956 patients, 9.4% were non-Dutch, 75.3% had low educational attainment, 35.9% (among patients ≤ 65 years old) were unemployed or worked only part-time, and 51.2% earned a low monthly income (**Table 1**). Delirium occurred in 393/956 of the patients (45.4%) for a median (interquartile range) of 2 days (1–5 d). Low-income patients were more likely to experience ICU delirium than high-income patients ($p = 0.05$) (Table 1). All covariates were significantly different between the delirium and nondelirium groups except baseline cognitive impairment, baseline benzodiazepine use, and admission type (**Table 2**).

TABLE 1.
Comparison of Select Social Determinant of Health Between Patients With and Without ICU Delirium

Social Determinant	All Patients	All Patients		*p*
		Delirium	No Delirium	
Social and community context				
Ethnic background, *n* (%)				
Total	893 (100)	361 (40)	532 (60)	0.13
Non-Dutch	84 (9)	41 (49)	43 (51)	
Dutch	809 (91)	320 (40)	489 (60)	
Education access and quality				
Educational attainment, *n* (%)				
Total	924 (100)	385 (42)	539 (58)	0.82
Low	696 (75)	292 (42)	404 (58)	
High	228 (25)	93 (41)	135 (59)	
Economic stability				
Employment status, *n* (%)				
Total	537 (100)	195 (36)	342 (64)	0.86
Part-time employed/unemployed	193 (36)	71 (37)	122 (63)	
Full-time employment	344 (64)	124 (36)	220 (64)	
$ U.S. monthly income, *n* (%)				
Total	815 (100)	325 (40)	490 (60)	
Low	417 (51)	180 (43)	237 (57)	0.05
Medium	239 (29)	89 (37)	150 (63)	0.32
High	159 (20)	56 (35)	103 (65)	0.18

TABLE 2.
Comparison of Model Covariables Between Patients With and Without ICU Delirium

Model Covariable	All Patients ($n = 956$)	All Patients		p
		Delirium ($n = 393$)	No Delirium ($n = 563$)	
Pre-ICU admission variables				
Age, median (IQR)	63 (51–71)	65 (54–72)	61 (49–70)	< 0.01
Modified Charlson comorbidity index, median (IQR)	2 (1–4)	3 (2–4)	2 (1–4)	< 0.01
Cognitive impairment, *n* (%)	42 (4)	21 (0.5)	21 (0.4)	0.23
Scheduled antipsychotic, antidepressant or benzodiazepine use, *n* (%)	35 (4)	22 (0.6)	13 (0.2)	< 0.01
ICU baseline variables				
Admission type, *n* (%)				
Medical	345 (36)	250 (41)	361 (59)	0.93
Surgical	611 (64)	143 (41)	202 (59)	
APACHE IV score, median (IQR)	67 (52–83)	75 (61–93)	61 (47–77)	< 0.01
Daily ICU variables				
Use of physical restraint, *n* (%)	593 (62)	313 (53)	280 (47)	< 0.01
Sequential Organ Failure Assessment score, median (IQR)	6 (4–8)	8.0 (6–10)	4.8 (3–7)	< 0.01
Presence of coma, *n* (%)	347 (36)	226 (65)	121 (35)	< 0.01
Opioid use, *n* (%)	278 (29)	274 (99)	4 (1)	< 0.01
Benzodiazepine use, *n* (%)	178 (19)	176 (99)	2 (1)	< 0.01
Days spent in the ICU, median (IQR)	2 (1–3)	1 (0–4)	2 (1–3)	< 0.01

IQR = interquartile range.

Across the multivariate models, none of the four SDOH was significantly associated with increased delirium occurrence or duration (**Table 3**). Low (vs high) monthly income was weakly associated with increased delirium occurrence (adjusted odds ratio, 1.83; 95% CI, 0.91–3.89). Low (vs high) educational attainment (adjusted relative risk, 1.21; 95% CI, 0.97–1.53) was weakly association with more ICU delirium days.

DISCUSSION

The potential relationships between SDOH and the adverse outcomes associated with critical illness have been at the forefront of the current severe acute respiratory coronavirus 2 (SARS-CoV-2) pandemic (23, 24). Delirium is highly prevalent during critical illness and associated with deleterious ICU and post-ICU outcomes (7, 9). Recognition of delirium risk factors, particularly if they are modifiable, is a key component of ICU delirium reduction efforts (7, 8). Our study is the first publication to explore the association between SDOH and ICU delirium occurrence and duration. If societal improvements (e.g., better access to quality education and better employment/higher income) lower chronic inflammation over the lifespan, the risk for delirium may be reduced in populations at high risk for developing it (e.g., the critically ill) (2, 6, 11).

Although we were unable to find evidence from one Dutch region that SDOH affect ICU delirium occurrence or duration, one should not assume these relationships do not exist in other populations. By evaluating patients from one relatively homogeneous region, our results may not apply to other countries or settings where SDOH may be quite different (1, 2). We did not consider data on race and healthcare access/quality in our study because the Nijmegen, NL, region is primarily White, and all Dutch citizens have access to high-quality medical care (1, 2). SDOH variability may exist between individual neighborhoods in the

TABLE 3.
Association Between Social Determinant of Health and ICU Delirium Occurrence and Duration

Social Determinant	Delirium Occurrence		Delirium Duration	
	Adjusted OR (95% CI)	*p*	Attributable Risk Ratio (95% CI)	*p*
Ethnicity ($n = 849$)				
Dutch (R)	1		1	
Non-Dutch	1.04 (0.41–2.42)	0.94	1.27 (0.94–1.69)	0.11
Educational attainment ($n = 881$)				
High (R)	1		1	
Low	0.80 (0.47–1.39)	0.43	1.21 (0.97–1.53)	0.10
Employment status ($n = 516$)				
Full-time employment (R)	1		1	
Part-time employment or unemployed	0.95 (0.42–2.09)	0.91	0.96 (0.71–1.30)	0.80
Monthly income ($n = 778$)				
High (R)	1		1	
Medium	1.08 (0.48–2.47)	0.85	1.15 (0.85–1.57)	0.36
Low	1.83 (0.91–3.89)	0.10	1.15 (0.88–1.52)	0.30

OR = odds ratio, R = reference.

Nijmegen region, but the Dutch government does not allow postal codes to be used in research.

Future research exploring the relationship between SDOH and ICU delirium is required in critically ill populations having diverse SDOH, despite Australian and French studies not demonstrating an association between SDOH and mortality or post-ICU psychologic health (4, 5). Non-White race and low educational attainment have each been shown to be associated with greater long-term cognitive impairment after ICU discharge for patients hospitalized in Nashville, TN—a region where SDOH epidemiology may be different from Australia or Europe (3, 5). Although Haddad et al (3) did not consider ICU delirium occurrence or duration in their Nashville-based study, delirium is strongly associated with greater long-term cognitive impairment (9). In older adult Americans admitted to the floor after major surgery, studies demonstrate low education and income level are associated with greater postoperative delirium (25, 26). The authors of these reports hypothesized lower education may reduce cognitive reserve and thus increase delirium (25, 26). With level of education and level of income closely interrelated, it remained unclear in either report whether low-income alone was an independent risk for postoperative delirium.

Our study has important strengths. We evaluated close to 1,000 critically ill adults, prospectively collected data on factors related to three SDOH domains, rigorously evaluated delirium three times daily, and accounted for 10 established ICU delirium risk factors in all analyses. Our study also has limitations. By excluding non-Dutch-speaking patients (because of the challenge of screening them for delirium with the CAM-ICU), we may have decreased the number of patients with a non-Dutch ethnicity in our cohort. Response or recall bias may have occurred during SDOH questionnaire completion. Validated socioeconomic scores were not used (3, 4). Although all ICU variables were collected before delirium first occurred, formal time-dependent analyses were not used, and thus, residual confounding may have resulted.

CONCLUSION

In conclusion, our study suggests SDOH may not affect ICU delirium occurrence or duration in one relatively homogenous Dutch region. Further research in diverse regions of the world, where multiple factors across all five SDOH domains can be evaluated, needs to be completed in critically ill adults, both with and without

coronavirus disease 2019, to better define the association between SDOH and delirium in critically ill adults.

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