Syncope While Driving and the Risk of a Subsequent Motor Vehicle Crash

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Study objective: Syncope that occurs while driving can result in a motor vehicle crash. Whether individuals with a prior syncope-related crash exhibit an exceptional risk of subsequent crash remains uncertain.

Methods: We performed a population-based retrospective observational study of patients diagnosed with 'syncope and collapse' at any of 6 emergency departments in British Columbia, Canada (2010 to 2015). Data were obtained from chart abstraction, administrative health records, insurance claims and police crash reports. We compared crash-free survival among individuals with crash-associated syncope (a crash and an emergency visit for syncope on the same date) to that among controls with syncope alone (no crash on date of emergency visit for syncope).

Results: In the year following their index emergency visit, 13 of 63 drivers with crash-associated syncope and 852 of 9,160 controls with syncope alone experienced a subsequent crash as a driver (crash risk 21% versus 9%). After accounting for censoring and potential confounders, *crash-associated syncope* was not associated with a significant increase in the risk of subsequent crash (adjusted hazard ratio [aHR] 1.38, 95% confidence interval [CI] 0.78 to 2.47). Individuals with crash-associated syncope were 31-fold more likely to have physician driving advice documented during their index visit (prevalence ratio 31.0, 95% CI, 21.3 to 45.1). In the subgroup without documented driving advice, crash-associated syncope was associated with a significant increase in subsequent crash risk (aHR 1.88, 95% CI 1.06 to 3.36).

Conclusions: Crash risk after crash-associated syncope appears similar to crash risk after syncope alone. [Ann Emerg Med. 2023;■:1-11.]

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INTRODUCTION

Background

Syncope is characterized by a sudden loss of consciousness and postural tone that can incapacitate a driver and cause a motor vehicle crash. Between 3% and 10% of patients referred to specialized syncope clinics report a history of syncope while driving, and up to one-quarter of these patients have a subsequent episode of syncope.[1-5] Individuals who experience syncope while driving are believed to be at high risk of a subsequent syncope-related crash, and clinicians often advise these patients to temporarily or permanently cease driving.[5,6]

Importance

Fitness-to-drive guidelines seem to recognize that individuals who experience syncope while driving ought to be subjected to unique medical driving restrictions (Appendix E1, available at http://www.annemergmed.com), but few studies inform physicians' driving recommendations to these patients. Among 23 patients referred after unexplained syncope while driving, Li et al[2] found that almost 40% had sustained an injury in a prior syncope-related crash, but only 4% had a recurrence of syncope while driving after a mean follow-up of 4 years. Sorajja et al[3] reported that only 1% of the 381 individuals referred to a single specialty clinic with syncope while driving went on to have recurrent syncope after 1 year, a rate lower than among patients with syncope unrelated to driving. Folino et al[4] performed tilt table testing on 40 patients with prior syncope while driving and found that 20% experienced a recurrence of syncope but none experienced a recurrence of syncope while driving at a mean follow-up of 5 years. In a Danish retrospective administrative data study, Numé et al[7] identified 349 crashes occurring "in immediate relation to syncope," but did not describe their subsequent crash risks. Limitations of these studies include small sample sizes, lack of a control group, use of single-center subspecialty referral cohorts that

Editor's Capsule Summary

What is already known on this topic

Syncope while driving may result in a motor vehicle crash, but how it is related to future risk of motor vehicle crash is unclear.

What question this study addressed

In this observational cohort of drivers with an emergency department visit for syncope, does crash-related syncope increase the risk of a subsequent crash compared to other syncopal events?

What this study adds to our knowledge

After controlling for potential confounders, crash-related syncope was not associated with a significant increase in a subsequent crash as a driver compared to those with syncope alone.

How this is relevant to clinical practice

Future driver vehicle crash risk does not differ based on car versus other site of initial syncope.

lack generalizability, lack of baseline driving data, and incomplete outcome ascertainment because crashes were self-reported.[2-4]

Goals of This Study

Clinicians and patients want to avoid crashes while also minimizing burdensome driving restrictions.[8] We examined subsequent crash risks among drivers with a prior episode of syncope while driving in order to inform fitness-to-drive decisionmaking in this group.

MATERIALS AND METHODS

Setting

We nested the current study within a population-based retrospective cohort of 9,223 licensed drivers diagnosed with 'syncope and collapse' between 2010 and 2015 at 1 of 6 emergency departments in British Columbia, Canada.[9] Patients were excluded from the original cohort if health and driving records could not be linked; if they had a prior emergency visit for syncope in a 3-year washout period (2007 to 2009); if the index emergency visit ended in death, departure without physician evaluation, or hospitalization for >7 days; if a full driver license had been held for <1 year; or if age ≤18 years. Crashes involving commercial vehicles were excluded because professional drivers are subject to distinct and exceptionally stringent driving restrictions.

Study Overview

The current study included 3 analyses nested within the original cohort of 9,223 drivers with an emergency visit for syncope: 1) a cohort analysis that sought to understand whether syncope while driving confers a particularly high risk of subsequent crash; 2) a responsibility analysis that examined the association between a history of syncope while driving and driver responsibility for subsequent crash; 3) a descriptive analysis that compared crash characteristics for syncope-associated crashes to those of other crashes. The relationships between this and our other syncope studies are described in the appendix (Appendix E2, available at http://www.annemergmed.com).[9,10]

Data Collection

We obtained population-based administrative health and driving records for all cohort members as previously described.[9-11] We obtained driving and crash data from the Insurance Corporation of British Columbia, the sole provider of mandatory basic automobile insurance and driver licensing services in the province. We used insurance claim data to identify crashes (ie, crashes that resulted in an insurance claim or attendance by police); police reports to obtain detailed information on police-attended crashes (police in BC attend all fatal crashes, most serious injury crashes, and some crashes with property damage only); administrative health data to identify comorbidities, prescription medication use, and recent health services use; and chart abstraction to obtain detailed clinical data about the index emergency visit. Chart abstraction included manual abstraction of any physician-documented driving recommendations. Abstractors were blinded to outcomes (subsequent crashes). Data were rarely missing (Appendix E3, available at http://www.annemergmed.com).

Exposure: Crash-Associated Syncope

All individuals in the current study had an emergency visit for syncope. The exposure of interest was crash-associated syncope, defined as an emergency visit for 'syncope and collapse' that occurred on the same date as a motor vehicle crash. Unexposed individuals had syncope alone, defined as an index emergency visit for syncope that occurred on a date without a crash.

We assumed that most cases of crash-associated syncope represented syncope that incapacitated a driver and immediately resulted in a crash (Appendix E4, available at http://www.annemergmed.com). We could not confirm this with absolute certainty because the current study was designed after chart abstractions for the original cohort study were completed and because privacy protections

meant we were provided the 3-hour interval in which the crash occurred but not the exact crash time. However, loss of consciousness that is a consequence rather than a cause of crash is likely coded with a diagnosis other than syncope (eg, postconcussional syndrome [CED-DxS v4.0 code F072], diffuse brain injury [S0625], unspecified coma [R4029]).[12,13] Our definition of crash-associated syncope mirrors the ambiguity typical of clinical practice, where event-related amnesia, the absence of collateral history, and intentional driver misreporting often make it difficult to conclusively establish the sequence of syncope and crash.[14,15]

Cohort Analysis: Design and Statistical Analysis

We conducted a cohort analysis to compare subsequent crash risk among patients with an emergency visit for crash-associated syncope to that among controls with an emergency visit for syncope alone. For the cohort analysis, the primary outcome was involvement as a driver in a police-attended or insurance claim crash occurring $\geq$1 and $\leq$365 days after the index emergency visit for syncope. We used a Cox proportional hazards model to examine crash-free survival during follow-up, with right-censoring for death, license suspension or expiry for >30 days, hospitalization for >30 days, completion of 1-year follow-up, or study end (December 31, 2016). We adjusted regression models for known crash risk factors: year, season, and site of index emergency visit; driver sex and age group; household income quintile, rural location, and health authority of the driver's residential neighborhood; Charlson Comorbidity Index $\geq$2; history of alcohol or substance misuse in the past 5 years; prescription fills for $\geq$2 medications, for benzodiazepines, and for opioids in the past 60 days; number of physician visits and overnight hospital admissions in the past year; license type (full versus learner or novice) and years since full license granted; and years insured, total contraventions, contraventions related to alcohol or drugs, and crashes in the past 5 years.[9] We repeated analyses in prespecified subgroups. We performed a sensitivity analysis that ignored license expiry as a censoring event and another that ignored censoring altogether.

Responsibility Analysis: Design and Statistical Analysis

We anticipated that patients would be more likely to temporarily cease driving after crash-associated syncope than after syncope alone. Because lack of data on road exposure (distance or hours of driving per week) was a potential source of bias in the cohort analysis, we also conducted a responsibility analysis on the subset of drivers with a police-attended crash occurring $\geq$1 day after their index emergency visit for syncope. Responsibility analysis is a type of case-control study commonly used to account for differences in road exposure (Appendix E5, available at http://www.annemergmed.com).[16-23]

For the responsibility analysis, the outcome of interest was involvement as a driver in a police-attended crash occurring $\geq$1 days after index emergency visit for syncope and for which driver responsibility for crash could be determined. We used police-reported crash data and a validated responsibility scoring tool to classify crash-involved drivers as responsible, nonresponsible, or of indeterminate responsibility for their crash.[24] If a driver observed all applicable road laws and external factors contributed to the crash (eg, icy roadway, limited visibility, dangerous driving by others), the responsibility tool assumes the crash occurred for reasons beyond the driver's control and deems the driver nonresponsible for the crash. If no external contributors were present or if the driver disobeyed road laws, the responsibility tool deems the driver responsible for the crash. Drivers with indeterminate responsibility for their crash are excluded from further analysis. As for a conventional case-control study, we used logistic regression to examine the association between crash responsibility (outcome; responsible versus nonresponsible) and prior crash-associated syncope (exposure; prior crash-associated syncope versus prior syncope alone). We adjusted for driver sex and age group; Charlson Comorbidity Index $\geq$2, based on a 1-year lookback; prescription fills for $\geq$2 medications in the past 60 days; number of physician visits and overnight hospitalizations in the past year; license type; and years insured and total contraventions in the past 5 years. We excluded some adjustment variables used in the cohort analysis because of small sample size and convergence issues. Partial separation (that is, no prior crash-associated syncope among nonresponsible drivers) necessitated use of Firth's penalized likelihood to estimate odds ratios.

Descriptive Analysis

To understand whether syncope-associated driver incapacitation results in crashes with unique features, we compared the characteristics of crashes occurring on the date of an index emergency visit for syncope to the characteristics of crashes occurring on the date of an emergency visit for a condition other than syncope. We use the term crash-associated syncope when syncope is the exposure of interest and syncope-associated crash when crash is the exposure of interest. However, these terms are interchangeable, and both refer to cohort of drivers with an emergency visit for syncope and a crash on the same date.

Ethics

The University of British Columbia Clinical Research Ethics Board approved the study and waived the requirement for individual consent (H16-02043). Data were deidentified before release to investigators. Data analysis occurred between June 2022 and February 2023 using R version 4.0.5. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. All inferences, opinions, and conclusions drawn in this publication are those of the authors, and do not reflect the opinions or policies of the Data Stewards.

RESULTS

Cohort Analysis

In a study cohort of 9,223 drivers with an emergency visit for syncope, 63 (0.7%) drivers had crash-associated syncope, and 9,160 controls had syncope alone (Figure 1). Relative to controls with syncope alone, individuals with crash-associated syncope were more likely to have an active driver license, an active vehicle insurance policy, prior crashes, and prior traffic contraventions (Table 1). Individuals with crash-associated syncope were also 4-fold more likely to have cardiac syncope (prevalence ratio [PR] 3.66, 95% confidence interval [CI] 2.24 to 5.99) and 3-fold more likely to be seen by a cardiologist in the emergency department (PR 3.20, 95% CI 1.80 to 5.68).

In the year after the index emergency visit for syncope, 13 of 63 drivers with crash-associated syncope and 852 of 9,160 drivers with syncope alone experienced a subsequent crash (crash risk 21% versus 9%, risk difference 11%, 95% CI 0.5% to 22%). For context, the general population of drivers in BC had an annual crash risk of 8.2% at study midpoint.[25] Drivers with syncope alone were much more

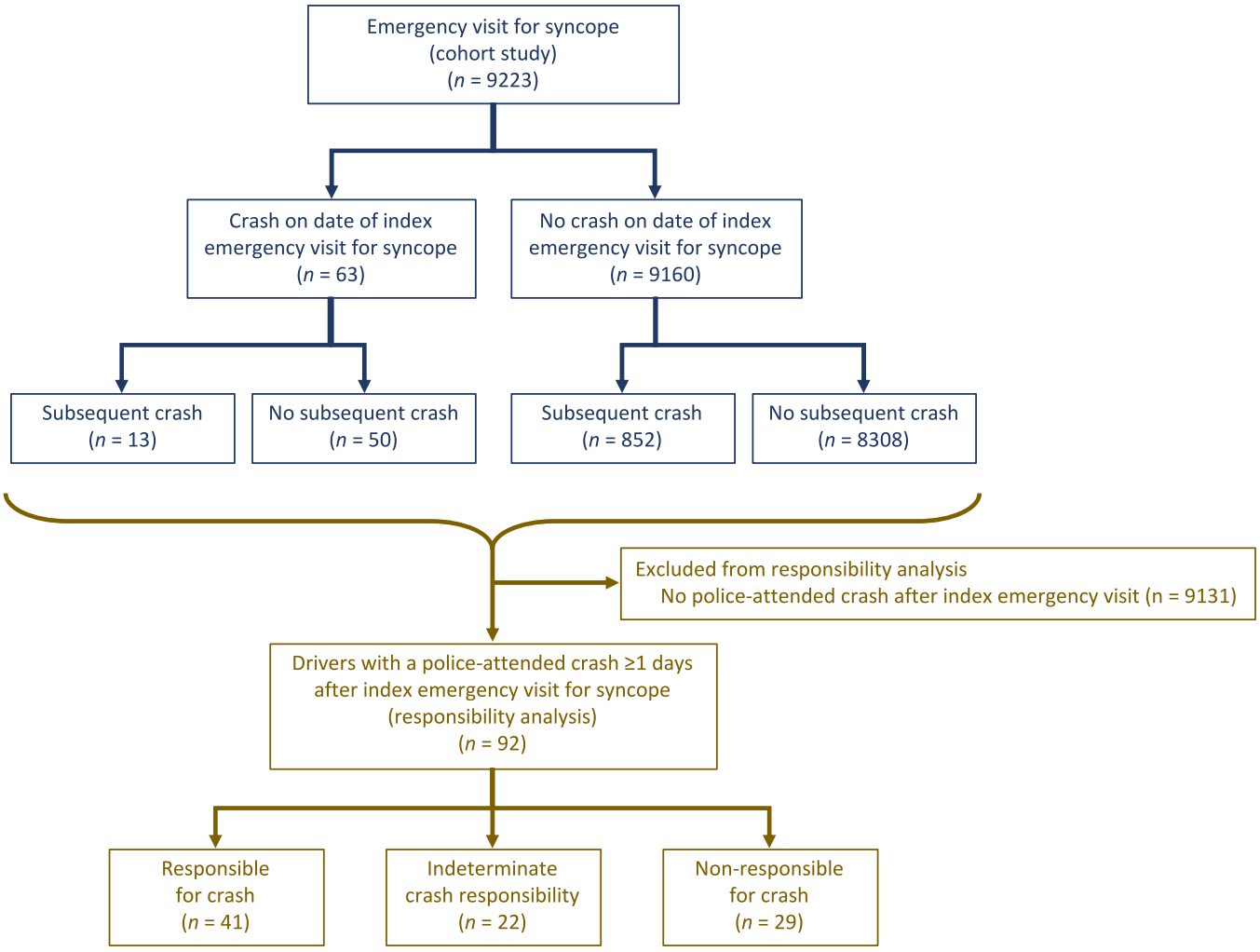

Figure 1. Study flow diagram.

Table 1. Baseline patient characteristics.

Characteristic	Drivers with crash-associated syncope, count (%) n=63	Controls with syncope alone, count (%) n=9,160	Difference in prevalence (95% CI)
Demographics			
Age (y), median [Q1, Q3]	58 [43.5, 70.5]	55 [34, 72]	-
Female sex	20 (31.7%)	4,690 (51.2%)	−19% (−32% to −7%)
Rural residence	9 (14.3%)	1,046 (11.4%)	3% (−7% to 12%)
Medical history			
≥1 hospitalizations in prior year	5 (7.9%)	1,262 (13.8%)	−6% (−13% to 2%)
≥7 physician clinic visits in prior year	47 (74.6%)	6,203 (67.7%)	7% (−5% to 18%)
Charlson comorbidity score ≥2	11 (17.5%)	2,020 (22.1%)	−5% (−15% to 6%)
Comorbidities			
Hypertension	20 (31.7%)	3,224 (35.2%)	−3% (−16% to 9%)
Psychiatric disorder	17 (27.0%)	2,780 (30.3%)	−3% (−15% to 8%)
Cardiovascular disease	<5	1,166 (12.7%)	−6% (−13% to 0%)
Diabetes	<5	621 (6.8%)	0% (−7% to 6%)
Alcohol and other substance misuse	<5	447 (4.9%)	1% (−5% to 8%)
Obstructive sleep apnea	<5	167 (1.8%)	5% (−2% to 11%)
Seizure disorder	<5	137 (1.5%)	5% (−2% to 12%)
≥2 prescription medications at baseline	25 (39.7%)	3,312 (36.2%)	4% (−9% to 16%)
Prescription medications			
Antihypertensives	21 (33.3%)	3,063 (33.4%)	0% (−12% to 12%)
Atrioventricular nodal blockers	10 (15.9%)	1,532 (16.7%)	−1% (−11% to 9%)
Diuretics	8 (12.7%)	1,395 (15.2%)	−3% (−12% to 7%)
QTc-prolonging	10 (15.9%)	1,037 (11.3%)	5% (−5% to 14%)
Opioid	8 (12.7%)	808 (8.8%)	4% (−5% to 13%)
Benzodiazepines	<5	677 (7.4%)	−1% (−8% to 6%)
Oral hypoglycemics	<5	596 (6.5%)	0% (−6% to 6%)
Insulin	0	164 (1.8%)	2% (NC)
Driving history			
Full license (instead of learner or novice)	60 (95.2%)	7,700 (84.1%)	11% (5% to 17%)
Years of driver experience, median [Q1, Q3]	26.9 [12.2, 40.6]	22.2 [7.0, 40.5]	42% (29% to 55%)
Held active license in prior 5 years	63 (100%)	8,406 (91.8%)	8% (7% to 10%)
Days with insurance policy in prior 5 years, median [Q1, Q3]	1,820 [1,470, 1820]	1,120 [0, 1820]	-
Held active insurance policy in prior 5 years	57 (90.5%)	6,112 (66.7%)	24% (16% to 32%)
≥1 crash in prior 5 years	49 (77.8%)	2,299 (25.1%)	53% (42% to 64%)
≥1 contravention in prior 5 years	29 (46.0%)	2,388 (26.1%)	20% (7% to 33%)
Emergency visit data			
First sBP (mmHg), median [Q1, Q3]	138 [127, 154]	126 [112, 142]	
Orthostatic hypotension documented	<5	259 (2.8%)	4% (−3% to 10%)
ECG performed	62 (98.4%)	8,252 (90.1%)	8% (4% to 12%)
Troponin I measured	51 (81.0%)	5,402 (59.0%)	22% (11% to 33%)
Value among those measured, median ng/mL [Q1, Q3]	0.05 [0.05, 0.075]	0.05 [0.03, 0.07]	0% (−1% to 1%)
Transient loss of consciousness:			
Was likely caused by alcohol or drugs[a]	<5	332 (3.6%)	3% (−4% to 10%)
Was likely caused by head trauma[b]	0	13 (0.1%)	0.1% (NC)

Table 1. Continued.

Characteristic	Drivers with crash-associated syncope, count (%) n=63	Controls with syncope alone, count (%) n=9,160	Difference in prevalence (95% CI)
Likely resulted in TBI or concussion	<5	66 (0.7%)	6% (−1% to 12%)
Syncope deemed definite or likely	44 (69.8%)	5,502 (60.1%)	10% (−2% to 22%)
Presyncope deemed definite or likely	22 (34.9%)	6,343 (69.2%)	−34% (−47% to −22%)
Cause of syncope			
Cardiac	13 (20.6%)	516 (5.6%)	15% (4% to 26%)
Reflex	29 (46.0%)	6,119 (66.8%)	−21% (−34% to −8%)
Other	5 (7.9%)	1,470 (16.0%)	−8% (−16% to −1%)
Nonsyncopal T-LOC	7 (11.1%)	205 (2.2%)	9% (0% to 17%)
No T-LOC; other cause of symptoms	<5	477 (5.2%)	1% (−6% to 8%)
San Francisco syncope rule score ≥1	31 (49.2%)	4,836 (52.8%)	−4% (−17% to 10%)
Canadian syncope risk score ≥1	17 (27.0%)	1,866 (20.4%)	7% (−5% to 18%)
Cardiology consulted in emergency department	10 (15.9%)	455 (5.0%)	11% (1% to 21%)
Discharged home	49 (77.8%)	8,294 (90.5%)	−13% (−24% to −2%)
Driving advice documented by physician	23 (36.5%)	108 (1.2%)	35% (23% to 48%)

Comorbidities deemed present if identified in ≥1 hospitalization or ≥2 physician visits in a 5-year lookback interval. Medications deemed present if a prescription was dispensed in a 60-day lookback interval. Contraventions included traffic violations for speeding, distracted driving, or impaired driving. Troponin I reported as "<0.05 ng/mL" conservatively assumed to be 0.05 ng/mL when calculating the median. Abstractor response to: [a] "Is it likely that alcohol, illicit drug intoxication/withdrawal, or prescription medications precipitated loss of consciousness by a mechanism other than syncope?"; [b] "Did head trauma occur immediately before loss of consciousness?". Prevalence ratios in text reflect Wald confidence intervals. Q1 and Q3 represent the 25th and 75th percentiles, respectively. *QTc*, Corrected electrocardiographic QT interval; *sBP*, systolic blood pressure; *TBI*, traumatic brain injury; *ECG*, electrocardiogram; *T-LOC*, transient loss of consciousness; *NC*, not calculable; *CI*, confidence interval. Data Stewards require small cell sizes with counts less than 5 to be reported as <5.

likely to be censored for license expiry (20% versus 8%, risk difference 13%, 95% CI, 5% to 20%); 82% of these licenses were already expired at the time of the index emergency visit resulting in right-censoring at time zero. After accounting for censoring events and adjusting for potential confounders, crash-associated syncope was not

Table 2. First event in the year following index emergency visit for syncope.

Outcome	Drivers with crash-associated syncope, count (%) n=63	Controls with syncope alone, count (%) n=9,160	Unadjusted HR (95% CI)	Adjusted HR (95% CI)
Crashes				
All crashes (primary outcome)	13 (20.6%)	833 (9.1%)	2.09 (1.21 to 3.62)	1.38 (0.78 to 2.47)
Fatality or injury	<5	205 (2.2%)	1.96 (0.63 to 6.12)	1.56 (0.47 to 5.14)
Property damage only	10 (15.9%)	628 (6.9%)	2.14 (1.14 to 3.99)	1.33 (0.69 to 2.58)
Censoring events				
Death (all cause)	0	120 (1.3%)		
Hospitalized for >30 days	<5	87 (0.9%)		
License suspended for >30 days	0	37 (0.4%)		
License expired for >30 days	5 (7.9%)	1,877 (20.5%)		
No crash or censoring event	43 (68.3%)	6,206 (67.8%)		

First crash or censoring event in the year following index emergency visit. Crashes occurring after a censoring event are not shown in the table (in total, there were 13 subsequent crashes among drivers with crash-associated syncope and 852 crashes among controls with syncope alone). License expiry occurred prior to index emergency visit for 0 (0%) of the 5 license expiries that resulted in censoring among drivers with crash-associated syncope and 1,536 (81.8%) of the 1,877 license expiries that resulted in censoring among syncope-alone controls. Sensitivity analyses that ignored license expiry as a censoring event (aHR 1.32, 95% CI 0.74 to 2.36) or ignored censoring altogether (aHR 1.32, 95% CI 0.74 to 2.35) yielded results very similar to the main analysis. *aHR*, adjusted hazard ratio; *CI*, confidence interval.

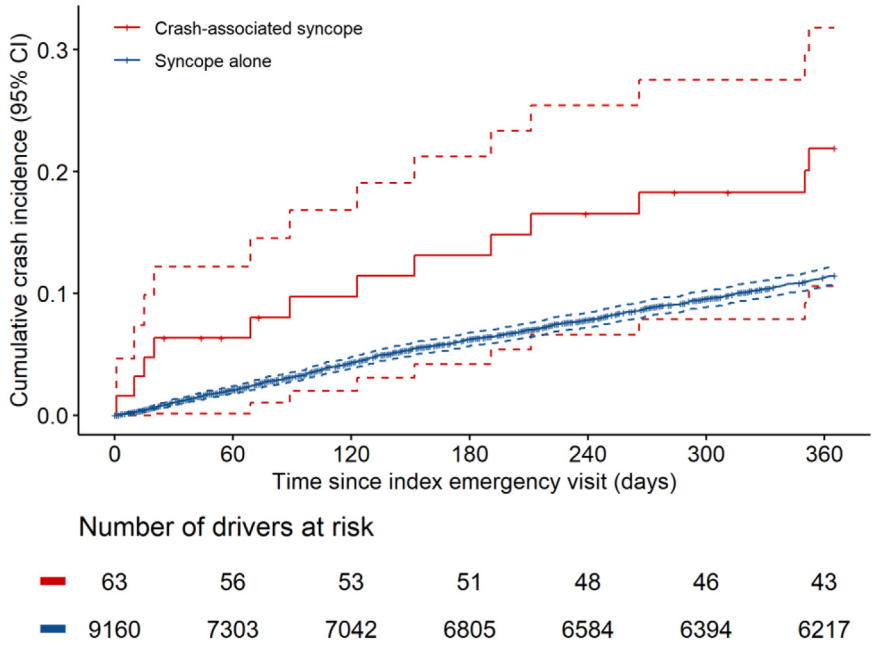

Figure 2. Cumulative crash incidence. Cumulative incidence of subsequent crash in the first year after index emergency visit for crash-associated syncope (red lines) and in the first year after index emergency visit for syncope alone (blue lines). Solid lines indicate the cumulative crash incidence; dashed lines indicate the 95% confidence interval. *CI*, confidence interval.

associated with an increased risk of subsequent motor vehicle crash relative to syncope alone (adjusted hazard ratio [aHR] 1.38, 95% CI 0.78 to 2.47, Table 2, Figure 2), although there was insufficient statistical power to rule out a clinically relevant increase in risk.

Relative to controls with syncope alone, individuals with crash-associated syncope were 31-fold more likely to have physician driving advice documented in the index emergency visit medical record (37% versus 1.2%, PR 31.0, 95% CI 21.3 to 45.1). Among patients without documented driving advice, individuals with crash-associated syncope were almost twice as likely to be involved in a subsequent crash relative to controls with syncope alone (aHR 1.88, 95% CI 1.06 to 3.36, Figure 3, Appendix E6, available at http://www.annemergmed.com). Results of other subgroup analyses were consistent with the main analysis.

Responsibility Analysis

Among the 70 drivers with an index emergency visit for syncope and a police-attended crash at least 1 day later, a history of crash-associated syncope was found in 2 of 41 drivers deemed responsible for their subsequent crash and in none of the 29 drivers deemed nonresponsible for their subsequent crash (crash risk 5% versus 0%, risk difference 5%, 95% CI −5% to 14%, Appendix E7, available at http://www.annemergmed.com). We did not find an association between prior crash-associated syncope and subsequent crash responsibility, and the point estimate was similar to that of the cohort analysis (adjusted odds ratio 1.67, 95% CI 0.05 to 332.5). However, we lacked statistical power to rule out a clinically meaningful effect.

Descriptive Analysis

We identified 63 crashes occurring on the date of the index emergency visit for syncope and 410 control crashes occurring on the date of an emergency visit for a condition other than syncope (most often injuries that presumably resulted from the crash). For 62 of the 63 syncope-associated crashes, the crash occurred in a 3-hour interval ending prior to the emergency department discharge time, suggesting that most of these crashes occurred because the patient was incapacitated by syncope while driving (Appendix E8, available at http://www.annemergmed.com). Syncope-associated crashes were 3-fold more likely than control crashes to involve only a single vehicle. Police attended the crash for 46 of 63 syncope-associated crashes and for 264 of 410 control crashes. Officers were 24-fold more likely to report sudden loss of consciousness and 20-fold more likely to report illness as a contributing factor for syncope-associated crashes than for control crashes (Appendix E8). Based on index emergency visit medical records,

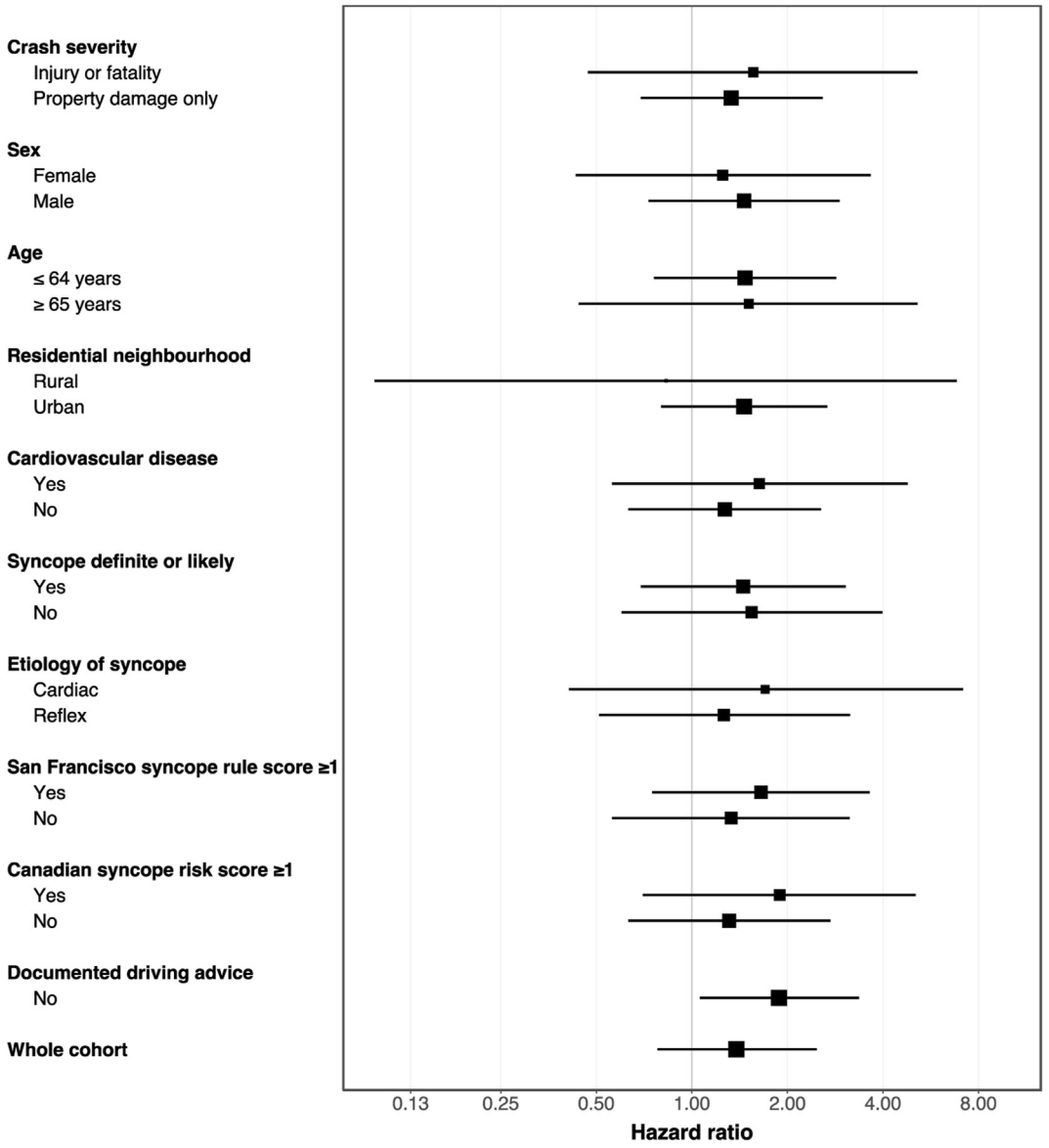

Figure 3. Subgroup analysis. Forest plot of adjusted hazard ratios for subsequent crash risk among patients with crash-associated syncope relative to patients with syncope alone. The *x* axis depicts the adjusted hazard ratio. Squares indicate the point estimate. Horizontal lines indicate the 95% confidence interval.

abstractors concluded that very few individuals with syncope-associated crash lost consciousness as a result of concussion or head trauma, further supporting the conclusion that syncope was the cause rather than a consequence of the crash (Table 1).

LIMITATIONS

As for all prior studies of syncope while driving, limited data on road exposure might bias our results toward the null if patients are more likely to reduce or cease driving after crash-associated syncope. We performed a responsibility analysis to account for differences in road exposure, but this analysis was underpowered because police-attended crashes are uncommon. We could not confirm with absolute certainty that crash-associated syncope represented syncope that incapacitated the driver and caused the crash. We did not include all diagnostic coding with the potential to cause syncope (eg, ventricular fibrillation, heart block). Some index emergency visits for crash-associated syncope might have been coded with a diagnosis of injury rather than syncope; noninclusion of such patients potentially reduces generalizability and introduces bias. The data for crash-associated syncope are

sparse, suggesting results are somewhat exploratory and should be interpreted with caution.

DISCUSSION

Using linked health and driving data for a population-based cohort of 9,223 drivers, we found that crash risk after crash-associated syncope was similar to crash risk after syncope alone. However, because crash-associated syncope is rare, our study lacks sufficient statistical power to rule out a clinically relevant 2.5-fold increase in risk. We found that patients were far more likely to have physician driving advice documented in the medical record after crash-associated syncope, and that crash-associated syncope was associated with a significant increase in subsequent crash risk only among individuals without documented physician driving advice. These novel findings have implications for both clinicians and traffic safety policymakers.

First, we found that 0.7% of emergency visits for syncope were associated with a motor vehicle crash. At face value, this implies that over 8,700 episodes of crash-associated syncope are evaluated in U.S. emergency departments annually (0.7% of 1.3 million emergency visits for syncope).[26] Further research on this topic is needed to provide guidance for thousands of patients each year.

Second, we found that crash-associated syncope is a distinct clinical presentation.[2,3] Drivers with crash-associated syncope were more likely to be diagnosed with cardiac syncope, perhaps because vasovagal and orthostatic syncope are both less likely in the seated position and because cardiac syncope often lacks a prodrome that could allow a driver to stop the vehicle prior to losing consciousness.[27] Syncope-associated crashes were more likely to involve only a single vehicle (plausible as incapacitated drivers are unable to steer or brake and might depart the roadway at speed), and the attending officer was far more likely to identify medical illness as a contributor to the crash.[28] These findings agree with recent guidelines that identify syncope while driving as a condition that deserves special consideration.[29]

Third, we found a striking 31-fold increase in documented driving advice after crash-associated syncope. However, we also found that 2 out of 3 drivers with crash-associated syncope had no documented physician driving advice, and this subgroup had a risk of subsequent crash double that of controls with syncope alone. These results should remind clinicians to provide sensible driving advice after crash-associated syncope.[30] Such reminders may be necessary because physicians often fail to provide advice about medical fitness-to-drive and patients often ignore physician driving recommendations.[1,31-33]

Fourth, our findings do not necessarily support prior suggestions that "recommendations for driving should not differ on the basis of whether the syncopal spell occurred while driving or not."[34] Although the 95% CI of our main analysis includes the null, our point estimate favors an association and our study may simply be underpowered to detect a true relationship between crash-associated syncope and subsequent crash risk. Additionally, a much higher crash rate while driving after crash-associated syncope might be hidden by a substantial reduction in aggregate road exposure.[35] The magnitude of potential bias might be considerable because up to 20% of patients with recurrent syncope cease driving.[36] Future research on medical fitness-to-drive should thus involve large sample sizes and should account for road exposure (Staples JA, 2023, unpublished data).[10,37]

Strengths of our study include the use of a population-based sampling frame representative of patients receiving emergency care for syncope, use of a clinically relevant control group, adjustment for baseline health and driving data not accounted for in prior studies, outcome ascertainment using objective crash data that avoids recall and self-reporting bias, censoring for driver license expiry and death to account for individuals who cease driving and are not at risk of crash, and use of responsibility analysis to account for between-group differences in road exposure.[9-11] Although somewhat circumstantial, our data strongly suggested that most crash-associated syncope represented syncope causing driver incapacitation that immediately resulted in a crash.

Crash-associated syncope is rare and our study was underpowered to rule out a clinically meaningful association with subsequent crash risk. However, our conclusions were strengthened by the similar point estimates generated by the cohort study and the responsibility analysis. Moreover, many jurisdictions in North America have decided that non-zero blood alcohol concentrations that double crash risk should not be subject to any penalty (ie, blood alcohol concentrations $<0.05\%$) and that only blood alcohol concentrations that more than quadruple crash risk should receive a fine or license suspension (ie, blood alcohol concentration 0.05 to 0.79%).[10,38,39] These bounds give some indication of the magnitude of risk deemed socially acceptable in these settings. We acknowledge these norms but also note that zero tolerance laws could reduce the substantial morbidity and mortality resulting from impaired driving.

Syncope while driving is a rare and distinctive clinical presentation. Our study suggests that overall crash risk after crash-associated syncope might be similar to crash risk after syncope alone. Further research is needed to investigate if subsequent crash risks are potentially related to instructions regarding driving.

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