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Incidence of delirium in the Emergency Department and its consequences on hospital length of stay

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Incidence of delirium in the Emergency Department and its consequences on hospital length of stay.

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Authors' contribution: MÉ had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. He was responsible of design, funding, conduct of the study and writing of the manuscript. VB managed the study, led the analyses and wrote the manuscript. MÉ, VB and PHC were involved in the statistical analysis, and data interpretation. MP, RD, EG and MEL were responsible for all four site recruitment. PV, SB, MM, TTMV, JL, MR, SL, NLS and LJ are all collaborator of INDEED project. PHC, MP, RD, EG, MEL, PV, SB, MM, TTMV, JL, MR, SL, NLS and LJ reviewed, and approve the manuscript.

ABSTRACT

Objective: We aim to determine the incidence of delirium and describe its impacts on Emergency department (ED) and hospital length of stay (LOS) among admitted community seniors with an 8-hour exposure to the ED environment.

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Design: This is a prospective observational multicentre cohort study (March-July 2015). Patients were assessed 2x/day during their entire ED stay and up to 24 hours on hospital ward.

Setting: The study took place in 4 Canadian EDs.

Participants: 338 included patients: 1) aged ≥65; 2) who had an ED stay ≥8 hours; 3) were admitted to hospital ward; 4) were independent/semi-independent.

Main Outcome(s) and Measure(s): The primary outcomes of this study were incident delirium in the ED or within 24 h of ward admission and ED and hospital LOS. Functional and cognitive status were assessed using validated Older Americans' Resources and Services (OARS) and the Telephone Interview for Cognitive Status- modified (TICS-m) tools. The Confusion Assessment Method (CAM) was used to detect incident delirium. Univariate and multivariate analyses were conducted to evaluate outcomes.

Results: Mean age was 76.8 (± 8.1), 17.7% were aged >85 years old and 48.8% were male. The mean incidence of delirium was 12.1% (n=41). Median Interquartile range ED LOS was 32.4 (24.5–47.9) hours and hospital LOS was 146.6 (75.2-267.8) hours. Adjusted mean ED LOS and mean hospital LOS were increased respectively by 5.0 hours (95% CI [-1.4, 14.1], p=0.06) and by 105.4 hours (4.4 days) (95% CI: [25.1, 162.0], p< 0.001) for patients who developed an episode of delirium compared to non-delirious patient.

Conclusions: An incident delirium was observed in 1 of 8 independent/semi-independent seniors after an 8-hour ED exposure. An episode of delirium increases hospital LOS by 4 days and therefore has important implications for patients and could contribute to ED overcrowding through a deleterious feedback loop.

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Strengths and limitations of this study

- **Largest prospective study on incident delirium in the Emergency Department.**
- **A systematic screening of delirium at study entry was realized with a validated tool.**
- **Multiple patient assessments for incident delirium were conducted.**
- **Study population was limited to independent/semi-independent elders, which may limit external validity of the findings.**
- **Hospital LOS were adjusted for potential cofounders relating to geriatric care.**

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INTRODUCTION

In 2016, the youngest of the "baby-boomers" turned 50 years old and people aged 65 and older represented 18.1% of the population in Quebec.(1) It is foreseen that by 2031, the proportion of seniors aged over 65 will nearly double, with a major increase among those aged 85 and older.(2) Over the coming decades, those demographic trends will fundamentally change the make-up of the population served by Quebec Emergency Departments (ED). Seniors are already the main users of emergency health care services(3-5) and in 2012-2013, 40% of ED stretchers were occupied by patients aged over 65.(6) Furthermore, patients over 75 years of age have the highest ED visit rate of any age group and in 2012-2013 those patients occupied 25% of ED stretchers.(7, 8) Those numbers will only increase over time as the elderly population grows and this "Silver Tsunami"(9) will have major consequences on the healthcare of seniors and on our health care system in general.

Caring for older patients in the ED is particularly challenging.(10) Indeed, the time-pressure environment and high level of background noise may impede efficient communications with older patients.(11, 12) Moreover, specialized geriatric training for ED health professionals remains in its infancy(13) and they may not be as equipped as they should be to face the specific issues of elderly patients. All of this may contribute to the fact that seniors have higher rates of unplanned returns to the ED,(14, 15) of hospitalization,(16) falls,(17) loss of independence(18) and unrecognized delirium(19-21) following an emergency visit. Delirium is an acute brain dysfunction defined as a mental disorder of acute onset with a fluctuating course, characterized by a disturbance in consciousness, attention, orientation, memory, thought, perception and behavior.(22, 23) It is a common problem in the ED and its prevalence in elderly patients admitted to acute and long-term care facilities ranges between 9.6% and 89%.(21, 24-26)

In August of 2013, Inouye *et al*. published a systematic review(27) in which they found no study reporting the incidence of delirium in the ED. The same author also demonstrated that an ED stay of 12 hours or more was one of the strongest independent predictors of the onset of subsequent delirium in older patients.(28-30) This is of increasing concern, as recent ED wait times have become quite significant. Since then, a few prospective studies were conducted in order to explore the problem of ED-stay associated delirium.(30-32) To our knowledge, there are few multicenter studies aimed at describing the incidence of delirium in ED of developed countries, such as Canada. Because the literature regarding the incidence of delirium in the ED and its potential impacts on hospital length of stay (LOS), functional status and unplanned ED readmissions is scant, its consequences have yet to be clearly identified in order to orient modern acute medical care. A study by McCusker *et al*. even found that hospital stay was increased by 7.78 days for patients diagnosed with delirium (either prevalent or incident) during the first 7 days of their stay.(33) The onset of such complication in the ED could influence hospital LOS and reflect back on ED crowding and seniors' use of emergency health services.

The present study focused on the incidence of delirium induced by emergency department stay. Although ED-induced delirium could be affected by acute illness, comorbidities, ED crowding metrics and health care providers' ability to provide basic care known to prevent delirium, we hypothesized that the incidence of new cases of delirium among older ED patients who are admitted to hospital affects a significant proportion of community elders, and ED-induced

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delirium leads to longer hospital LOS creating a deleterious feedback loop on ED care and operations (34).

The objective of this study was to fill a basic knowledge gap regarding the incidence of delirium and its impacts on hospital LOS for older, non-delirious ED patients with an 8-hour ED stay who are admitted to a hospital ward.

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METHODS

Study setting and population

This prospective multicenter study included patients who presented to one of the 4 participating Quebec EDs (two university-affiliated level 1 trauma centers and two regional hospitals) between March and July 2015. ***Inclusion criteria*** were: 1) Patients aged 65 and over; 2) Patients with an ED stay of ≥ 8 hours; 3) Patients needing and/or waiting for admission to any hospital ward; 4) Independent or semi-independent patients (able to perform 5/7 activities of daily living according to the Older Americans Resources and Services scale (OARS)). ***Exclusion criteria*** were: 1) Patient with unstable medical condition requiring admission to the psychiatric ward, intensive or palliative care units; 2) Patient who are unable to consent; 3) Patients who live (or are in transition) in a long-term care facility; 4) Patients unable to speak French or English; 5) Patients presenting a delirium before coming to the ED, upon arrival or by the end of the first 8 hours in the ED; 6) Patients with a history of psychiatric disorders (such as schizophrenia, psychotic symptoms and bipolar disorder).

Our study experts suggested an 8-hour ED exposure for our patients, as opposed to the 12-hour exposure previously determined to be a predictor of subsequent delirium(28-30) because of soon to be published new recommendations from the Direction Nationale des Urgences regarding elderly patients' lengths of ED stay, which should be kept under 8 hours. Our pragmatic approach led us to include patients who need or are awaiting admission to a hospital ward; since, Caplan *et al*. showed that patients admitted to hospital have a significantly at higher proportion of delirium than their equivalent counterparts discharged and treated with home resources.(35)

Potential participants were identified using the emergency department information system. Research assistants (RAs) obtained consent and screened the participants for eligibility after their 8-hour exposure to the ED. Sociodemographic, medical and comorbidity data were collected upon initial interview. RAs also assessed patients' baseline physical, frailty and cognitive status. Patients were screened for delirium during initial interview, and twice a day (with at least 6 hours between each evaluation) during their entire ED stay and up to 24 hours after being admitted to a hospital ward. Potential participants were considered as "missed" when they was no RA on-site for the recruitment.

Measures

Patients' frailty, physical and cognitive status were assessed using the Clinical Frailty Scale (CFS),(36) the Older Americans Resources and Services scale (OARS)(37), the Telephone Interview for Cognitive Status-modified (TICS-m)(38) and the Confusion Assessment Method (CAM) (39) and the Delirium Index (40), respectively. Other information on medications, comorbidities (Charlson comorbidity risk index) (41), severity of illness (Acute Physiological and Chronic Health Evaluation II (APACHE II) (42) and ED environment evaluation were collected in addition to sociodemographic data.

The CAM is the most commonly used tool for the detection of delirium with its sensitivity ranging between 94% and 100% and its specificity between 90% and 100%.(39, 43, 44) Because

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of the fluctuating nature of delirium, patients were systematically assessed with the CAM and the Delirium Index (a validated tool used to measure the severity of delirium) (40) twice a day during their entire ED stay. Furthermore, the CAM was used over a 24-hour period following transfer to the hospital ward. ED and ward nurses and doctors were blinded to the study's objectives in order to avoid them changing their practice. The TICS-m was used to assess baseline cognitive status of our study participants.(45) ED environmental information, such as presence of proper lighting, patient's hydration, presence of physical restraints or medical interventions limiting movement, was also recorded by RAs.

Each site's team of RAs received standardized training by an experienced member of the mentoring team of the *Centre d'Excellence sur le Vieillissement de Québec(46)*, who also specializes in the administration of the CAM. They also attended a group training session conducted by the study coordinator and an experienced research nurse and underwent a 5-hour personalized field training. They were also provided with a detailed training manual. Inter-rater reliability was assessed during patient follow-ups at the coordinating site to ensure that the test was administered in a standardized manner.

Outcomes

Incident delirium during the patients' ED-stay was the main outcome of this study. The CAM was administrated during the initial interview ensuring that the patient was not already delirious after the first 8 hours of their ED stay.

There are two existing interpretation methods to the CAM scores: the sensitive (SENS) and the specific (SPEC) methods.(47) A patient is diagnosed with delirium according the SPEC method if they: had an acute onset, a fluctuation in any of the items evaluated in the CAM (inattention, disorganized thinking, altered level of consciousness, disorientation, memory, sensory disturbances, psycho-motor activity, sleep disturbances) as well as inattention and either disorganized thinking or altered state of consciousness.(25) A patient has delirium according to the SENS method if they: had either an acute onset or a fluctuation in any of the items evaluated in the CAM, inattention and either disorganized thinking or altered state of consciousness.(25) Patients whose symptoms corresponded to either of those definitions were considered as "delirious" in this study.

ED LOS was measured from the date and time of triage up to the date and time when the patients were physically transferred to the hospital ward. Hospital LOS was also measured from ED triage up to the date and time of hospital discharge. ED and hospital LOS were compared between patients with a positive CAM and those with a negative CAM for each site.

Statistical analyses

Descriptive statistics were computed on patient characteristics and measured outcomes. Cumulative incidence rates are estimated using Kaplan-Meier curves. ED and hospital LOS is compared in patients with and without incident delirium in the various sites using multiple linear regression, adjusting for APACHE, Charlson and age. Site and its interaction with incident delirium is treated as a fixed factor. TICS-m scores were adjusted for patients' level of

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education. Kappa statistics were computed to measure inter-rater reliability of the CAM. Based on an alpha of 5%, 138 patients would allow 80% power for an estimated overall incidence proportion of 15 % with 5% precision. Analyses were performed using SAS, version 9.4 (SAS Institute, Inc., Cary, NC).

The Comité d'éthique du CHU de Québec acted as the centralized research ethics board and approved this study (project # MP-20-2015-2130). Written consent was obtained for each study participant. Patient records/information were anonymized prior to analysis.

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RESULTS

Population

A total of 2699 patients were screened by research assistants across our 4 sites (figure 1). Of those, 1780 did not meet our inclusion criteria or had one of our exclusion criteria, 417 were missed and 164 refused to participate to the study. This leaves us with a sample of 338 patients (12.5%). Females represented 51.2% of our population and mean age was 76.8 (±8.09) (table 1).

A sample analysis of patients who were missed revealed that they had a similar profile to that of those who were included in our study. 54.9% were female, with a mean age of 77.4 (±9.4) years old. The mean Charlson Comorbidity Score was 1.7 (±1.7), 36.7% were considered level 1 or 2 on the Canadian Triage Assessment Scale (CTAS) and 38% were level 3. The medical notes revealed only one case of incident delirium within 24 hours of triage for this group of patients. Table 1 provides details on sociodemographic and environmental variables.

Incidence of delirium

In our cohort, we found that the overall incidence of delirium was 12.1% (n=41) using the SENS method, overall incidence and its distribution across sites are provided in figure 2. Our results indicate that the delirium incidence rate was 2.9 cases per 1000 patient-hours. Figure 3 shows a cumulative incidence of delirium curve. Median ED LOS before developing a delirium was 45.2 h (38.0-52.5).

Inter-rater agreement on main outcome

Inter-rater agreements were performed at the coordinating site on 12% of the site's participants. A perfect agreement was obtained regarding the incidence of delirium, and agreement for each of the CAM items had Kappa ranging between 0.63 and 1.0.

ED and hospital length of stay

Median (IQR) ED LOS was 32.4 (24.5–47.9) hours. When adjusting for site, age, Charlson, APACHE, OARS and TICS-m scores, a difference of 5.0 hours was found in the average adjusted ED LOS between individuals who developed a delirium and those who did not (p=0.21) (see Figure 4). Of note, a statistically significant difference was found for site 2 (p=0.03). Therefore, patients who developed incident delirium generally had slightly longer exposure to the ED environment than patients who did not develop the condition.

Median (IQR) hospital LOS was 146.6 (75.2-267.8) hours. Mean hospital LOS for patients with incident delirium was increased by 136.4 hours (5.7 days), 66.4 hours (2.8 days), 155.4 hours (6.5 days) and 63.5 hours (2.6 days) for sites 1, 2, 3 and 4, respectively (see Figure 5). On average, adjusted hospital LOS was 209 hours (8.7 days) for non-delirious participants while patients who were found to have incident delirium had a 314.4-hour (13.1 days) hospital stay. Mean hospital adjusted LOS was significantly increased by 105.4 hours (4.4 days) in the delirious patients compared to non-delirious patient (p=0.003).

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INTERPRETATION

Our study is, to our knowledge, the first large Canadian prospective study aiming to determine the incidence of delirium induced by ED stay in elderly patients and then to analyze its impacts on the length of in-hospital stay. We found a 12.1% incidence for delirium in our cohort of 338 elderly patients. Our study determined that there was a statistically significant association between incident delirium and hospital LOS, which was increased by 4.4 days in patients with incident delirium. A statistically non-significant increase of 5.0 hours was also found in the average ED LOS between those 2 groups, but this increase is of clinical importance for patient care.

Our results confirm the clinical importance of incident delirium in acute medicine care. A previous Canadian retrospective study was conducted by our team(48) using a chart-based CAM,(49) in which an 18% incidence of delirium was found in 200 patients medical charts. Half of those patients developed a delirium within 36 hours of arrival to the ED. A prospective cohort study by Bo *et al*. also discovered that ED LOS >10 hours is strongly associated with delirium onset.(30) They included patients over 75 years of age. Delirium was detected using the 4AT tool (sensitivity of 89.7% and specificity of 84.1% compared to that of the CAM) (50), which was administered soon after the patient's ED arrival (3.3 ±1 hours). Patients were then assessed 4 times a day during 72 hours of their admission to the acute medical or geriatric ward. 15.8% of their cohort was diagnosed with delirium 3 days after their ward admission. Their participants were older (mean age 83.2±5.4) and less independent (only 50% were independent in their ADLs and one third had at least moderate cognitive impairment). Our patients were exclusively independent and semi-independent living in the community, who presented to the ED with various medical complaints leading to their admission to any hospital ward (including surgical wards).

Han *et al*. showed a 17.2% delirium incidence in their ED cohort study of 628 patients.(31) However, the number of delirious patients may have been underestimated since those who were in the ED for over 12 hours were excluded from this study. The CAM for the Intensive Care Unit (CAM-ICU) tool was used in order to detect delirium. Even with its high sensitivity and specificity (93-100% and 89-100% respectively),(51, 52) the CAM is a more comprehensive tool for the detection of delirium and is better suited to the ED environment.

Delaney *et al*. found that implementing an alert into the EMR system for triage nurses to screen every patient over 65 years old for delirium helped decreasing the number of unrecognized prevalent delirium cases being discharged home.(32) In fact, they found that ED nurses identified 23% of patients as potentially positive for delirium, in an unknown number of patients seen. They used a combination of the Richmond Assessment Sedation Scale (RASSS)(23) and the brief-Confusion Assessment Method (bCAM) in order to identify patients with delirium.(53) To our knowledge, no other study has evaluated the combination of those two tools in the detection of delirium and furthermore, no descriptive data on the population other than age is available.

In 2011, the Ministère de la Santé et des Services Sociaux has published its provincial guide "Approche adaptée à la personne âgée en milieu hospitalier",(54) a senior-friendly initiative which aimed to better address the in-hospital care of elders. This initiative stresses the importance of keeping lengths of stay as short as possible for seniors and presents various methods to prevent delirium. Every hospital in the province has implemented these guidelines at

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different levels. However, our results show that over 4 years post-implementation, ED lengths of stay for elderly patients are still quite significant in Quebec, increasing their risk of developing delirium according to previous studies. Our results also clearly confirm the fact that patients with incident delirium have longer hospital length of stay, making them more at risk for further complications. We also recorded an important difference in incident delirium across the 4 study sites, varying from 8.3% to 20%. Although inter-site comparisons were not powered by our sample size, many factors could have explained this difference. The different level of implementation of the provincial senior-friendly guidelines at each site could be a possible cause.

Our study has some limitations. Our high rate of missed patients is mainly due to logistic constraints. However, after comparing the socio-demographic characteristics and comorbidities, we have found no significant difference between patients who were included and those who were missed. Furthermore, including those missed patients would likely have reinforced our results, resulting in higher delirium rates and longer ED and hospital LOS. Therefore, we believe the likelihood of selection bias is low.

Our cohort represents only a portion of the elderly population usually seen in the ED. We have chosen to exclude patients with moderate to severe dementia, those who lived in long-term nursing homes, those with pre-existing psychological conditions and patients who had a lesser functional level. We have made this decision because we were mainly interested to investigate the impact of delirium on the most robust elderly patients.

The CAM was administered by different research assistants, and therefore this might have underestimated or overestimated the frequency of an acute onset of a new symptom. This may have introduced an interviewer bias; however, this situation is not any different from real-life clinical practice. We tried to decrease this potential bias by providing research assistants with standardized training, which was proven effective given our good inter-observer agreement. The study coordinator also reviewed every single research file to ensure completeness.

This study aimed at assessing the present situation in our Canadian EDs regarding the incidence of delirium induced by a prolonged ED-stay in independent and semi-independent elderly patients. The high incidence rate and increased hospital LOS are alarming and could have substantial consequences for the patient and for our health care system in general. Delirium itself is an economic burden in the United States as it is estimated to 152$ billion per year.(31)

An interesting solution to this issue might be the use of a short triage tool aiming to identify patients more at risk of developing a delirium during their ED stay. Delaney *et al*. found that implementing an alert into the EMR system for triage nurses to screen every patient over 65 years old for delirium helped ED nurses better identify 23% of patients as potentially positive for delirium.(32) However, more research is needed in order to identify an appropriate tool to be used by triage nurses.

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Conflicts of interest: None

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Data sharing statement: Being a prospective observational multicentre study, this project includes other data results to be solely used by our research team. The data use is guide by a public funding agency - FQRS

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TABLES

Table 1. Description of the study population

	Site 1 n(%)	Site 2 n(%)	Site 3 n(%)	Site 4 n(%)	Site comparison p-value	Total
Age						
65-74 y/o	61 (57)	21 (32)	38 (45)	35 (42)	0.001	155 (46)
75-84 y/o	36 (34)	23 (35)	35 (42)	29 (35)		123 (36)
≥85 y/o	9 (9)	21 (32)	11 (13)	19 (23)		60 (18)
Sex						
Female	53 (50)	37 (57)	39 (46)	44 (53)	0.618	173 (51)
Home alone						
CTAS						
1 & 2	39 (37)	25 (38)	25 (30)	18 (22)	0.076	107 (31,7)
3	47 (44)	28 (43)	43 (51)	37 (45)		155 (45,9)
4 & 5	20 (19)	12 (18)	16 (19)	28 (34)		76 (22,5)
OARS at baseline (mean ± SD)	26.33 ±1.98	26.41 ±2.20	25.95 ±2.60	24.92 ±2.41	<0.001	25.91 ±2.36
TICS-m at baseline (mean ± SD)*	30.36 ±5.68	31.88 ±4.69	29.37 ±5.92	26.81 ±6.70	<0.001	29.53 ±6.08
Charlson (mean ± SD)	1.93 ±1.78	1.65 ±1.69	3.13 ±2.48	1.81 ±1.55	<0.001	2.14 ±1.99
APACHE II (mean ± SD)	10.99 ±3.43	10.77 ±3.37	9.48 ±3.43	8.70 ±3.17	<0.001	10.01 ±3.48
Environmental factors						
Proper lighting [a]	65 (63)	49 (75)	71 (85)	18 (22)	<0.001	203 (61)
Patient hydration						
Fasting	10 (10)	8 (12)	11 (13)	16 (19)	0.369	45 (14)
Glass of water within reach	70 (72)	55 (85)	52 (65)	71 (86)	0.005	248 (76)
Presence of saliva[¥]	74 (76)	52 (80)	49 (60)	9 (11)	<0.001	184 (56)
Any IV Fluids	75 (77)	58 (89)	78 (95)	65 (78)	0.003	276 (84)
Physical restraints (any)[+]	78 (77)	30 (46)	1 (1)	65 (79)	<0.001	174 (53)
Medical interventions limiting movement						
Bed rest	1 (1)	1 (2)	5 (6)	0 (0,0)	0.071	7 (2)
Urinary catheter	7 (8)	5 (9)	2 (2)	2 (3)	0.217	16 (6)
O2	15 (17)	15 (26)	22 (27)	4 (6)	0.007	56 (19)
Saline-lock Catheter or IV drip	72 (84)	53 (91)	75 (92)	57 (88)	0.377	257 (88)
Other	10 (12)	8 (14)	18 (22)	6 (9)	0.125	42 (14)
Temporal orientation aid[•]	67 (63)	45 (69)	53 (63)	37 (45)	0.010	202 (60)

* Adjusted for level of education

[a] According to the research assistant

[¥] Research assistant verified if the patients had saliva under their tongue

[+] Tablet, bed rails or other

[•] Clock, watch, cell phone, calendar

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CTAS: Canadian Triage Assessment Scale; OARS: Older American's Resources and Services; TICS-m: Telephone Interview for Cognitive Status-modified; APACHE II: Acute Physiological and Chronic Health Evaluation II; IV: intravenous injection;

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FIGURES LEGEND

Figure 1. Study flowchart

Figure 2. Distribution of delirium across participating sites

Figure 3. Cumulative incidence of delirium curve

Figure 4. Adjusted length of ED stay (hours)*

* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

Figure 5. Adjusted length of hospital stay (hours)*

* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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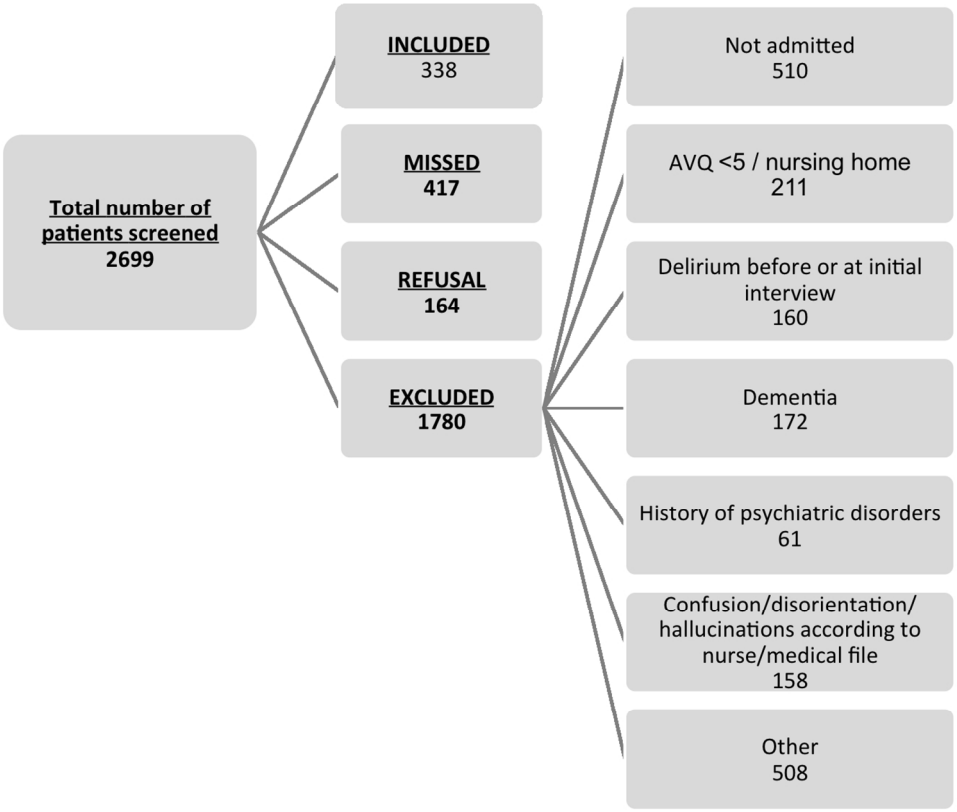

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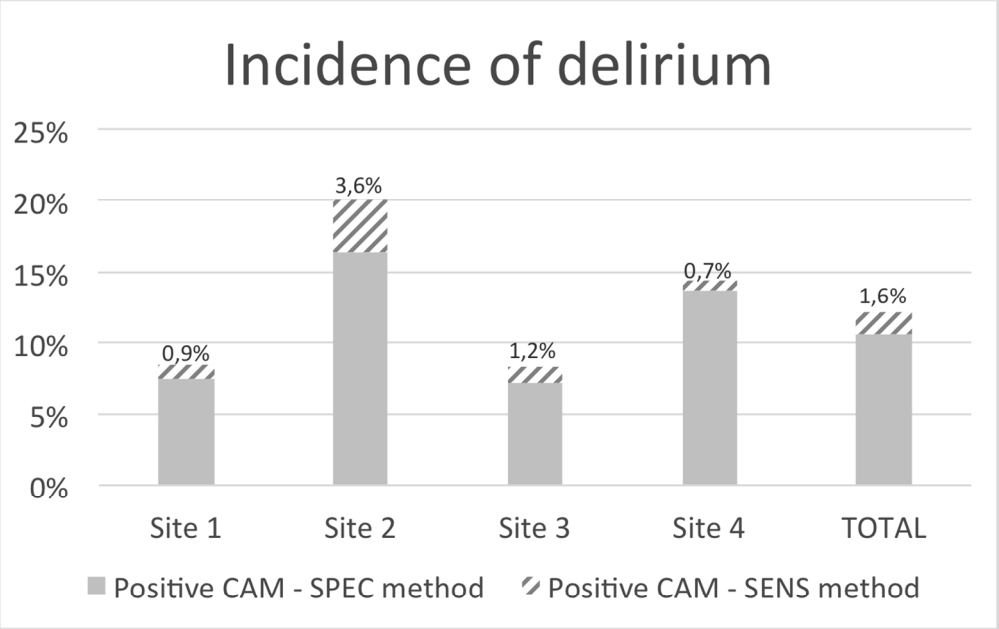

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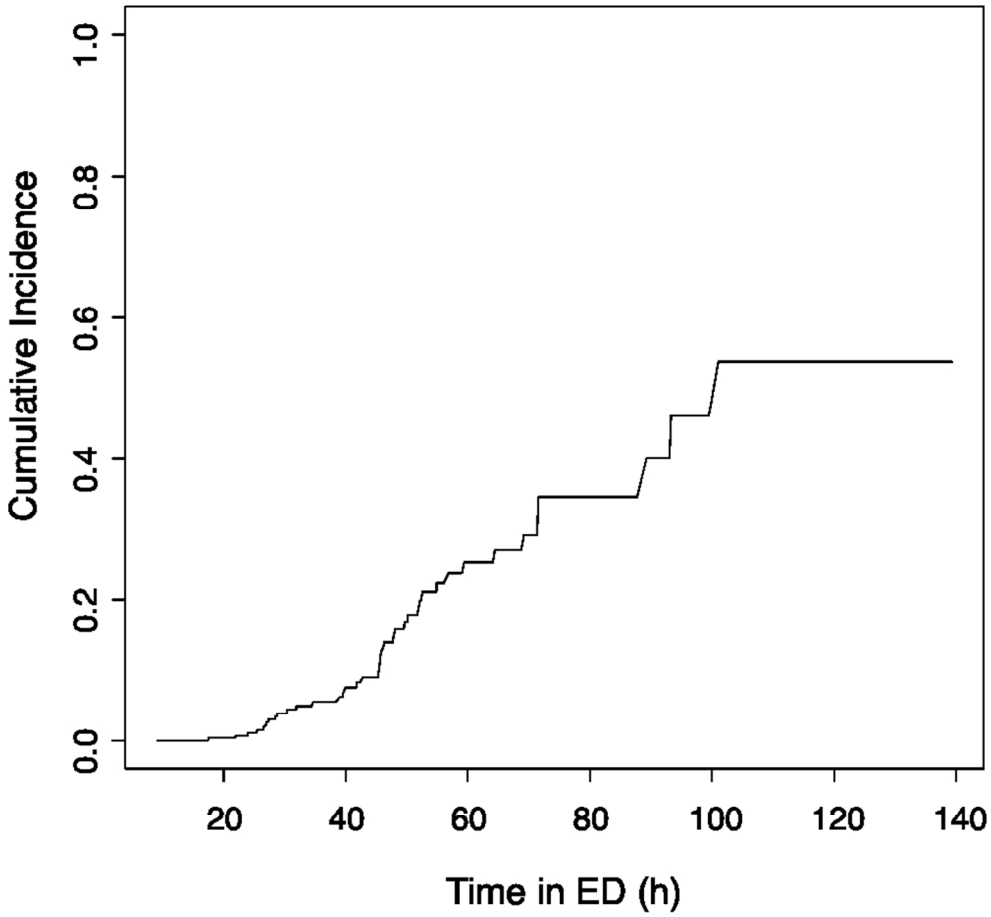
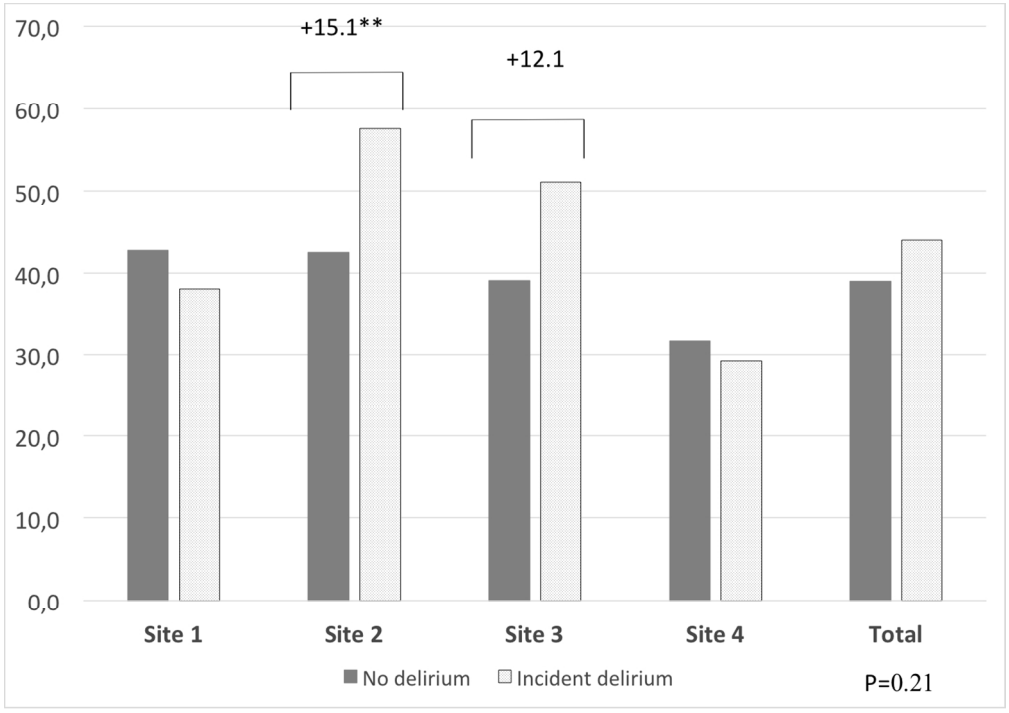

Cumulative Incidence
0.0
0.2
0.4
0.6
0.8
1.0
20
40
60
80
100
120
140
Time in ED (h)



* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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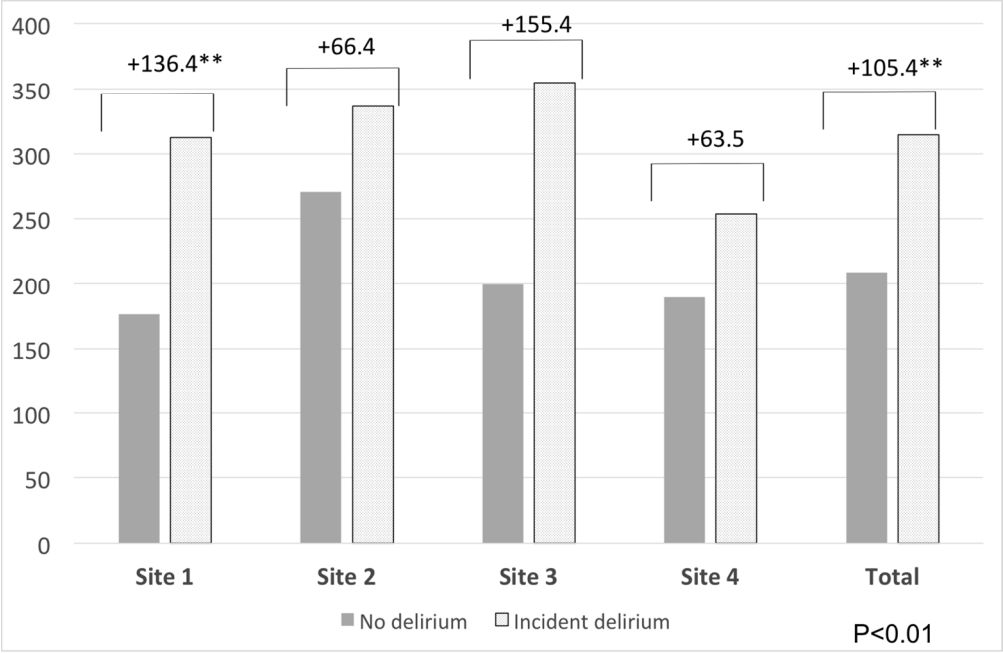

* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7-8*
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	8
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Incidence of delirium in the Emergency Department and its consequences on Emergency Department and hospital length of stay : a prospective observational multicentre cohort study in Canadian EDs

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Primary Subject Heading:	Emergency medicine

Secondary Subject Heading:	Geriatric medicine
Keywords:	Delirium, Emergency Department, Community seniors, Cognitive status, Functional status

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Manuscripts

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Incidence of delirium in the Emergency Department and its consequences on Emergency Department and hospital length of stay: a prospective observational multicentre cohort study in Canadian EDs

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Authors' contribution: MÉ had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. He was responsible of design, funding, conduct of the study and writing of the manuscript. VB managed the study, led the analyses and wrote the manuscript. MÉ, VB and PHC were involved in the statistical analysis, and data interpretation. MP, RD, EG and MEL were responsible for all four site recruitment. PV, SB, MM, TTMV, JL, MR, SL, NLS and LJ are all collaborator of INDEED project. PHC, MP, RD, EG, MEL, PV, SB, MM, TTMV, JL, MR, SL, NLS and LJ reviewed, and approve the manuscript.

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ABSTRACT

Objective: We aim to determine the incidence of delirium and describe its impacts on Emergency department (ED) and hospital length of stay (LOS) among admitted older adults with an 8-hour exposure to the ED environment.

Design: This is a prospective observational multicentre cohort study (March-July 2015). Patients were assessed 2x/day during their entire ED stay and up to 24 hours on hospital ward.

Setting: The study took place in 4 Canadian EDs.

Participants: 338 included patients: 1) aged ≥65; 2) who had an ED stay ≥8 hours; 3) were admitted to hospital ward; 4) were independent/semi-independent.

Main Outcome(s) and Measure(s): The primary outcomes of this study were incident delirium in the ED or within 24 h of ward admission and ED and hospital LOS. Functional and cognitive status were assessed using validated Older Americans' Resources and Services (OARS) and the Telephone Interview for Cognitive Status- modified (TICS-m) tools. The Confusion Assessment Method (CAM) was used to detect incident delirium. Univariate and multivariate analyses were conducted to evaluate outcomes.

Results: Mean age was 76.8 (± 8.1), 17.7% were aged >85 years old and 48.8% were male. The mean incidence of delirium was 12.1% (n=41). Median Interquartile range ED LOS was 32.4 (24.5–47.9) hours and hospital LOS was 146.6 (75.2-267.8) hours. Adjusted mean ED LOS and mean hospital LOS were increased respectively by 5.0 hours (95% CI [-1.4, 14.1], p=0.06) and by 105.4 hours (4.4 days) (95% CI: [25.1, 162.0], p< 0.001) for patients who developed an episode of delirium compared to non-delirious patient.

Conclusions: An incident delirium was observed in 1 of 8 independent/semi-independent older adults after an 8-hour ED exposure. An episode of delirium increases hospital LOS by 4 days and therefore has important implications for patients and could contribute to ED overcrowding through a deleterious feedback loop.

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Strengths and limitations of this study

- **Largest prospective study on incident delirium in the Emergency Department.**
- **A systematic screening of delirium at study entry was realized with a validated tool.**
- **Multiple patient assessments for incident delirium were conducted.**
- **Study population was limited to independent/semi-independent elders, which may limit external validity of the findings.**
- **Hospital LOS were adjusted for potential cofounders relating to geriatric care.**

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INTRODUCTION

In 2016, the youngest of the "baby-boomers" turned 50 years old and people aged 65 and older represented 18.1% of the population in Quebec.(1) It is foreseen that by 2031, the proportion of older adults aged over 65 will nearly double, with a major increase among those aged 85 and older.(2) Over the coming decades, those demographic trends will fundamentally change the make-up of the population served by Quebec Emergency Departments (ED). Older adults are already the main users of emergency health care services(3-5) and in 2012-2013, 40% of ED stretchers were occupied by patients aged over 65.(6) Furthermore, patients over 75 years of age have the highest ED visit rate of any age group and in 2012-2013 those patients occupied 25% of ED stretchers.(7, 8) Those numbers will only increase over time as the older adults population grows and this "Silver Tsunami"(9) will have major consequences on the healthcare of seniors and on our health care system in general.

Caring for older patients in the ED is particularly challenging.(10) Indeed, the time-pressure environment and high level of background noise may impede efficient communications with older patients.(11, 12) Moreover, specialized geriatric training for ED health professionals remains in its infancy(13) and they may not be as equipped as they should be to face the specific issues of older patients. All of this may contribute to the fact that older adults have higher rates of unplanned returns to the ED,(14, 15) of hospitalization,(16) falls,(17) loss of independence(18) and unrecognized delirium(19-21) following an emergency visit. Delirium is an acute brain dysfunction defined as a mental disorder of acute onset with a fluctuating course, characterized by a disturbance in consciousness, attention, orientation, memory, thought, perception and behavior.(22, 23) It is a common problem in the ED and its prevalence in older patients admitted to acute and long-term care facilities ranges between 9.6% and 89%.(21, 24-26)

In August of 2013, Inouye *et al*. published a systematic review(27) in which they found no study reporting the incidence of delirium in the ED. The same author also demonstrated that an ED stay of 12 hours or more was one of the strongest independent predictors of the onset of subsequent delirium in older patients.(28-30) This is of increasing concern, as recent ED wait times have become quite significant. Since then, a few prospective studies were conducted in order to explore the problem of ED-stay associated delirium.(30-32) To our knowledge, there are few multicenter studies aimed at describing the incidence of delirium in ED of developed countries, such as Canada. Because the literature regarding the incidence of delirium in the ED and its potential impacts on hospital length of stay (LOS), functional status and unplanned ED readmissions is scant, its consequences have yet to be clearly identified in order to orient modern acute medical care. A study by McCusker *et al*. even found that hospital stay was increased by 7.78 days for patients diagnosed with delirium (either prevalent or incident) during the first 7 days of their stay.(33) The onset of such complication in the ED could influence hospital LOS and reflect back on ED crowding and older adults' use of emergency health services.The present study focused on the incidence of delirium induced by emergency department stay. Although ED-induced delirium could be affected by acute illness, comorbidities, ED crowding metrics and health care providers' ability to provide basic care known to prevent delirium, we hypothesized that the incidence of new cases of delirium among older ED patients who are admitted to hospital affects a significant proportion of community older adults, and ED-induced delirium leads to

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longer hospital LOS creating a deleterious feedback loop on ED care and operations (34). The study focused on the incident delirium, because in opposite to prevalent delirium, ED services can act in a way to prevent it.

The objective of this study was to fill a basic knowledge gap regarding the incidence of delirium and its impacts on ED and hospital LOS for older, community independent/semi-independent, non-delirious ED patients with an 8-hour ED stay who are admitted to a hospital ward.

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METHODS

Study setting and population

This prospective multicenter study included patients who presented to one of the 4 participating Quebec EDs (two university-affiliated level 1 trauma centers and two regional hospitals) between March and July 2015. ***Inclusion criteria*** were: 1) Patients aged 65 and over; 2) Patients with an ED stay of ≥ 8 hours; 3) Patients needing and/or waiting for admission to any hospital ward; 4) Independent or semi-independent patients (able to perform 5/7 activities of daily living according to the Older Americans Resources and Services scale (OARS)). ***Exclusion criteria*** were: 1) Patient with unstable medical condition requiring admission to the psychiatric ward, intensive or palliative care units; 2) Patient who are unable to consent; 3) Patients who live (or are in transition) in a long-term care facility; 4) Patients unable to speak French or English; 5) Patients presenting a delirium before coming to the ED, upon arrival or by the end of the first 8 hours in the ED; 6) Patients with a history of psychiatric disorders (such as schizophrenia, psychotic symptoms and bipolar disorder).

Based on soon to be published new recommendations from the Direction Nationale des Urgences regarding older patients' lengths of ED stay, which should be kept under 8 hours, we choose an 8-hour exposure for our patients, as opposed to the 12-hour exposure previously determined to be a predictor of subsequent delirium (28-30). Our pragmatic approach led us to include patients who need or are awaiting admission to a hospital ward; since, Caplan *et al*. showed that patients admitted to hospital have a significantly at higher proportion of delirium than their equivalent counterparts discharged and treated with home resources.(35) Also, even if we know that delirium is more prevalent in this population, we chose to exclude patients who are not independent or semi-independent, because we were mainly interested to investigate the impact of delirium on the most robust older patients. In addition, we chose to exclude patients who were unable to consent, because assessing initial interview and follow-up with those patients would have been difficult.

Potential participants were identified using the emergency department information system. Research assistants (RAs) obtained consent and screened the participants for eligibility after their 8-hour exposure to the ED. Sociodemographic, medical and comorbidity data were collected upon initial interview. RAs also assessed patients' baseline physical, frailty and cognitive status. Patients were screened for delirium during initial interview, and twice a day (with at least 6 hours between each evaluation) during their entire ED stay and up to 24 hours after being admitted to a hospital ward. Potential participants were considered as "missed" when they was no RA on-site for the recruitment. RAs were on site for the screening of patients about 12 hours a day, 7 days a week.

Measures

Patients' frailty and physical status were assessed using respectively the Clinical Frailty Scale (CFS) (36) and the Older Americans Resources and Services scale (OARS)(37),while the Telephone Interview for Cognitive Status-modified (TICS-m),(38) the Confusion Assessment Method (CAM) (39) and the Delirium Index (40), were used to assess cognitive status. Other

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information on medications, comorbidities (Charlson comorbidity risk index) (41), severity of illness (Acute Physiological and Chronic Health Evaluation II (APACHE II) (42) and ED environment evaluation were collected in addition to sociodemographic data.

The CAM is the most commonly used tool for the detection of delirium with its sensitivity ranging between 34% and 58% and its specificity between 89% and 94% when performed by a research assistant. However, even if this sensitivity seems low, it has been shown that when the CAM is administered several times during a shift, it is more sensitive than a diagnosis made by a psychiatrist.(43) Because of the fluctuating nature of delirium, patients were systematically assessed with the CAM and the Delirium Index (a validated tool used to measure the severity of delirium) (40) twice a day during their entire ED stay. Furthermore, the CAM was used over a 24-hour period following transfer to the hospital ward. ED and ward nurses and doctors were blinded to the study's objectives in order to avoid them changing their practice. The TICS-m was used to assess baseline cognitive status of our study participants.(44) ED environmental information, such as presence of proper lighting (according to the RAs), patient's hydration, presence of physical restraints or medical interventions limiting movement at initial interview and presence of a family member or a friend at initial interview was also recorded by RAs.

Each site's team of RAs received standardized training by an experienced member of the mentoring team of the *Centre d'Excellence sur le Vieillissement de Québec(45)*, who also specializes in the administration of the CAM. They also attended a group training session conducted by the study coordinator and an experienced research nurse and underwent a 5-hour personalized field training. They were also provided with a detailed training manual. Inter-rater reliability was assessed during patient follow-ups at the coordinating site to ensure that the test was administered in a standardized manner.

In order to be sure that the missed patients were similar to our participants, some data were collected on those missed patients, such as their gender, their date of birth, their Charlson Comorbidity Score and their score at the Canadian Triage Assessment Scale (CTAS). As well, the incidence of delirium was collected for those patients.

Outcomes

Incident delirium during the patients' ED-stay was the main outcome of this study, as well as ED and hospital LOS. Incident delirium was defined by a delirium who occurred either in the ED or in the first 24 hours of the hospital stay. The CAM was administrated during the initial interview ensuring that the patient was not already delirious after the first 8 hours of their ED stay.

There are two existing interpretation methods to the CAM scores: the sensitive (SENS) and the specific (SPEC) methods.(46) A patient is diagnosed with delirium according the SPEC method if they: had an acute onset, a fluctuation in any of the items evaluated in the CAM (inattention, disorganized thinking, altered level of consciousness, disorientation, memory, sensory disturbances, psycho-motor activity, sleep disturbances) as well as inattention and either disorganized thinking or altered state of consciousness.(25) A patient has delirium according to the SENS method if they: had either an acute onset or a fluctuation in any of the items evaluated

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in the CAM, inattention and either disorganized thinking or altered state of consciousness.(25) The SENS method was used to ascertain delirium.

ED LOS was measured from the date and time of triage up to the date and time when the patients were physically transferred to the hospital ward. Hospital LOS was also measured from ED triage up to the date and time of hospital discharge. ED and hospital LOS were compared between patients with a positive CAM and those with a negative CAM for each site.

Statistical analyses

Descriptive statistics were computed on patient characteristics and measured outcomes. Cumulative incidence rates are estimated using Kaplan-Meier curves. ED and hospital LOS is compared in patients with and without incident delirium in the various sites using multiple linear regression, adjusting for APACHE, Charlson, OARS, age and TICS-m. Site and its interaction with incident delirium is treated as a fixed factor. TICS-m scores were adjusted for patients' level of education. Kappa statistics were computed to measure inter-rater reliability of the CAM. Based on an alpha of 5%, 138 patients would allow 80% power for an estimated overall incidence proportion of 15 % with 5% precision. Analyses were performed using SAS, version 9.4 (SAS Institute, Inc., Cary, NC).

The Comité d'éthique du CHU de Québec acted as the centralized research ethics board and approved this study (project # MP-20-2015-2130). Written consent was obtained for each study participant. Patient records/information were anonymized prior to analysis.

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RESULTS

Population

A total of 2699 patients were screened by research assistants across our 4 sites (figure 1). Of those, 1780 did not meet our inclusion criteria or had one of our exclusion criteria, 417 were missed and 164 refused to participate to the study. This leaves us with a sample of 338 patients (12.5%). Females represented 51.2% of our population and mean age was 76.8 (±8.09) (table 1).

A sample analysis of patients who were missed revealed that they had a similar profile to that of those who were included in our study. 54.9% were female, with a mean age of 77.4 (±9.4) years old. The mean Charlson Comorbidity Score was 1.7 (±1.7), 36.7% were considered level 1 or 2 on the Canadian Triage Assessment Scale (CTAS) and 38% were level 3. The medical notes revealed only one case of incident delirium within 24 hours of triage for this group of patients. Table 1 provides details on sociodemographic and environmental variables.

Incidence of delirium

In our cohort, we found that the overall incidence of delirium was 12.1% (n=41) using the SENS method, overall incidence and its distribution across sites are provided in figure 2. Fourteen cases occurred in the ED, while 27 cases occurred on the ward. Our results indicate that the delirium incidence rate was 2.9 cases per 1000 patient-hours. Figure 3 shows a cumulative incidence of delirium curve. Median ED LOS before developing a delirium was 45.2 h (38.0-52.5). Inter-rater agreements were performed at the coordinating site on 12% of the site's participants. A perfect agreement was obtained regarding the incidence of delirium, and agreement for each of the CAM items had Kappa ranging between 0.63 and 1.0.

ED and hospital length of stay

Median (IQR) ED LOS was 32.4 (24.5–47.9) hours. When adjusting for site, age, Charlson, APACHE, OARS and TICS-m scores, a difference of 5.0 hours was found in the average adjusted ED LOS between individuals who developed a delirium and those who did not (p=0.21) (see Figure 4). Of note, a statistically significant difference was found for site 2 (p=0.03). Therefore, patients who developed incident delirium generally had slightly longer exposure to the ED environment than patients who did not develop the condition.

Median (IQR) hospital LOS was 146.6 (75.2-267.8) hours. On average, adjusted hospital LOS was 209 hours (8.7 days) for non-delirious participants while patients who were found to have incident delirium had a 314.4-hour (13.1 days) hospital stay. The hospital LOS for each site are shown in Figure 5. Mean hospital adjusted LOS was significantly increased by 105.4 hours (4.4 days) in the delirious patients compared to non-delirious patient (p=0.003).

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DISCUSSION

Our study is, to our knowledge, the first large Canadian prospective study aiming to determine the incidence of delirium induced by ED stay in older patients and then to analyze its impacts on the length of in-hospital stay. We found a 12.1% incidence for delirium in our cohort of 338 older patients. Our study determined that there was a statistically significant association between incident delirium and hospital LOS, which was increased by 4.4 days in patients with incident delirium. A statistically non-significant increase of 5.0 hours was also found in the average ED LOS between those 2 groups, but this increase is of clinical importance for patient care.

Our results confirm the clinical importance of incident delirium in acute medicine care. A previous Canadian retrospective study was conducted by our team(47) using a chart-based CAM,(48) in which an 18% incidence of delirium was found in 200 patients medical charts. Half of those patients developed a delirium within 36 hours of arrival to the ED. It was shown previously that in prevalent delirious older ED patients that delirium is a predictor of prolonged hospital LOS (31). With our results, we confirm that incident delirium also has such result. However, contrary to prevalent delirium, it is possible to change the interventions in hospital to prevent this episode that has been shown to influence hospital LOS and long-term function and cognition (49).

In 2011, the Ministère de la Santé et des Services Sociaux has published its provincial guide "Approche adaptée à la personne âgée en milieu hospitalier",(50) a senior-friendly initiative which aimed to better address the in-hospital care of elders. This initiative stresses the importance of keeping lengths of stay as short as possible for older adults and presents various methods to prevent delirium. Every hospital in the province has implemented these guidelines at different levels. However, our results show that over 4 years post-implementation, ED lengths of stay for older patients are still quite significant in Quebec, increasing their risk of developing delirium according to previous studies. Our results also clearly confirm the fact that patients with incident delirium have longer hospital length of stay, making them more at risk for further complications. We also recorded an important difference in incident delirium across the 4 study sites, varying from 8.3% to 20%. Although inter-site comparisons were not powered by our sample size, many factors could have explained this difference. The different level of implementation of the provincial senior-friendly guidelines at each site could be a possible cause.

Our study has some limitations. Our high rate of missed patients is mainly due to logistic constraints. However, after comparing the socio-demographic characteristics and comorbidities, we have found no significant difference between patients who were included and those who were missed. Furthermore, including those missed patients would likely have reinforced our results, resulting in higher delirium rates and longer ED and hospital LOS. Therefore, we believe the likelihood of selection bias is low. Our cohort represents only a portion of the older adults population usually seen in the ED. We have chosen to exclude patients with moderate to severe dementia, those who lived in long-term nursing homes, those with pre-existing psychological conditions and patients who had a lesser functional level. We have made this decision because we were mainly interested to investigate the impact of delirium on the most robust older patients. The CAM was administered by different research assistants, and therefore this might have underestimated or overestimated the frequency of an acute onset of a new symptom. This may have introduced an interviewer bias; however, this situation is not any different from real-life

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clinical practice. We tried to decrease this potential bias by providing research assistants with standardized training, which was proven effective given our good inter-observer agreement. The study coordinator also reviewed every single research file to ensure completeness.

This study aimed at assessing the present situation in our Canadian EDs regarding the incidence of delirium induced by a prolonged ED-stay in independent and semi-independent older patients. The high incidence rate and increased hospital LOS are alarming and could have substantial consequences for the patient and for our health care system in general. Delirium itself is an economic burden in the United States as it is estimated to 152$ billion per year.(31)

An interesting solution to this issue might be the use of a short triage tool aiming to identify patients more at risk of developing a delirium during their ED stay. Delaney *et al*. found that implementing an alert into the EMR system for triage nurses to screen every patient over 65 years old for delirium helped ED nurses better identify 23% of patients as potentially positive for delirium.(32) However, more research is needed in order to identify an appropriate tool to be used by triage nurses.

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Conflicts of interest: None

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Data sharing statement: Being a prospective observational multicentre study, this project includes other data results to be solely used by our research team. The data use is guide by a public funding agency - FQRS

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TABLES

Table 1. Description of the study population

	Site 1 n(%)	Site 2 n(%)	Site 3 n(%)	Site 4 n(%)	Site comparison p-value	Total
Age						
65-74 y/o	61 (57)	21 (32)	38 (45)	35 (42)	0.001	155 (46)
75-84 y/o	36 (34)	23 (35)	35 (42)	29 (35)		123 (36)
≥85 y/o	9 (9)	21 (32)	11 (13)	19 (23)		60 (18)
Sex						
Female	53 (50)	37 (57)	39 (46)	44 (53)	0.618	173 (51)
CTAS						
1 & 2	39 (37)	25 (38)	25 (30)	18 (22)	0.076	107 (31,7)
3	47 (44)	28 (43)	43 (51)	37 (45)		155 (45,9)
4 & 5	20 (19)	12 (18)	16 (19)	28 (34)		76 (22,5)
Main reason of admission						
Medical						
Cardiology	15 (14.0)	16 (21.9)	23 (25.2)	16 (18.0)		70 (19.4)
Pneumology	22 (20.6)	15 (20.5)	26 (28.6)	12 (13.5)		75 (20.8)
Gastroenterology	13 (12.1)	7 (9.6)	8 (8.8)	17 (19.1)		45 (12.5)
Internal medicine	6 (5.6)	8 (11.0)	7 (7.7)	8 (9.0)		29 (8.1)
Neurology	13 (12.1)	7 (9.6)	9 (9.9)	10 (11.2)		39 (10.8)
Other	28 (26.2)	14 (19.2)	14 (15.4)	21 (23.6)		77 (21.4)
Surgical						
Orthopedics	2 (1.9)	6 (8.2)	4 (4.4)	5 (5.6)		17 (4.7)
General surgery	5 (4.7)	0 (0)	0 (0)	0 (0)		5 (1.4)
Other	3 (2.8)	0 (0)	0 (0)	0 (0)		3 (0.8)
Time of admission in the ED						
0:00-8:00	18 (16.5)	12 (16.2)	21 (22.1)	5 (5.6)		56 (15.3)
8:00-16:00	66 (60.6)	34 (46.0)	43 (45.3)	54 (60.7)		197 (53.7)
16:00-0:00	25 (22.9)	28 (37.8)	31 (32.6)	30 (33.7)		114 (31.0)
OARS at baseline (mean ± SD)	26.33 ±1.98	26.41 ±2.20	25.95 ±2.60	24.92 ±2.41	<0.001	25.91 ±2.36
TICS-m at baseline (mean ± SD)*	30.36 ±5.68	31.88 ±4.69	29.37 ±5.92	26.81 ±6.70	<0.001	29.53 ±6.08
Charlson (mean ± SD)	1.93 ±1.78	1.65 ±1.69	3.13 ±2.48	1.81 ±1.55	<0.001	2.14 ±1.99
APACHE II (mean ± SD)	10.99 ±3.43	10.77 ±3.37	9.48 ±3.43	8.70 ±3.17	<0.001	10.01 ±3.48
Environmental factors						
Proper lighting [a]	65 (63)	49 (75)	71 (85)	18 (22)	<0.001	203 (61)
Patient hydration						
Fasting	10 (10)	8 (12)	11 (13)	16 (19)	0.369	45 (14)

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Glass of water within reach	70 (72)	55 (85)	52 (65)	71 (86)	0.005	248 (76)
Presence of saliva[¥]	74 (76)	52 (80)	49 (60)	9 (11)	<0.001	184 (56)
Any IV Fluids	75 (77)	58 (89)	78 (95)	65 (78)	0.003	276 (84)
Physical restraints (any)[+]	78 (77)	30 (46)	1 (1)	65 (79)	<0.001	174 (53)
Medical interventions limiting movement						
Bed rest	1 (1)	1 (2)	5 (6)	0 (0,0)	0.071	7 (2)
Urinary catheter	7 (8)	5 (9)	2 (2)	2 (3)	0.217	16 (6)
O2	15 (17)	15 (26)	22 (27)	4 (6)	0.007	56 (19)
Saline-lock Catheter or IV drip	72 (84)	53 (91)	75 (92)	57 (88)	0.377	257 (88)
Other	10 (12)	8 (14)	18 (22)	6 (9)	0.125	42 (14)
Temporal orientation aid[•]	67 (63)	45 (69)	53 (63)	37 (45)	0.010	202 (60)

* Adjusted for level of education

[a] According to the research assistant

[¥] Research assistant had a standardized training to verified if the patients had saliva under their tongue

[+] Tablet, bed rails or other

[•] Clock, watch, cell phone, calendar

CTAS: Canadian Triage Assessment Scale; OARS: Older American's Resources and Services; TICS-m: Telephone Interview for Cognitive Status-modified; APACHE II: Acute Physiological and Chronic Health Evaluation II; IV: intravenous injection;

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FIGURES LEGEND

Figure 1. Study flowchart

Figure 2. Distribution of delirium across participating sites

Figure 3. Cumulative incidence of delirium curve

Figure 4. Adjusted length of ED stay (hours)*

* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

Figure 5. Adjusted length of hospital stay (hours)*

* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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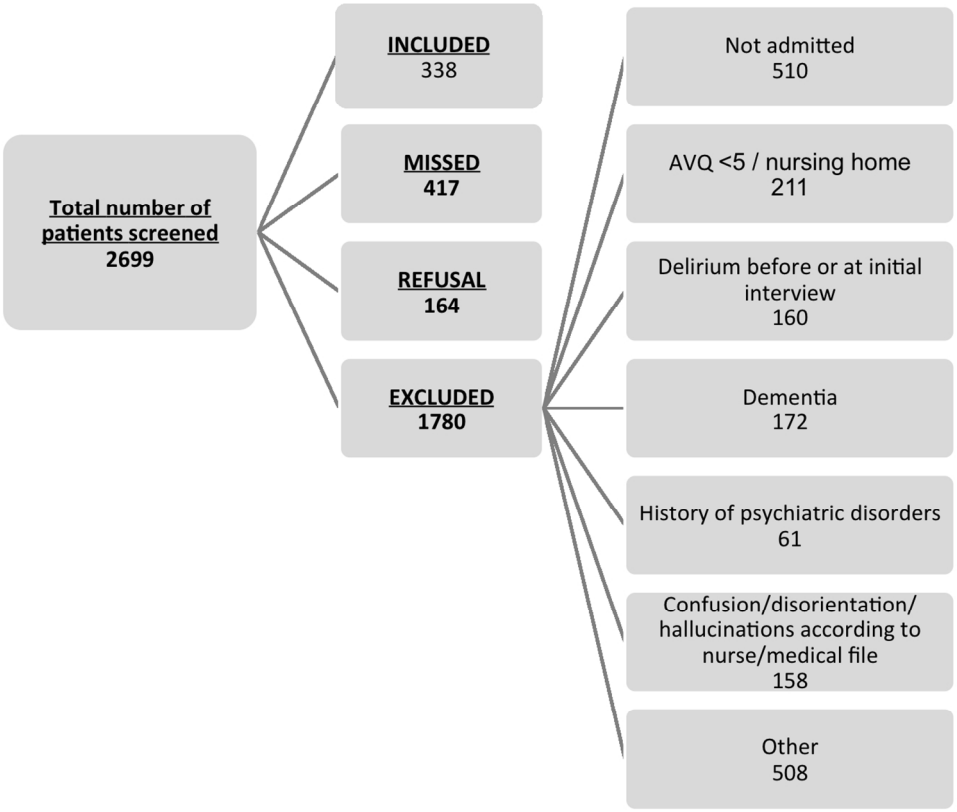

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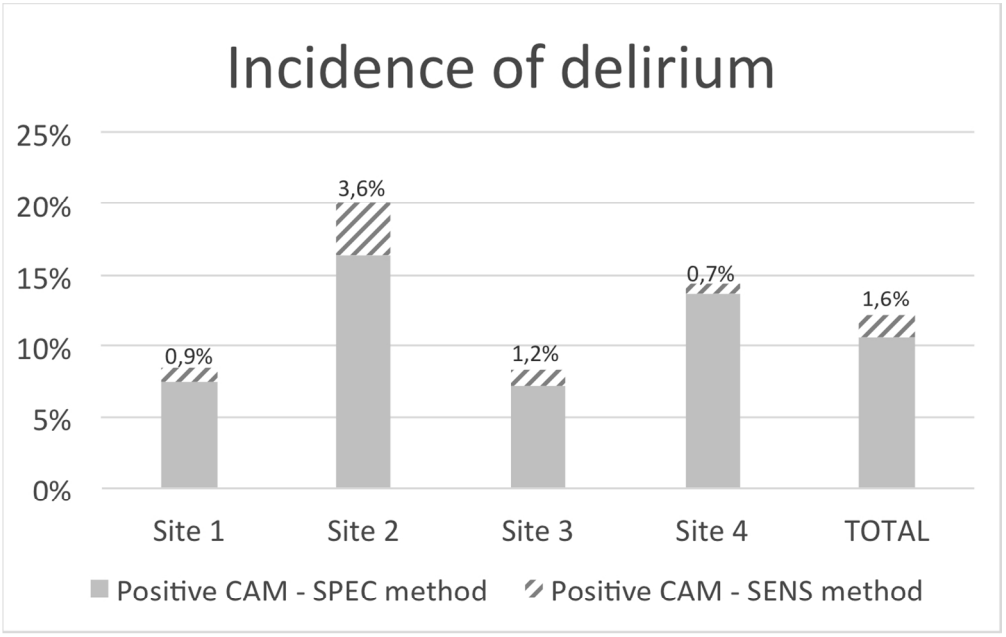

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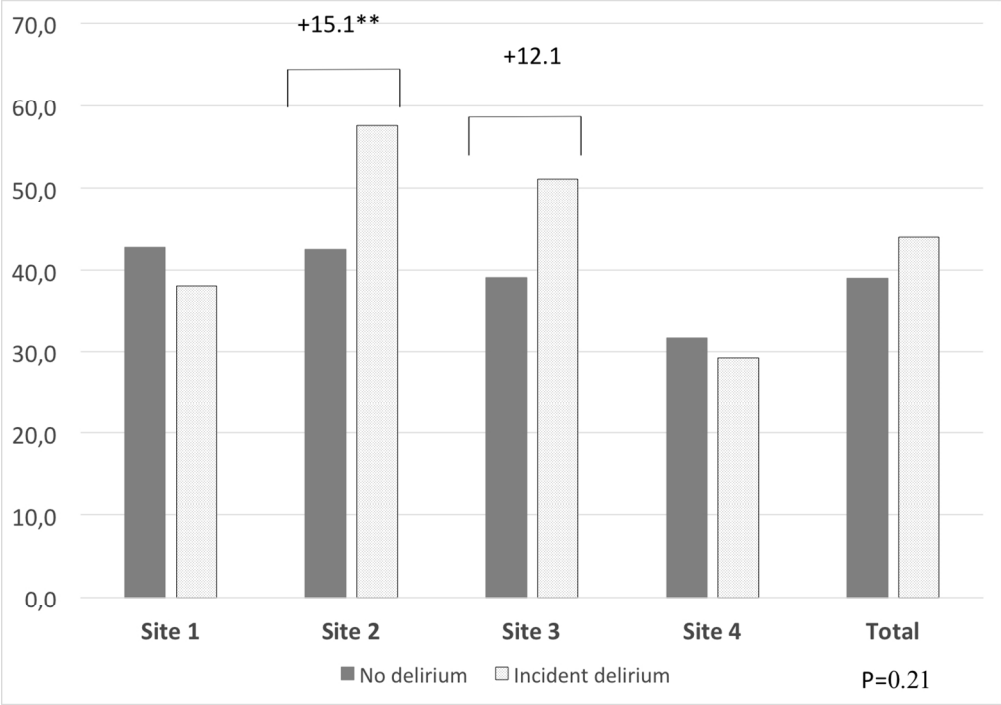

* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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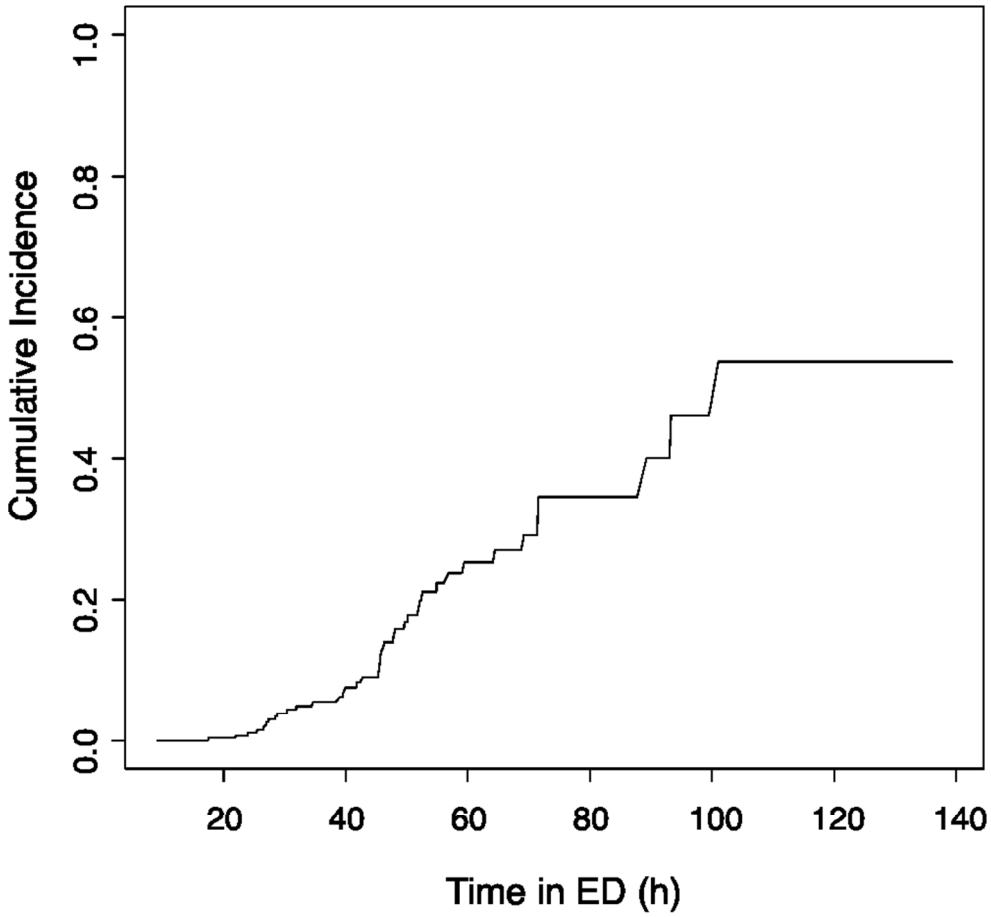
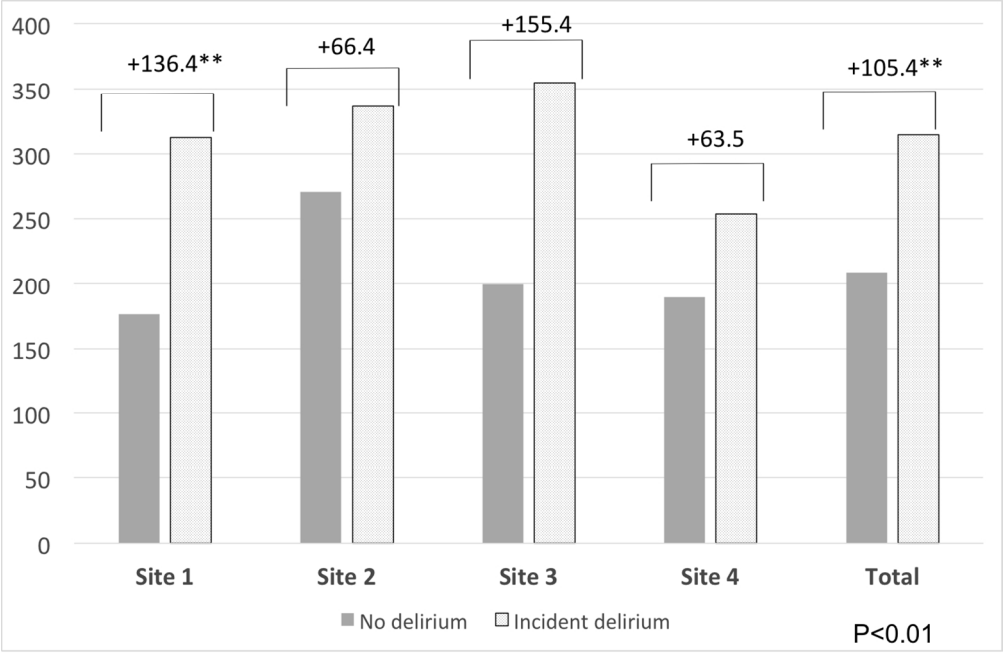

Cumulative Incidence
0.0
0.2
0.4
0.6
0.8
1.0
20
40
60
80
100
120
140
Time in ED (h)



* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7-8*
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	8
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Incidence of delirium in the Emergency Department and its consequences on hospital length of stay : a prospective observational multicentre cohort study in Canadian EDs

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Primary Subject	Emergency medicine

Heading:	
Secondary Subject Heading:	Geriatric medicine
Keywords:	Delirium, Emergency Department, Community seniors, Cognitive status, Functional status

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Incidence of delirium in the Emergency Department and its consequences on hospital length of stay : a prospective observational multicentre cohort study in Canadian EDs

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3225 words

Authors' contribution: MÉ had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. He was responsible of design, funding, conduct of the study and writing of the manuscript. VB managed the study, led the analyses and wrote the manuscript. MÉ, VB and PHC were involved in the statistical analysis, and data interpretation. MP, RD, EG and MEL were responsible for all four site recruitment. PV, SB, MM, TTMV, JL, MR, SL, NLS and LJ are all collaborator of INDEED project. PHC, MP, RD, EG, MEL, PV, SB, MM, TTMV, AN, JL, MR, SL, NLS and LJ reviewed, and approve the manuscript.

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ABSTRACT

Objective: We aim to determine the incidence of delirium and describe its impacts on hospital length of stay (LOS) among non-delirious community older adults with an 8-hour exposure to the Emergency Department (ED) environment.

Design: This is a prospective observational multicentre cohort study (March-July 2015). Patients were assessed 2x/day during their entire ED stay and up to 24 hours on hospital ward.

Setting: The study took place in 4 Canadian EDs.

Participants: 338 included patients: 1) aged ≥65; 2) who had an ED stay ≥8 hours; 3) were admitted to hospital ward; 4) were independent/semi-independent.

Main Outcome(s) and Measure(s): The primary outcomes of this study were incident delirium in the ED or within 24 h of ward admission and ED and hospital LOS. Functional and cognitive status were assessed using validated Older Americans' Resources and Services (OARS) and the Telephone Interview for Cognitive Status- modified (TICS-m) tools. The Confusion Assessment Method (CAM) was used to detect incident delirium. Univariate and multivariate analyses were conducted to evaluate outcomes.

Results: Mean age was 76.8 (± 8.1), 17.7% were aged >85 years old and 48.8% were male. The mean incidence of delirium was 12.1% (n=41). Median Interquartile range ED LOS was 32.4 (24.5–47.9) hours and hospital LOS was 146.6 (75.2-267.8) hours. Adjusted mean ED LOS and mean hospital LOS were increased respectively by 5.0 hours (95% CI [-1.4, 14.1], p=0.06) and by 105.4 hours (4.4 days) (95% CI: [25.1, 162.0], p< 0.001) for patients who developed an episode of delirium compared to non-delirious patient.

Conclusions: An incident delirium was observed in 1 of 8 independent/semi-independent older adults after an 8-hour ED exposure. An episode of delirium increases hospital LOS by 4 days and therefore has important implications for patients and could contribute to ED overcrowding through a deleterious feedback loop.

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Strengths and limitations of this study

- **Largest prospective study on incident delirium in the Emergency Department.**
- **A systematic screening of delirium at study entry was realized with a validated tool.**
- **Multiple patient assessments for incident delirium were conducted.**
- **Study population was limited to independent/semi-independent elders, which may limit external validity of the findings.**
- **Hospital LOS were adjusted for potential cofounders relating to geriatric care.**

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INTRODUCTION

In 2016, the youngest of the "baby-boomers" turned 50 years old and people aged 65 and older represented 18.1% of the population in Quebec.(1) It is foreseen that by 2031, the proportion of older adults aged over 65 will nearly double, with a major increase among those aged 85 and older.(2) Over the coming decades, those demographic trends will fundamentally change the make-up of the population served by Quebec Emergency Departments (ED). Older adults are already the main users of emergency health care services(3-5) and in 2012-2013, 40% of ED stretchers were occupied by patients aged over 65.(6) Furthermore, patients over 75 years of age have the highest ED visit rate of any age group and in 2012-2013 those patients occupied 25% of ED stretchers.(7, 8) Those numbers will only increase over time as the older adults population grows and this "Silver Tsunami"(9) will have major consequences on the healthcare of seniors and on our health care system in general.

Caring for older patients in the ED is particularly challenging.(10) Indeed, the time-pressure environment and high level of background noise may impede efficient communications with older patients.(11, 12) Moreover, specialized geriatric training for ED health professionals remains in its infancy(13) and they may not be as equipped as they should be to face the specific issues of older patients. All of this may contribute to the fact that older adults have higher rates of unplanned returns to the ED,(14, 15) of hospitalization,(16) falls,(17) loss of independence(18) and unrecognized delirium(19-21) following an emergency visit. Delirium is an acute brain dysfunction defined as a mental disorder of acute onset with a fluctuating course, characterized by a disturbance in consciousness, attention, orientation, memory, thought, perception and behavior.(22, 23) It is a common problem in the ED and its prevalence in older patients admitted to acute and long-term care facilities ranges between 9.6% and 89%.(21, 24-26)

In August of 2013, Inouye *et al*. published a systematic review(27) in which they found no study reporting the incidence of delirium in the ED. The same author also demonstrated that an ED stay of 12 hours or more was one of the strongest independent predictors of the onset of subsequent delirium in older patients.(28-30) This is of increasing concern, as recent ED wait times have become quite significant. Since then, a few prospective studies were conducted in order to explore the problem of ED-stay associated delirium.(30-32) To our knowledge, there are few multicenter studies aimed at describing the incidence of delirium in ED of developed countries, such as Canada. Because the literature regarding the incidence of delirium in the ED and its potential impacts on hospital length of stay (LOS), functional status and unplanned ED readmissions is scant, its consequences have yet to be clearly identified in order to orient modern acute medical care. A study by McCusker *et al*. even found that hospital stay was increased by 7.78 days for patients who developed a delirium (incident delirium) during the first 7 days of their stay.(33) The onset of such complication in the ED could influence hospital LOS and reflect back on ED crowding and older adults' use of emergency health services.The present study focused on the incidence of delirium induced by emergency department stay. Although ED-induced delirium could be affected by acute illness, comorbidities, ED crowding metrics and health care providers' ability to provide basic care known to prevent delirium, we hypothesized that the incidence of new cases of delirium among older ED patients who are admitted to hospital affects a significant proportion of community older adults, and ED-induced delirium leads to

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longer hospital LOS creating a deleterious feedback loop on ED care and operations (34). The study focused on the incident delirium because, as opposed to prevalent delirium, ED services can act in a way to prevent it.

The objective of this study was to fill a basic knowledge gap regarding the incidence of delirium and its impacts on hospital LOS for older, community independent/semi-independent, non-delirious ED patients with an 8-hour ED stay who are admitted to a hospital ward.

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METHODS

Study setting and population

This prospective multicenter study included patients who presented to one of the 4 participating Quebec EDs (two university-affiliated level 1 trauma centers and two regional hospitals) between March and July 2015. ***Inclusion criteria*** were: 1) Patients aged 65 and over; 2) Patients with an ED stay of ≥ 8 hours; 3) Patients needing and/or waiting for admission to any hospital ward; 4) Independent or semi-independent patients (able to perform 5/7 activities of daily living according to the Older Americans Resources and Services scale (OARS)). ***Exclusion criteria*** were: 1) Patient with unstable medical condition requiring admission to the psychiatric ward, intensive or palliative care units; 2) Patient who are unable to consent; 3) Patients who live (or are in transition) in a long-term care facility; 4) Patients unable to speak French or English; 5) Patients presenting a delirium before coming to the ED, upon arrival or by the end of the first 8 hours in the ED; 6) Patients with a history of psychiatric disorders (such as schizophrenia, psychotic symptoms and bipolar disorder).

Based on soon to be published new recommendations from the Direction Nationale des Urgences regarding older patients' lengths of ED stay, which should be kept under 8 hours, we choose an 8-hour exposure for our patients, as opposed to the 12-hour exposure previously determined to be a predictor of subsequent delirium (28-30). Our pragmatic approach led us to include patients who need or are awaiting admission to a hospital ward; since, Caplan *et al*. showed that patients admitted to hospital have a significantly at higher proportion of delirium than their equivalent counterparts discharged and treated with home resources.(35) Also, even if we know that delirium is more prevalent in this population, we chose to exclude patients who are not independent or semi-independent, because we were mainly interested to investigate the impact of delirium on the most robust older patients. In addition, we chose to exclude patients who were unable to consent, because assessing initial interview and follow-up with those patients would have been difficult.

Potential participants were identified using the emergency department information system. Research assistants (RAs) obtained consent and screened the participants for eligibility after their 8-hour exposure to the ED. Sociodemographic, medical and comorbidity data were collected upon initial interview. RAs also assessed patients' baseline physical, frailty and cognitive status. Patients were screened for delirium during initial interview, and twice a day (with at least 6 hours between each evaluation) during their entire ED stay and up to 24 hours after being admitted to a hospital ward. Potential participants were considered as "missed" when they was no RA on-site for the recruitment. RAs were on site for the screening of patients about 12 hours a day, 7 days a week.

Measures

Patients' frailty and physical status were assessed using respectively the Clinical Frailty Scale (CFS) (36) and the Older Americans Resources and Services scale (OARS)(37),while the Telephone Interview for Cognitive Status-modified (TICS-m),(38) the Confusion Assessment Method (CAM) (39) and the Delirium Index (40), were used to assess cognitive status. Other

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information on medications, comorbidities (Charlson comorbidity risk index) (41), severity of illness (Acute Physiological and Chronic Health Evaluation II (APACHE II) (42) and ED environment evaluation were collected in addition to sociodemographic data.

The CAM is the most commonly used tool for the detection of delirium with its sensitivity ranging between 34% and 58% and its specificity between 89% and 94% when performed by a research assistant. However, even if this sensitivity seems low, it has been shown that when the CAM is administered several times during a shift, it is more sensitive than a diagnosis made by a psychiatrist.(43) There are two existing interpretation methods to the CAM scores: the sensitive (SENS) and the specific (SPEC) methods.(44) A patient is diagnosed with delirium according the SPEC method if they: had an acute onset, a fluctuation in any of the items evaluated in the CAM (inattention, disorganized thinking, altered level of consciousness, disorientation, memory, sensory disturbances, psycho-motor activity, sleep disturbances) as well as inattention and either disorganized thinking or altered state of consciousness.(25) A patient has delirium according to the SENS method if they: had either an acute onset or a fluctuation in any of the items evaluated in the CAM, inattention and either disorganized thinking or altered state of consciousness.(25) The SENS method was used to ascertain delirium. Because of the fluctuating nature of delirium, patients were systematically assessed with the CAM and the Delirium Index (a validated tool used to measure the severity of delirium) (40) twice a day during their entire ED stay. Furthermore, the CAM was used over a 24-hour period following transfer to the hospital ward. ED and ward nurses and doctors were blinded to the study's objectives in order to avoid them changing their practice. The TICS-m was used to assess baseline cognitive status of our study participants.(45) ED environmental information, such as presence of proper lighting (according to the RAs), patient's hydration, presence of physical restraints or medical interventions limiting movement at initial interview and presence of a family member or a friend at initial interview was also recorded by RAs. ED LOS was recorded from administrative databases.

Each site's team of RAs received standardized training by an experienced member of the mentoring team of the *Centre d'Excellence sur le Vieillissement de Québec(46)*, who also specializes in the administration of the CAM. They also attended a group training session conducted by the study coordinator and an experienced research nurse and underwent a 5-hour personalized field training. They were also provided with a detailed training manual. Inter-rater reliability was assessed during patient follow-ups at the coordinating site to ensure that the test was administered in a standardized manner.

In order to be sure that the missed patients were similar to our participants, basic clinical and demographic data were collected on those missed patients. The incidence of delirium was also collected for those patients.

Outcomes

Incident delirium during the patients' ED-stay was the main outcome of this study, hospital LOS was our secondary outcome. Incident delirium was defined by a delirium who occurred either in the ED or in the first 24 hours of the hospital stay. The CAM was administrated during the initial

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interview ensuring that the patient was not already delirious after the first 8 hours of their ED stay.

ED LOS was measured from the date and time of triage up to the date and time when the patients were physically transferred to the hospital ward. Hospital LOS was also measured from ED triage up to the date and time of hospital discharge. ED and hospital LOS were compared between patients with a positive CAM and those with a negative CAM for each site.

Statistical analyses

Descriptive statistics were computed on patient characteristics and measured outcomes. Cumulative incidence rates for delirium were estimated using Kaplan-Meier curves. ED and hospital LOS is compared in patients with and without incident delirium in the various sites using multiple linear regression, adjusting for APACHE, Charlson, OARS, age and TICS-m. Site and its interaction with incident delirium is treated as a fixed factor. TICS-m scores were adjusted for patients' level of education. Kappa statistics were computed to measure inter-rater reliability of the CAM. Based on an alpha of 5%, 138 patients would allow 80% power for an estimated overall incidence proportion of 15 % with 5% precision. Analyses were performed using SAS, version 9.4 (SAS Institute, Inc., Cary, NC).

The Comité d'éthique du CHU de Québec acted as the centralized research ethics board and approved this study (project # MP-20-2015-2130). Written consent was obtained for each study participant. Patient records/information were anonymized prior to analysis.

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RESULTS

Population

A total of 2699 patients were screened by research assistants across our 4 sites (figure 1). Of those, 1780 did not meet our inclusion criteria or had one of our exclusion criteria, 417 were missed and 164 refused to participate to the study. This leaves us with a sample of 338 patients (12.5%). Females represented 51.2% of our population and mean age was 76.8 (±8.09) (table 1).

A sample analysis of patients who were missed revealed that they had a similar profile to that of those who were included in our study. 54.9% were female, with a mean age of 77.4 (±9.4) years old. The mean Charlson Comorbidity Score was 1.7 (±1.7), 36.7% were considered level 1 or 2 on the Canadian Triage Assessment Scale (CTAS) and 38% were level 3. The medical notes revealed only one case of incident delirium within 24 hours of triage for this group of patients. Table 1 provides details on sociodemographic and environmental variables.

Incidence of delirium

In our cohort, we found that the overall incidence of delirium was 12.1% (n=41) using the SENS method, overall incidence and its distribution across sites are provided in figure 2. Fourteen cases occurred in the ED, while 27 cases occurred on the ward. Our results indicate that the delirium incidence rate was 2.9 cases per 1000 patient-hours. Figure 3 shows a cumulative incidence of delirium curve. Median ED LOS before developing a delirium was 45.2 h (38.0-52.5). Inter-rater agreements were performed at the coordinating site on 12% of the site's participants. A perfect agreement was obtained regarding the incidence of delirium, and agreement for each of the CAM items had Kappa ranging between 0.63 and 1.0.

Median (IQR) ED LOS was 32.4 (24.5–47.9) hours. When adjusting for site, age, Charlson, APACHE, OARS and TICS-m scores, a difference of 5.0 hours was found in the average adjusted ED LOS between individuals who developed a delirium and those who did not (p=0.21) (see Figure 4). Of note, a statistically significant difference was found for site 2 (p=0.03). Therefore, patients who developed incident delirium generally had slightly longer exposure to the ED environment than patients who did not develop the condition.

Hospital length of stay

Median (IQR) hospital LOS was 146.6 (75.2-267.8) hours. On average, adjusted hospital LOS was 209 hours (8.7 days) for non-delirious participants while patients who were found to have incident delirium had a 314.4-hour (13.1 days) hospital stay. The hospital LOS for each site are shown in Figure 5. Mean hospital adjusted LOS was significantly increased by 105.4 hours (4.4 days) in the delirious patients compared to non-delirious patient (p=0.003).

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DISCUSSION

Our study is, to our knowledge, the first large Canadian prospective study aiming to determine the incidence of delirium induced by ED stay in older patients and then to analyze its impacts on the length of in-hospital stay. We found a 12.1% incidence for delirium in our cohort of 338 older patients. Our study determined that there was a statistically significant association between incident delirium and hospital LOS, which was increased by 4.4 days in patients with incident delirium. A statistically non-significant increase of 5.0 hours was also found in the average ED LOS between those 2 groups, but this increase is of clinical importance for patient care.

Our results confirm the clinical importance of incident delirium in acute medicine care. A previous Canadian retrospective study was conducted by our team(47) using a chart-based CAM,(48) in which an 18% incidence of delirium was found in 200 patients medical charts. Half of those patients developed a delirium within 36 hours of arrival to the ED. It was shown previously that in prevalent delirious older ED patients that delirium is a predictor of prolonged hospital LOS (31). With our results, we confirm that incident delirium also has such result. However, contrary to prevalent delirium, it is possible to change the interventions in hospital to prevent this episode that has been shown to influence hospital LOS and long-term function and cognition (49).

In 2011, the Ministère de la Santé et des Services Sociaux has published its provincial guide "Approche adaptée à la personne âgée en milieu hospitalier",(50) a senior-friendly initiative which aimed to better address the in-hospital care of elders. This initiative stresses the importance of keeping lengths of stay as short as possible for older adults and presents various methods to prevent delirium. Every hospital in the province has implemented these guidelines at different levels. However, our results show that over 4 years post-implementation, ED lengths of stay for older patients are still quite significant in Quebec, increasing their risk of developing delirium according to previous studies. Our results also clearly confirm the fact that patients with incident delirium have longer hospital length of stay, making them more at risk for further complications. We also recorded an important difference in incident delirium across the 4 study sites, varying from 8.3% to 20%. Although inter-site comparisons were not powered by our sample size, many factors could have explained this difference. The different level of implementation of the provincial senior-friendly guidelines at each site could be a possible cause.

Our study has some limitations. Our high rate of missed patients is mainly due to logistic constraints. However, after comparing the socio-demographic characteristics and comorbidities, we have found no significant difference between patients who were included and those who were missed. Furthermore, including those missed patients would likely have reinforced our results, resulting in higher delirium rates and longer ED and hospital LOS. Therefore, we believe the likelihood of selection bias is low. Our cohort represents only a portion of the older adults population usually seen in the ED and may not be generalizable to all elders. We have chosen to exclude patients with moderate to severe dementia, those who lived in long-term nursing homes, those with pre-existing psychological conditions and patients who had a lesser functional level. We have made this decision because we were mainly interested to investigate the impact of delirium on the most robust older patients. The CAM was administered by different research

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assistants, and therefore this might have underestimated or overestimated the frequency of an acute onset of a new symptom. Misclassification of delirium may have occurred as we excluded patient with delirium using a single first initial assessment with CAM, this pragmatic approach was used to ensure feasibility of the study. This may have introduced an interviewer bias; however, this situation is not any different from real-life clinical practice. We tried to decrease this potential bias by providing research assistants with standardized training, which was proven effective given our good inter-observer agreement. The study coordinator also reviewed every single research file to ensure completeness.

This study aimed at assessing the present situation in our Canadian EDs regarding the incidence of delirium induced by a prolonged ED-stay in independent and semi-independent older patients. The high incidence rate and increased hospital LOS are alarming and could have substantial consequences for the patient and for our health care system in general. Delirium itself is an economic burden in the United States as it is estimated to 152$ billion per year.(31)

An interesting solution to this issue might be the use of a short triage tool aiming to identify patients more at risk of developing a delirium during their ED stay. Delaney *et al*. found that implementing an alert into the EMR system for triage nurses to screen every patient over 65 years old for delirium helped ED nurses better identify 23% of patients as potentially positive for delirium.(32) However, more research is needed in order to identify an appropriate tool to be used by triage nurses.

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Conflicts of interest: None

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Data sharing statement: Being a prospective observational multicentre study, this project includes other data results to be solely used by our research team. The data use is guide by a public funding agency - FQRS

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TABLES

Table 1. Description of the study population

	Site 1 n(%)	Site 2 n(%)	Site 3 n(%)	Site 4 n(%)	Site comparison p-value	Total
Age						
65-74 y/o	61 (57)	21 (32)	38 (45)	35 (42)		155 (46)
75-84 y/o	36 (34)	23 (35)	35 (42)	29 (35)	0.001	123 (36)
≥85 y/o	9 (9)	21 (32)	11 (13)	19 (23)		60 (18)
Sex						
Female	53 (50)	37 (57)	39 (46)	44 (53)	0.618	173 (51)
Home alone						
CTAS						
1 & 2	39 (37)	25 (38)	25 (30)	18 (22)		107 (31,7)
3	47 (44)	28 (43)	43 (51)	37 (45)	0.076	155 (45,9)
4 & 5	20 (19)	12 (18)	16 (19)	28 (34)		76 (22,5)
Admission diagnostic						
Medical						
Cardiology	15 (14.0)	16 (21.9)	23 (25.2)	16 (18.0)		70 (19.4)
Pneumology	22 (20.6)	15 (20.5)	26 (28.6)	12 (13.5)		75 (20.8)
Gastroenterology	13 (12.1)	7 (9.6)	8 (8.8)	17 (19.1)		45 (12.5)
Internal medicine	6 (5.6)	8 (11.0)	7 (7.7)	8 (9.0)		29 (8.1)
Neurology	13 (12.1)	7 (9.6)	9 (9.9)	10 (11.2)		39 (10.8)
Other	28 (26.2)	14 (19.2)	14 (15.4)	21 (23.6)		77 (21.4)
Surgical						
Orthopedics	2 (1.9)	6 (8.2)	4 (4.4)	5 (5.6)		17 (4.7)
General surgery	5 (4.7)	0 (0)	0 (0)	0 (0)		5 (1.4)
Other	3 (2.8)	0 (0)	0 (0)	0 (0)		3 (0.8)
Time of day of presentation						
0:00-8:00	18 (16.5)	12 (16.2)	21 (22.1)	5 (5.6)		56 (15.3)
8:00-16:00	66 (60.6)	34 (46.0)	43 (45.3)	54 (60.7)		197 (53.7)
16:00-0:00	25 (22.9)	28 (37.8)	31 (32.6)	30 (33.7)		114 (31.0)
OARS at baseline (mean ± SD)	26.33 ±1.98	26.41 ±2.20	25.95 ±2.60	24.92 ±2.41	<0.001	25.91 ±2.36
TICS-m at baseline (mean ± SD)*	30.36 ±5.68	31.88 ±4.69	29.37 ±5.92	26.81 ±6.70	<0.001	29.53 ±6.08
Charlson (mean ± SD)	1.93 ±1.78	1.65 ±1.69	3.13 ±2.48	1.81 ±1.55	<0.001	2.14 ±1.99
APACHE II (mean ± SD)	10.99 ±3.43	10.77 ±3.37	9.48 ±3.43	8.70 ±3.17	<0.001	10.01 ±3.48
Environmental factors						
Proper lighting [a]	65 (63)	49 (75)	71 (85)	18 (22)	<0.001	203 (61)
Patient hydration						

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Fasting	10 (10)	8 (12)	11 (13)	16 (19)	0.369	45 (14)
Glass of water within reach	70 (72)	55 (85)	52 (65)	71 (86)	0.005	248 (76)
Presence of saliva[¥]	74 (76)	52 (80)	49 (60)	9 (11)	<0.001	184 (56)
Any IV Fluids	75 (77)	58 (89)	78 (95)	65 (78)	0.003	276 (84)
Physical restraints (any)[+]	78 (77)	30 (46)	1 (1)	65 (79)	<0.001	174 (53)
Medical interventions limiting movement						
Bed rest	1 (1)	1 (2)	5 (6)	0 (0,0)	0.071	7 (2)
Urinary catheter	7 (8)	5 (9)	2 (2)	2 (3)	0.217	16 (6)
O2	15 (17)	15 (26)	22 (27)	4 (6)	0.007	56 (19)
Saline-lock Catheter or IV drip	72 (84)	53 (91)	75 (92)	57 (88)	0.377	257 (88)
Other	10 (12)	8 (14)	18 (22)	6 (9)	0.125	42 (14)
Temporal orientation aid[•]	67 (63)	45 (69)	53 (63)	37 (45)	0.010	202 (60)

* Adjusted for level of education

[a] According to the research assistant

[¥] Research assistant verified if the patients had saliva under their tongue

[+] Tablet, bed rails or other

[•] Clock, watch, cell phone, calendar

CTAS: Canadian Triage Assessment Scale; OARS: Older American's Resources and Services; TICS-m: Telephone Interview for Cognitive Status-modified; APACHE II: Acute Physiological and Chronic Health Evaluation II; IV: intravenous injection;

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FIGURES LEGEND

Figure 1. Study flowchart

Figure 2. Distribution of delirium across participating sites

Figure 3. Cumulative incidence of delirium curve

Figure 4. Adjusted length of ED stay (hours)*

* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

Figure 5. Adjusted length of hospital stay (hours)*

* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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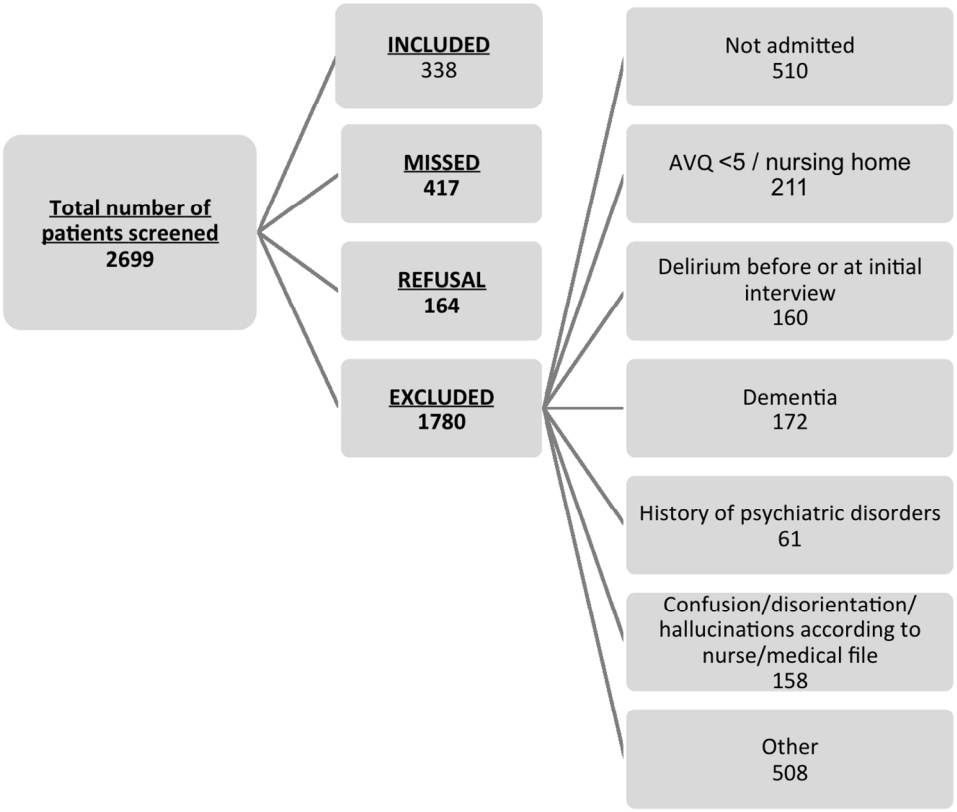

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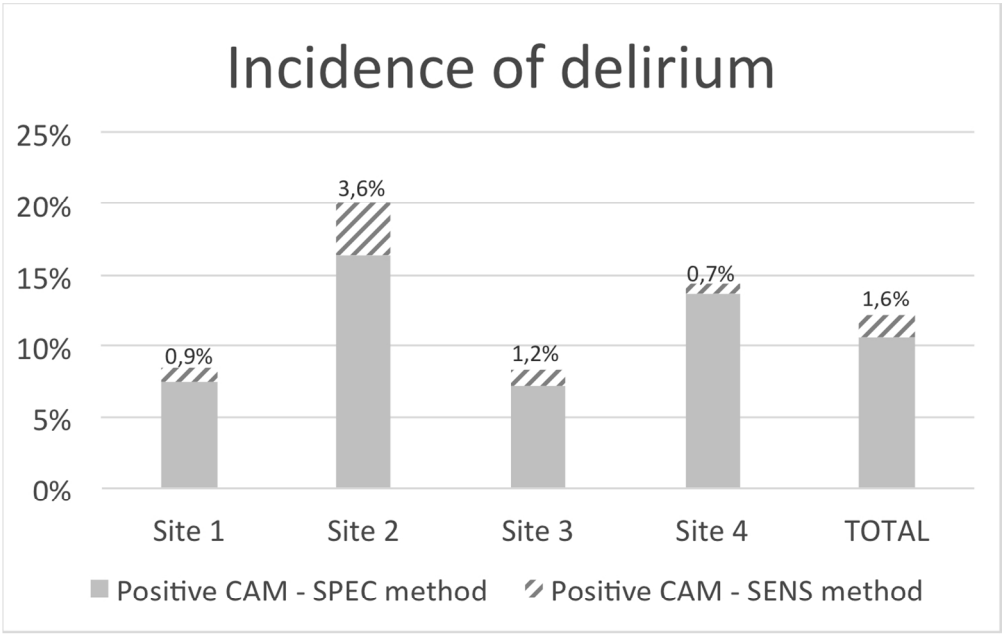

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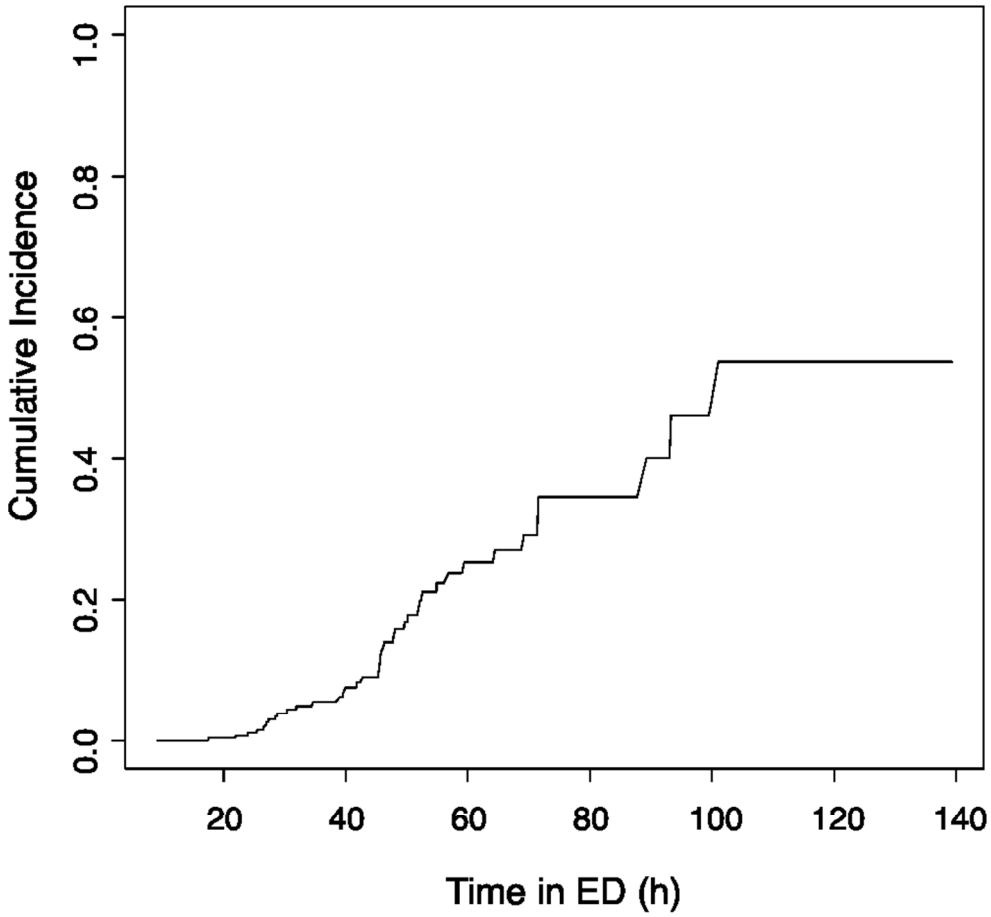
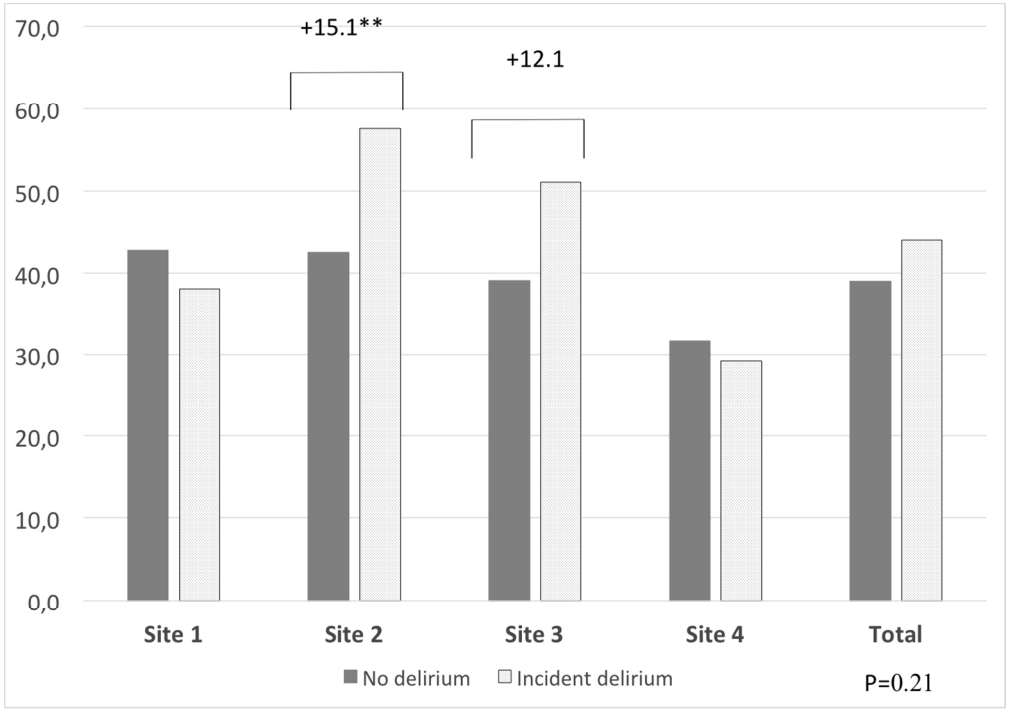

Cumulative Incidence
0.0
0.2
0.4
0.6
0.8
1.0
20
40
60
80
100
120
140
Time in ED (h)



* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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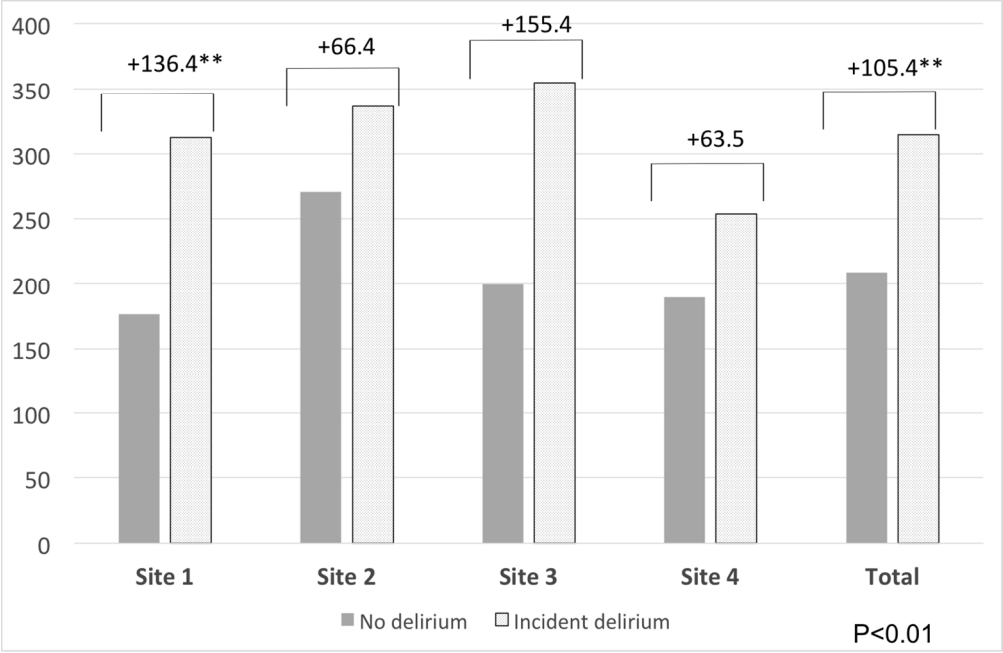

* Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7-8*
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	8
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Incidence of delirium in the Canadian Emergency Department and its consequences on hospital length of stay : a prospective observational multicentre cohort study

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Primary Subject	Emergency medicine

Heading:	
Secondary Subject Heading:	Geriatric medicine
Keywords:	Delirium, Emergency Department, Community seniors, Cognitive status, Functional status

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Incidence of delirium in the Canadian Emergency Department and its consequences on hospital length of stay : a prospective observational multicentre cohort study

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3177 words

Authors' contribution: MÉ had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. He was responsible of design, funding, conduct of the study and writing of the manuscript. VB managed the study, led the analyses and wrote the manuscript. MÉ, VB and PHC were involved in the statistical analysis, and data interpretation. MP, RD, EG and MEL were responsible for all four site recruitment. PV, SB, MM, TTMV, JL, MR, SL, NLS and LJ are all collaborator of INDEED project. PHC, MP, RD, EG, MEL, PV, SB, MM, TTMV, AN, JL, MR, SL, NLS and LJ reviewed, and approved the manuscript.

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ABSTRACT

Objective: We aim to determine the incidence of delirium and describe its impacts on hospital length of stay (LOS) among non-delirious community older adults with an 8-hour exposure to the Emergency Department (ED) environment.

Design: This is a prospective observational multicentre cohort study (March-July 2015). Patients were assessed 2x/day during their entire ED stay and up to 24 hours on hospital ward.

Setting: The study took place in 4 Canadian EDs.

Participants: 338 included patients: 1) aged ≥65; 2) who had an ED stay ≥8 hours; 3) were admitted to hospital ward; 4) were independent/semi-independent.

Main Outcome(s) and Measure(s): The primary outcomes of this study were incident delirium in the ED or within 24 h of ward admission and ED and hospital LOS. Functional and cognitive status were assessed using validated Older Americans' Resources and Services (OARS) and the Telephone Interview for Cognitive Status- modified (TICS-m) tools. The Confusion Assessment Method (CAM) was used to detect incident delirium. Univariate and multivariate analyses were conducted to evaluate outcomes.

Results: Mean age was 76.8 (± 8.1), 17.7% were aged >85 years old and 48.8% were male. The mean incidence of delirium was 12.1% (n=41). Median Interquartile range ED LOS was 32.4 (24.5–47.9) hours and hospital LOS was 146.6 (75.2-267.8) hours. Adjusted mean hospital LOS was increased by 105.4 hours (4.4 days) (95% CI: [25.1, 162.0], p< 0.001) for patients who developed an episode of delirium compared to non-delirious patient.

Conclusions: An incident delirium was observed in 1 of 8 independent/semi-independent older adults after an 8-hour ED exposure. An episode of delirium increases hospital LOS by 4 days and therefore has important implications for patients and could contribute to ED overcrowding through a deleterious feedback loop.

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Strengths and limitations of this study

- **Largest prospective study on incident delirium in the Emergency Department.**
- **A systematic screening of delirium at study entry was realized with a validated tool.**
- **Multiple patient assessments for incident delirium were conducted.**
- **Study population was limited to independent/semi-independent elders, which may limit external validity of the findings.**
- **Hospital LOS were adjusted for potential cofounders relating to geriatric care.**

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INTRODUCTION

In 2016, the youngest of the "baby-boomers" turned 50 years old and people aged 65 and older represented 18.1% of the population in Quebec.(1) It is foreseen that by 2031, the proportion of older adults aged over 65 will nearly double, with a major increase among those aged 85 and older.(2) Over the coming decades, those demographic trends will fundamentally change the make-up of the population served by Quebec Emergency Departments (ED). Older adults are already the main users of emergency health care services(3-5) and in 2012-2013, 40% of ED stretchers were occupied by patients aged over 65.(6) Furthermore, patients over 75 years of age have the highest ED visit rate of any age group and in 2012-2013 those patients occupied 25% of ED stretchers.(7, 8) Those numbers will only increase over time as the older adults population grows and this "Silver Tsunami"(9) will have major consequences on the healthcare of seniors and on our health care system in general.

Caring for older patients in the ED is particularly challenging.(10) Indeed, the time-pressure environment and high level of background noise may impede efficient communications with older patients.(11, 12) Moreover, specialized geriatric training for ED health professionals remains in its infancy(13) and they may not be as equipped as they should be to face the specific issues of older patients. All of this may contribute to the fact that older adults have higher rates of unplanned returns to the ED,(14, 15) of hospitalization,(16) falls,(17) loss of independence(18) and unrecognized delirium(19-21) following an emergency visit. Delirium is an acute brain dysfunction defined as a mental disorder of acute onset with a fluctuating course, characterized by a disturbance in consciousness, attention, orientation, memory, thought, perception and behavior.(22, 23) It is a common problem in the ED and its prevalence in older patients admitted to acute and long-term care facilities ranges between 9.6% and 89%.(21, 24-26)

In August of 2013, Inouye *et al*. published a systematic review(27) in which they found no study reporting the incidence of delirium in the ED. The same author also demonstrated that an ED stay of 12 hours or more was one of the strongest independent predictors of the onset of subsequent delirium in older patients.(28-30) This is of increasing concern, as recent ED wait times have become quite significant. Since then, a few prospective studies were conducted in order to explore the problem of ED-stay associated delirium.(30-32) To our knowledge, there are few multicenter studies aimed at describing the incidence of delirium in ED of developed countries, such as Canada. Because the literature regarding the incidence of delirium in the ED and its potential impacts on hospital length of stay (LOS), functional status and unplanned ED readmissions is scant, its consequences have yet to be clearly identified in order to orient modern acute medical care. A study by McCusker *et al*. even found that hospital stay was increased by 7.78 days for patients who developed a delirium (incident delirium) during the first 7 days of their stay.(33) The onset of such complication in the ED could influence hospital LOS and reflect back on ED crowding and older adults' use of emergency health services. The present study focused on the incidence of delirium induced by emergency department stay. Although ED-induced delirium could be affected by acute illness, comorbidities, ED crowding metrics and health care providers' ability to provide basic care known to prevent delirium, we hypothesized that the incidence of new cases of delirium among older ED patients who are admitted to hospital affects a significant proportion of community older adults, and ED-induced delirium leads to

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longer hospital LOS creating a deleterious feedback loop on ED care and operations (34). The study focused on the incident delirium because, as opposed to prevalent delirium, ED services can act in a way to prevent it.

The objective of this study was to fill a basic knowledge gap regarding the incidence of delirium and its impacts on hospital LOS for older, community independent/semi-independent, non-delirious ED patients with an 8-hour ED stay who are admitted to a hospital ward.

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METHODS

Study setting and population

This prospective multicenter study included patients who presented to one of the 4 participating Quebec EDs (two university-affiliated level 1 trauma centers and two regional hospitals) between March and July 2015. ***Inclusion criteria*** were: 1) Patients aged 65 and over; 2) Patients with an ED stay of ≥ 8 hours; 3) Patients needing and/or waiting for admission to any hospital ward; 4) Independent or semi-independent patients (able to perform 5/7 activities of daily living according to the Older Americans Resources and Services scale (OARS)). ***Exclusion criteria*** were: 1) Patient with unstable medical condition requiring admission to the psychiatric ward, intensive or palliative care units; 2) Patient who are unable to consent; 3) Patients who live (or are in transition) in a long-term care facility; 4) Patients unable to speak French or English; 5) Patients presenting a delirium before coming to the ED, upon arrival or by the end of the first 8 hours in the ED; 6) Patients with a history of psychiatric disorders (such as schizophrenia, psychotic symptoms and bipolar disorder).

Based on soon to be published new recommendations from the Direction Nationale des Urgences regarding older patients' lengths of ED stay, which should be kept under 8 hours, we choose an 8-hour exposure for our patients, as opposed to the 12-hour exposure previously determined to be a predictor of subsequent delirium (28-30). Our pragmatic approach led us to include patients who need or are awaiting admission to a hospital ward; since, Caplan *et al*. showed that patients admitted to hospital have a significantly at higher proportion of delirium than their equivalent counterparts discharged and treated with home resources.(35) Also, even if we know that delirium is more prevalent in this population, we chose to exclude patients who are not independent or semi-independent, because we were mainly interested to investigate the impact of delirium on the most robust older patients. In addition, we chose to exclude patients who were unable to consent, because assessing initial interview and follow-up with those patients would have been difficult.

Potential participants were identified using the emergency department information system. Research assistants (RAs) obtained consent and screened the participants for eligibility after their 8-hour exposure to the ED. Sociodemographic, medical and comorbidity data were collected upon initial interview. RAs also assessed patients' baseline physical, frailty and cognitive status. Patients were screened for delirium during initial interview, and twice a day (with at least 6 hours between each evaluation) during their entire ED stay and up to 24 hours after being admitted to a hospital ward. We assessed the patient up to 24h on the basis that a patient who develop a delirium let say an hour after arrival on the ward is most likely due to the 48 hours in the ED than the first hour on the ward. We kept this evaluation for possible causality purposes. Potential participants were considered as "missed" when they was no RA on-site for the recruitment. RAs were on site for the screening of patients about 12 hours a day, 7 days a week.

Measures

Patients' frailty and physical status were assessed using respectively the Clinical Frailty Scale (CFS) (36) and the Older Americans Resources and Services scale (OARS)(37),while the

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Telephone Interview for Cognitive Status-modified (TICS-m),(38) the Confusion Assessment Method (CAM) (39) and the Delirium Index (40), were used to assess cognitive status. Other information on medications, comorbidities (Charlson comorbidity risk index) (41), severity of illness (Acute Physiological and Chronic Health Evaluation II (APACHE II) (42) and ED environment evaluation were collected in addition to sociodemographic data.

The CAM is the most commonly used tool for the detection of delirium with its sensitivity ranging between 34% and 58% and its specificity between 89% and 94% when performed by a research assistant. However, even if this sensitivity seems low, it has been shown that when the CAM is administered several times during a shift, it is more sensitive than a diagnosis made by a psychiatrist.(43) There are two existing interpretation methods to the CAM scores: the sensitive (SENS) and the specific (SPEC) methods.(44) A patient has delirium according to the SENS method if they: had either an acute onset or a fluctuation in any of the items evaluated in the CAM, inattention and either disorganized thinking or altered state of consciousness.(25) The SENS method was used to ascertain delirium in this study. Because of the fluctuating nature of delirium, patients were systematically assessed with the CAM and the Delirium Index (a validated tool used to measure the severity of delirium) (40) twice a day during their entire ED stay. Furthermore, the CAM was used over a 24-hour period following transfer to the hospital ward. ED and ward nurses and doctors were blinded to the study's objectives in order to avoid them changing their practice. The TICS-m was used to assess baseline cognitive status of our study participants.(45) ED environmental information, such as presence of proper lighting (according to the RAs), patient's hydration, presence of physical restraints or medical interventions limiting movement at initial interview and presence of a family member or a friend at initial interview was also recorded by RAs. ED LOS was recorded from administrative databases. ED LOS was measured from the date and time of triage up to the date and time when the patients were physically transferred to the hospital ward.

Each site's team of RAs received standardized training by an experienced member of the mentoring team of the *Centre d'Excellence sur le Vieillissement de Québec(46)*, who also specializes in the administration of the CAM. They also attended a group training session conducted by the study coordinator and an experienced research nurse and underwent a 5-hour personalized field training. They were also provided with a detailed training manual. Inter-rater reliability was assessed during patient follow-ups at the coordinating site to ensure that the test was administered in a standardized manner.

In order to be sure that the missed patients were similar to our participants, basic clinical and demographic data were collected on those missed patients. The incidence of delirium was also collected for those patients in their medical file, as reported by the ED medical staff..

Outcomes

Incident delirium was the main outcome of this study, hospital LOS was our secondary outcome. Incident delirium was defined by a delirium who occurred either in the ED or in the first 24 hours of the hospital stay. The CAM was administrated during the initial interview ensuring that the patient was not already delirious after the first 8 hours of their ED stay. Hospital LOS was

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measured from ED triage up to the date and time of hospital discharge. Hospital LOS was compared between patients with a positive CAM and those with a negative CAM for each site.

Statistical analyses

Descriptive statistics were computed on patient characteristics and measured outcomes. Cumulative incidence rates for delirium were estimated using Kaplan-Meier curves. Hospital LOS is compared in patients with and without incident delirium in the various sites using multiple linear regression, adjusting for ED LOS, APACHE, Charlson, OARS, age and TICS-m. Site and its interaction with incident delirium is treated as a fixed factor. TICS-m scores were adjusted for patients' level of education. Kappa statistics were computed to measure inter-rater reliability of the CAM. Based on an alpha of 5%, 138 patients would allow 80% power for an estimated overall incidence proportion of 15 % with 5% precision. Analyses were performed using SAS, version 9.4 (SAS Institute, Inc., Cary, NC).

The Comité d'éthique du CHU de Québec acted as the centralized research ethics board and approved this study (project # MP-20-2015-2130). Written consent was obtained for each study participant. Patient records/information were anonymized prior to analysis.

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RESULTS

Population

A total of 2699 patients were screened by research assistants across our 4 sites (figure 1). Of those, 1780 did not meet our inclusion criteria or had one of our exclusion criteria, 417 were missed and 164 refused to participate to the study. This leaves us with a sample of 338 patients (12.5%). Females represented 51.2% of our population and mean age was 76.8 (±8.09) (table 1).

A sample analysis of patients who were missed revealed that they had a similar profile to that of those who were included in our study. 54.9% were female, with a mean age of 77.4 (±9.4) years old. The mean Charlson Comorbidity Score was 1.7 (±1.7), 36.7% were considered level 1 or 2 on the Canadian Triage Assessment Scale (CTAS) and 38% were level 3. The medical notes revealed only one case of incident delirium within 24 hours of triage for this group of patients. Table 1 provides details on sociodemographic and environmental variables.

Incidence of delirium

In our cohort, we found that the overall incidence of delirium was 12.1% (n=41) using the SENS method, overall incidence and its distribution across sites are provided in figure 2. Fourteen cases occurred in the ED, while 27 cases occurred on the ward. Our results indicate that the delirium incidence rate was 2.9 cases per 1000 patient-hours. Figure 3 shows a cumulative incidence of delirium curve. Median ED LOS before developing a delirium was 45.2 h (38.0-52.5). Inter-rater agreements were performed at the coordinating site on 12% of the site's participants. A perfect agreement was obtained regarding the incidence of delirium, and agreement for each of the CAM items had Kappa ranging between 0.63 and 1.0.

Hospital length of stay

Median (IQR) hospital LOS was 146.6 (75.2-267.8) hours. On average, adjusted hospital LOS was 209 hours (8.7 days) for non-delirious participants while patients who were found to have incident delirium had a 314.4-hour (13.1 days) hospital stay. The hospital LOS for each site are shown in Figure 4. Mean hospital adjusted LOS was significantly increased by 105.4 hours (4.4 days) in the delirious patients compared to non-delirious patient (p=0.003).

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DISCUSSION

Our study is, to our knowledge, the first large Canadian prospective study aiming to determine the incidence of delirium induced by ED stay in older patients and then to analyze its impacts on the length of in-hospital stay. We found a 12.1% incidence for delirium in our cohort of 338 older patients. Our study determined that there was a statistically significant association between incident delirium and hospital LOS, which was increased by 4.4 days in patients with incident delirium. A statistically non-significant increase of 5.0 hours was also found in the average ED LOS between those 2 groups, but this increase is of clinical importance for patient care.

Our results confirm the clinical importance of incident delirium in acute medicine care. A previous Canadian retrospective study was conducted by our team(47) using a chart-based CAM,(48) in which an 18% incidence of delirium was found in 200 patients medical charts. Half of those patients developed a delirium within 36 hours of arrival to the ED. It was shown previously that in prevalent delirious older ED patients that delirium is a predictor of prolonged hospital LOS (31). With our results, we confirm that incident delirium also has such result. However, contrary to prevalent delirium, it is possible to change the interventions in hospital to prevent this episode that has been shown to influence hospital LOS and long-term function and cognition (49).

In 2011, the Ministère de la Santé et des Services Sociaux has published its provincial guide "Approche adaptée à la personne âgée en milieu hospitalier",(50) a senior-friendly initiative which aimed to better address the in-hospital care of elders. This initiative stresses the importance of keeping lengths of stay as short as possible for older adults and presents various methods to prevent delirium. Every hospital in the province has implemented these guidelines at different levels. However, our results show that over 4 years post-implementation, ED lengths of stay for older patients are still quite significant in Quebec, increasing their risk of developing delirium according to previous studies. Our results also clearly confirm the fact that patients with incident delirium have longer hospital length of stay, making them more at risk for further complications. We also recorded an important difference in incident delirium across the 4 study sites, varying from 8.3% to 20%. Although inter-site comparisons were not powered by our sample size, many factors could have explained this difference. The different level of implementation of the provincial senior-friendly guidelines at each site could be a possible cause.

Our study has some limitations. Our high rate of missed patients is mainly due to logistic constraints. However, after comparing the socio-demographic characteristics and comorbidities, we have found no significant difference between patients who were included and those who were missed. Furthermore, including those missed patients would likely have reinforced our results, resulting in higher delirium rates and longer ED and hospital LOS. Therefore, we believe the likelihood of selection bias is low. Because we have chosen to exclude patients with moderate to severe dementia, those who lived in long-term nursing homes, those with pre-existing psychological conditions and patients who had a lesser functional level, our cohort represents only a portion of the older adults population usually seen in the ED and may not be generalizable to all elders. We have made this decision because we were mainly interested to investigate the impact of delirium on the most robust older patients. The CAM was administered by different

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research assistants, and therefore this might have underestimated or overestimated the frequency of an acute onset of a new symptom. Misclassification of delirium may have occurred as we excluded patient with delirium using a single first initial assessment with CAM, this pragmatic approach was used to ensure feasibility of the study. This may have introduced an interviewer bias; however, this situation is not any different from real-life clinical practice. We tried to decrease this potential bias by providing research assistants with standardized training, which was proven effective given our good inter-observer agreement. The study coordinator also reviewed every single research file to ensure completeness.

This study aimed at assessing the present situation in our Canadian EDs regarding the incidence of delirium induced by a prolonged ED-stay in independent and semi-independent older patients. The high incidence rate and increased hospital LOS are alarming and could have substantial consequences for the patient and for our health care system in general. Delirium itself is an economic burden in the United States as it is estimated to 152$ billion per year.(31)

An interesting solution to this issue might be the use of a short triage tool aiming to identify patients more at risk of developing a delirium during their ED stay. Delaney *et al*. found that implementing an alert into the EMR system for triage nurses to screen every patient over 65 years old for delirium helped ED nurses better identify 23% of patients as potentially positive for delirium.(32) However, more research is needed in order to identify an appropriate tool to be used by triage nurses.

Briefly, a 12.1% incidence for delirium was found in 4 Canadian EDs. Developing delirium increases hospital stay by 4.4, with the impact it can have on our health system.

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Conflicts of interest: None

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TABLES

Table 1. Description of the study population

	Site 1 n(%)	Site 2 n(%)	Site 3 n(%)	Site 4 n(%)	Site comparison p-value	Total
Age						
65-74 y/o	61 (57)	21 (32)	38 (45)	35 (42)		155 (46)
75-84 y/o	36 (34)	23 (35)	35 (42)	29 (35)	0.001	123 (36)
≥85 y/o	9 (9)	21 (32)	11 (13)	19 (23)		60 (18)
Sex						
Female	53 (50)	37 (57)	39 (46)	44 (53)	0.618	173 (51)
CTAS						
1 & 2	39 (37)	25 (38)	25 (30)	18 (22)		107 (31,7)
3	47 (44)	28 (43)	43 (51)	37 (45)	0.076	155 (45,9)
4 & 5	20 (19)	12 (18)	16 (19)	28 (34)		76 (22,5)
Admission diagnostic						
Medical						
Cardiology	15 (14.0)	16 (21.9)	23 (25.2)	16 (18.0)		70 (19.4)
Pneumonology	22 (20.6)	15 (20.5)	26 (28.6)	12 (13.5)		75 (20.8)
Gastroenterology	13 (12.1)	7 (9.6)	8 (8.8)	17 (19.1)		45 (12.5)
Internal medicine	6 (5.6)	8 (11.0)	7 (7.7)	8 (9.0)		29 (8.1)
Neurology	13 (12.1)	7 (9.6)	9 (9.9)	10 (11.2)		39 (10.8)
Other	28 (26.2)	14 (19.2)	14 (15.4)	21 (23.6)		77 (21.4)
Surgical						
Orthopedics	2 (1.9)	6 (8.2)	4 (4.4)	5 (5.6)		17 (4.7)
General surgery	5 (4.7)	0 (0)	0 (0)	0 (0)		5 (1.4)
Other	3 (2.8)	0 (0)	0 (0)	0 (0)		3 (0.8)
Time of day of presentation						
0:00-8:00	18 (16.5)	12 (16.2)	21 (22.1)	5 (5.6)		56 (15.3)
8:00-16:00	66 (60.6)	34 (46.0)	43 (45.3)	54 (60.7)		197 (53.7)
16:00-0:00	25 (22.9)	28 (37.8)	31 (32.6)	30 (33.7)		114 (31.0)
OARS at baseline (mean ± SD)	26.33 ±1.98	26.41 ±2.20	25.95 ±2.60	24.92 ±2.41	<0.001	25.91 ±2.36
TICS-m at baseline (mean ± SD)*	30.36 ±5.68	31.88 ±4.69	29.37 ±5.92	26.81 ±6.70	<0.001	29.53 ±6.08
Charlson (mean ± SD)	1.93 ±1.78	1.65 ±1.69	3.13 ±2.48	1.81 ±1.55	<0.001	2.14 ±1.99
APACHE II (mean ± SD)	10.99 ±3.43	10.77 ±3.37	9.48 ±3.43	8.70 ±3.17	<0.001	10.01 ±3.48
Environmental factors						
Proper lighting [a]	65 (63)	49 (75)	71 (85)	18 (22)	<0.001	203 (61)
Patient hydration						
Fasting	10 (10)	8 (12)	11 (13)	16 (19)	0.369	45 (14)

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Glass of water within reach	70 (72)	55 (85)	52 (65)	71 (86)	0.005	248 (76)
Presence of saliva[¥]	74 (76)	52 (80)	49 (60)	9 (11)	<0.001	184 (56)
Any IV Fluids	75 (77)	58 (89)	78 (95)	65 (78)	0.003	276 (84)
Physical restraints (any)[+]	78 (77)	30 (46)	1 (1)	65 (79)	<0.001	174 (53)
Medical interventions limiting movement						
Bed rest	1 (1)	1 (2)	5 (6)	0 (0,0)	0.071	7 (2)
Urinary catheter	7 (8)	5 (9)	2 (2)	2 (3)	0.217	16 (6)
O2	15 (17)	15 (26)	22 (27)	4 (6)	0.007	56 (19)
Saline-lock Catheter or IV drip	72 (84)	53 (91)	75 (92)	57 (88)	0.377	257 (88)
Other	10 (12)	8 (14)	18 (22)	6 (9)	0.125	42 (14)
Temporal orientation aid[•]	67 (63)	45 (69)	53 (63)	37 (45)	0.010	202 (60)

* Adjusted for level of education

[a] According to the research assistant

[¥] Research assistant verified if the patients had saliva under their tongue

[+] Tablet, bed rails or other

[•] Clock, watch, cell phone, calendar

CTAS: Canadian Triage Assessment Scale; OARS: Older American's Resources and Services; TICS-m: Telephone Interview for Cognitive Status-modified; APACHE II: Acute Physiological and Chronic Health Evaluation II; IV: intravenous injection;

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FIGURES LEGEND

Figure 1. Study flowchart

Figure 2. Distribution of delirium across participating sites

Figure 3. Cumulative incidence of delirium curve

Figure 4. Adjusted length of hospital stay (hours)*

* Length of stay was adjusted for ED LOS, site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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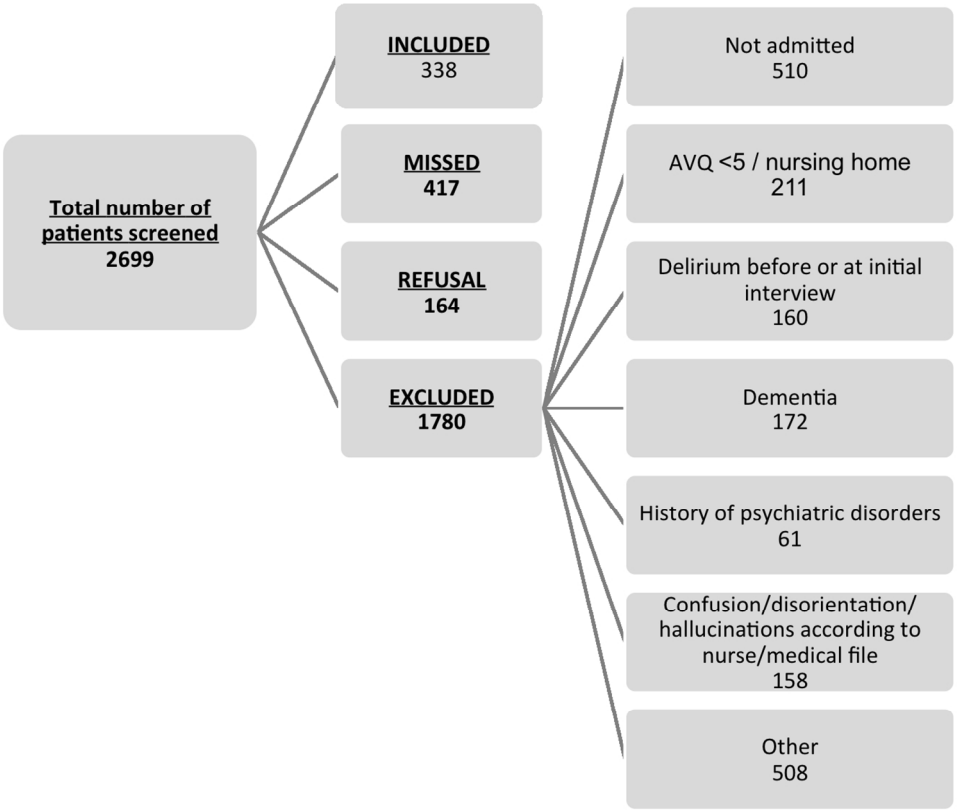

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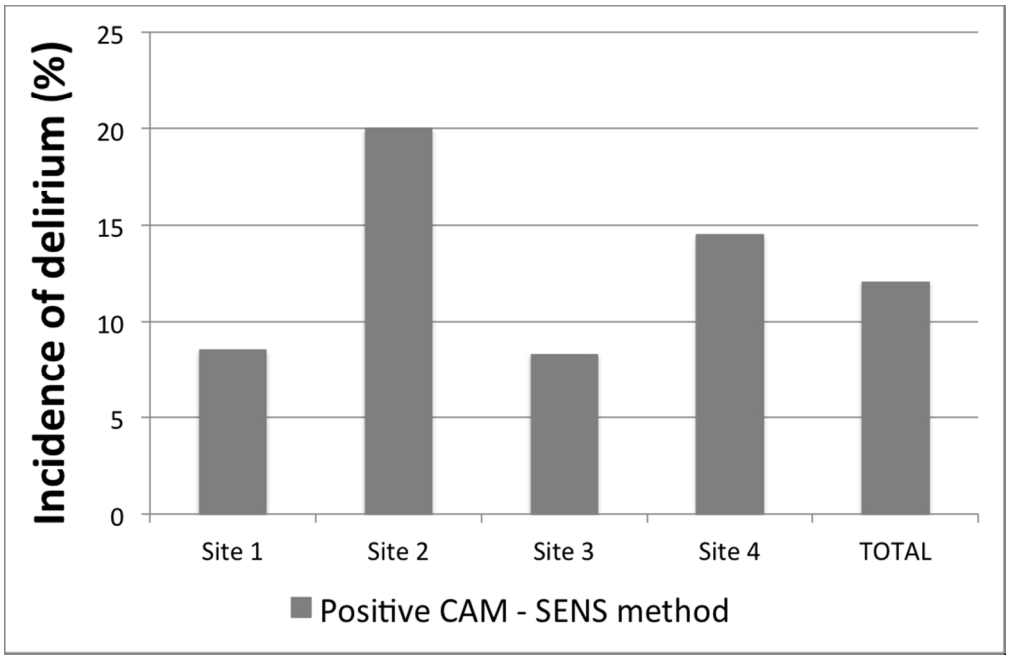
Incidence of delirium (%)
25
20
15
10
5
0
Site 1
Site 2
Site 3
Site 4
TOTAL
Positive CAM - SENS method

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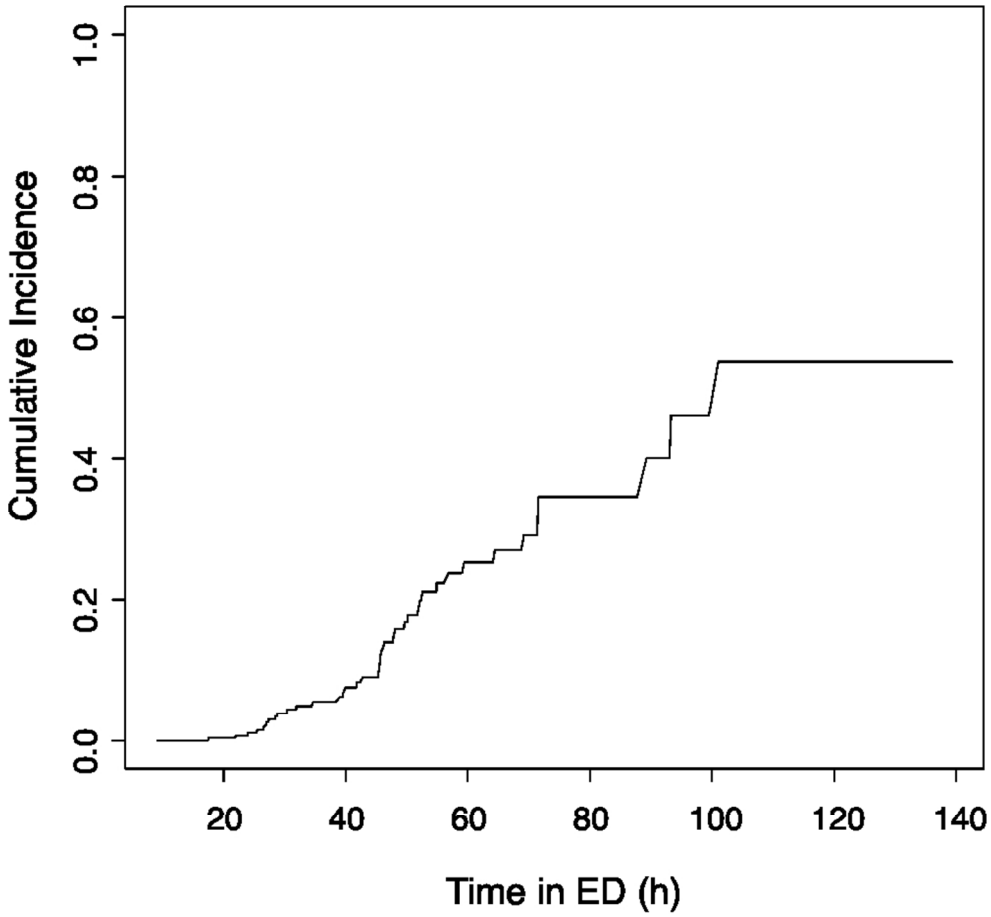
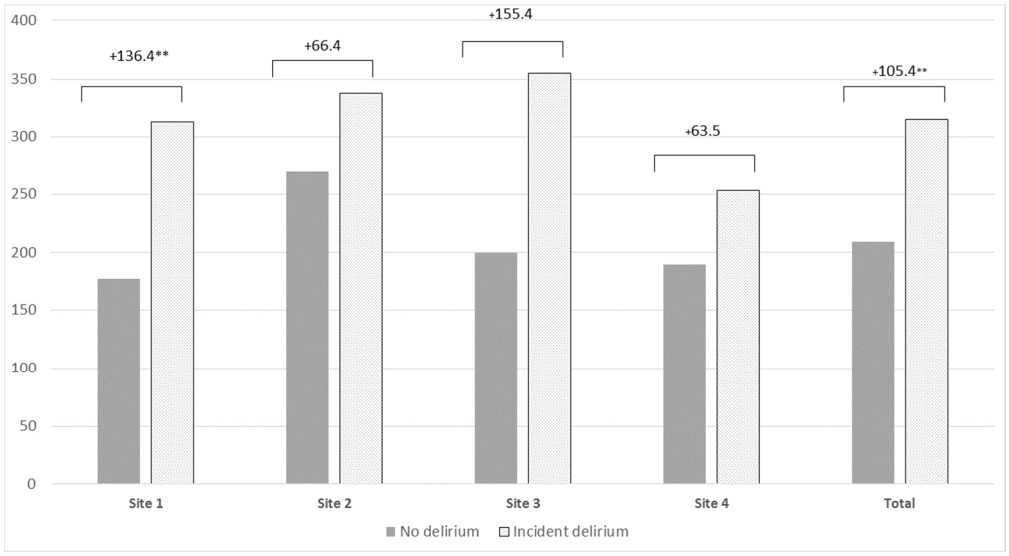

Cumulative Incidence
0.0
0.2
0.4
0.6
0.8
1.0
20
40
60
80
100
120
140
Time in ED (h)



Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7-8*
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	8
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Incidence of delirium in the Canadian Emergency Department and its consequences on hospital length of stay : a prospective observational multicentre cohort study

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Primary Subject	Emergency medicine

Heading:	
Secondary Subject Heading:	Geriatric medicine
Keywords:	Delirium, Emergency Department, Community seniors, Cognitive status, Functional status

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Incidence of delirium in the Canadian Emergency Department and its consequences on hospital length of stay : a prospective observational multicentre cohort study

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3177 words

Authors' contribution: MÉ had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. He was responsible for design, funding, conduct of the study and writing of the manuscript. VB managed the study, led the analyses and wrote the manuscript. MÉ, VB and PHC were involved in the statistical analysis, and data interpretation. MP, RD, EG and MEL were responsible for recruitment at all four sites. PV, SB, MM, TTMV, JL, MR, SL, NLS and LJ are all collaborators of INDEED project. PHC, MP, RD, EG, MEL, PV, SB, MM, TTMV, AN, JL, MR, SL, NLS and LJ reviewed and approved the manuscript.

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ABSTRACT

Objective: We aim to determine the incidence of delirium and describe its impacts on hospital length of stay (LOS) among non-delirious community dwelling older adults with an 8-hour exposure to the Emergency Department (ED) environment.

Design: This is a prospective observational multicentre cohort study (March-July 2015). Patients were assessed 2x/day during their entire ED stay and up to 24 hours on hospital ward.

Setting: The study took place in 4 Canadian EDs.

Participants: 338 included patients: 1) aged ≥65; 2) who had an ED stay ≥8 hours; 3) were admitted to hospital ward; 4) were independent/semi-independent.

Main Outcome(s) and Measure(s): The primary outcomes of this study were incident delirium in the ED or within 24 h of ward admission and ED and hospital LOS. Functional and cognitive status were assessed using validated Older Americans' Resources and Services (OARS) and the Telephone Interview for Cognitive Status- modified (TICS-m) tools. The Confusion Assessment Method (CAM) was used to detect incident delirium. Univariate and multivariate analyses were conducted to evaluate outcomes.

Results: Mean age was 76.8 (± 8.1), 17.7% were aged >85 years old and 48.8% were male. The mean incidence of delirium was 12.1% (n=41). Median Interquartile range ED LOS was 32.4 (24.5–47.9) hours and hospital LOS was 146.6 (75.2-267.8) hours. Adjusted mean hospital LOS was increased by 105.4 hours (4.4 days) (95% CI: [25.1, 162.0], p< 0.001) for patients who developed an episode of delirium compared to non-delirious patient.

Conclusions: An incident delirium was observed in 1 of 8 independent/semi-independent older adults after an 8-hour ED exposure. An episode of delirium increases hospital LOS by 4 days and therefore has important implications for patients and could contribute to ED overcrowding through a deleterious feedback loop.

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Strengths and limitations of this study

- **Largest prospective study on incident delirium in the Emergency Department.**
- **A systematic screening of delirium at study entry was realized with a validated tool.**
- **Multiple patient assessments for incident delirium were conducted.**
- **Study population was limited to independent/semi-independent elders, which may limit external validity of the findings.**
- **Hospital LOS were adjusted for potential cofounders relating to geriatric care.**

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INTRODUCTION

In 2016, the youngest of the "baby-boomers" turned 50 years old and people aged 65 and older represented 18.1% of the population in Quebec.(1) It is foreseen that by 2031, the proportion of older adults aged over 65 will nearly double, with a major increase among those aged 85 and older.(2) Over the coming decades, those demographic trends will fundamentally change the make-up of the population served by Quebec Emergency Departments (ED). Older adults are already the main users of emergency health care services(3-5) and in 2012-2013, 40% of ED stretchers were occupied by patients aged over 65.(6) Furthermore, patients over 75 years of age have the highest ED visit rate of any age group and in 2012-2013 those patients occupied 25% of ED stretchers.(7, 8) Those numbers will only increase over time as the older adults population grows and this "Silver Tsunami"(9) will have major consequences on the healthcare of seniors and on our health care system in general.

Caring for older patients in the ED is particularly challenging.(10) Indeed, the time-pressure environment and high level of background noise may impede efficient communications with older patients.(11, 12) Moreover, specialized geriatric training for ED health professionals remains in its infancy(13) and they may not be as equipped as they should be to face the specific issues of older patients. All of this may contribute to the fact that older adults have higher rates of unplanned returns to the ED,(14, 15) of hospitalization,(16) falls,(17) loss of independence(18) and unrecognized delirium(19-21) following an emergency visit. Delirium is an acute brain dysfunction defined as a mental disorder of acute onset with a fluctuating course, characterized by a disturbance in consciousness, attention, orientation, memory, thought, perception and behavior.(22, 23) It is a common problem in the ED and its prevalence in older patients admitted to acute and long-term care facilities ranges between 9.6% and 89%.(21, 24-26)

In August of 2013, Inouye *et al*. published a systematic review(27) in which they found no study reporting the incidence of delirium in the ED. The same author also demonstrated that an ED stay of 12 hours or more was one of the strongest independent predictors of the onset of subsequent delirium in older patients.(28-30) This is of increasing concern, as recent ED wait times have become quite significant. Since then, a few prospective studies were conducted in order to explore the problem of ED-stay associated delirium.(30-32) To our knowledge, there are few multicenter studies aimed at describing the incidence of delirium in ED of developed countries, such as Canada. Because the literature regarding the incidence of delirium in the ED and its potential impacts on hospital length of stay (LOS), functional status and unplanned ED readmissions is scant, its consequences have yet to be clearly identified in order to orient modern acute medical care. A study by McCusker *et al*. even found that hospital stay was increased by 7.78 days for patients who developed a delirium (incident delirium) during the first 7 days of their stay.(33) The onset of such complication in the ED could influence hospital LOS and reflect back on ED crowding and older adults' use of emergency health services. The present study focused on the incidence of delirium induced by emergency department stay. Although ED-induced delirium could be affected by acute illness, comorbidities, ED crowding metrics and health care providers' ability to provide basic care known to prevent delirium, we hypothesized that the incidence of new cases of delirium among older ED patients who are admitted to hospital affects a significant proportion of community older adults, and ED-induced delirium leads to

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longer hospital LOS creating a deleterious feedback loop on ED care and operations (34). The study focused on the incident delirium because, as opposed to prevalent delirium, ED services can act in a way to prevent it.

The objective of this study was to fill a basic knowledge gap regarding the incidence of delirium and its impacts on hospital LOS for older, community independent/semi-independent, non-delirious ED patients with an 8-hour ED stay who are admitted to a hospital ward.

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METHODS

Study setting and population

This prospective multicenter study included patients who presented to one of the 4 participating Quebec EDs (two university-affiliated level 1 trauma centers and two regional hospitals) between March and July 2015. ***Inclusion criteria*** were: 1) Patients aged 65 and over; 2) Patients with an ED stay of ≥ 8 hours; 3) Patients needing and/or waiting for admission to any hospital ward; 4) Independent or semi-independent patients (able to perform 5/7 activities of daily living according to the Older Americans Resources and Services scale (OARS)). ***Exclusion criteria*** were: 1) Patient with unstable medical condition requiring admission to the psychiatric ward, intensive or palliative care units; 2) Patient who are unable to consent; 3) Patients who live (or are in transition) in a long-term care facility; 4) Patients unable to speak French or English; 5) Patients presenting a delirium before coming to the ED, upon arrival or by the end of the first 8 hours in the ED; 6) Patients with a history of psychiatric disorders (such as schizophrenia, psychotic symptoms and bipolar disorder).

Based on soon to be published new recommendations from the Direction Nationale des Urgences regarding older patients' lengths of ED stay, which should be kept under 8 hours, we choose an 8-hour exposure for our patients, as opposed to the 12-hour exposure previously determined to be a predictor of subsequent delirium (28-30). Our pragmatic approach led us to include patients who need or are awaiting admission to a hospital ward; since, Caplan *et al*. showed that patients admitted to hospital have a significantly at higher proportion of delirium than their equivalent counterparts discharged and treated with home resources.(35) Also, even if we know that delirium is more prevalent in this population, we chose to exclude patients who are not independent or semi-independent, because we were mainly interested to investigate the impact of delirium on the most robust older patients. In addition, we chose to exclude patients who were unable to consent, because assessing initial interview and follow-up with those patients would have been difficult.

Potential participants were identified using the emergency department information system. Research assistants (RAs) obtained consent and screened the participants for eligibility after their 8-hour exposure to the ED. Sociodemographic, medical and comorbidity data were collected upon initial interview. RAs also assessed patients' baseline physical, frailty and cognitive status. Patients were screened for delirium during initial interview, and twice a day (with at least 6 hours between each evaluation) during their entire ED stay and up to 24 hours after being admitted to a hospital ward. We assessed the patient up to 24h on the basis that a patient who develop a delirium let say an hour after arrival on the ward is most likely due to the 48 hours in the ED than the first hour on the ward. We kept this evaluation for possible causality purposes. Potential participants were considered as "missed" when they was no RA on-site for the recruitment. RAs were on site for the screening of patients about 12 hours a day, 7 days a week.

Measures

Patients' frailty and physical status were assessed using respectively the Clinical Frailty Scale (CFS) (36) and the Older Americans Resources and Services scale (OARS)(37),while the

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Telephone Interview for Cognitive Status-modified (TICS-m),(38) the Confusion Assessment Method (CAM) (39) and the Delirium Index (40), were used to assess cognitive status. Other information on medications, comorbidities (Charlson comorbidity risk index) (41), severity of illness (Acute Physiological and Chronic Health Evaluation II (APACHE II) (42) and ED environment evaluation were collected in addition to sociodemographic data.

The CAM is the most commonly used tool for the detection of delirium with its sensitivity ranging between 34% and 58% and its specificity between 89% and 94% when performed by a research assistant. However, even if this sensitivity seems low, it has been shown that when the CAM is administered several times during a shift, it is more sensitive than a diagnosis made by a psychiatrist.(43) There are two existing interpretation methods to the CAM scores: the sensitive (SENS) and the specific (SPEC) methods.(44) A patient has delirium according to the SENS method if they: had either an acute onset or a fluctuation in any of the items evaluated in the CAM, inattention and either disorganized thinking or altered state of consciousness.(25) The SENS method was used to ascertain delirium in this study. Because of the fluctuating nature of delirium, patients were systematically assessed with the CAM and the Delirium Index (a validated tool used to measure the severity of delirium) (40) twice a day during their entire ED stay. Furthermore, the CAM was used over a 24-hour period following transfer to the hospital ward. ED and ward nurses and doctors were blinded to the study's objectives in order to avoid them changing their practice. The TICS-m was used to assess baseline cognitive status of our study participants.(45) ED environmental information, such as presence of proper lighting (according to the RAs), patient's hydration, presence of physical restraints or medical interventions limiting movement at initial interview and presence of a family member or a friend at initial interview was also recorded by RAs. ED LOS was measured from the date and time of triage up to the date and time when the patients were physically transferred to the hospital ward.

Each site's team of RAs received standardized training by an experienced member of the mentoring team of the *Centre d'Excellence sur le Vieillissement de Québec(46)*, who also specializes in the administration of the CAM. They also attended a group training session conducted by the study coordinator and an experienced research nurse and underwent a 5-hour personalized field training. They were also provided with a detailed training manual. Inter-rater reliability was assessed during patient follow-ups at the coordinating site to ensure that the test was administered in a standardized manner.

In order to be sure that the missed patients were similar to our participants, basic clinical and demographic data were collected on those missed patients. The incidence of delirium was also collected for those patients in their medical file, as reported by the ED medical staff.

Outcomes

Incident delirium was the main outcome of this study, hospital LOS was our secondary outcome. Incident delirium was defined by a delirium who occurred either in the ED or in the first 24 hours of the hospital stay. The CAM was administrated during the initial interview ensuring that the patient was not already delirious after the first 8 hours of their ED stay.

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Hospital LOS was also measured from ED triage up to the date and time of hospital discharge. Hospital LOS was compared between patients with a positive CAM and those with a negative CAM for each site.

Statistical analyses

Descriptive statistics were computed on patient characteristics and measured outcomes. Cumulative incidence rates for delirium were estimated using Kaplan-Meier curves. Hospital LOS is compared in patients with and without incident delirium in the various sites using multiple linear regression, adjusting for ED LOS, APACHE, Charlson, OARS, age and TICS-m. Site and its interaction with incident delirium is treated as a fixed factor. TICS-m scores were adjusted for patients' level of education. Kappa statistics were computed to measure inter-rater reliability of the CAM. Based on an alpha of 5%, 138 patients would allow 80% power for an estimated overall incidence proportion of 15 % with 5% precision. Analyses were performed using SAS, version 9.4 (SAS Institute, Inc., Cary, NC).

The Comité d'éthique du CHU de Québec acted as the centralized research ethics board and approved this study (project # MP-20-2015-2130). Written consent was obtained for each study participant. Patient records/information were anonymized prior to analysis.

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RESULTS

Population

A total of 2699 patients were screened by research assistants across our 4 sites (figure 1). Of those, 1780 did not meet our inclusion criteria or had one of our exclusion criteria, 417 were missed and 164 refused to participate to the study. This leaves us with a sample of 338 patients (12.5%). Females represented 51.2% of our population and mean age was 76.8 (±8.09) (table 1).

A sample analysis of patients who were missed revealed that they had a similar profile to that of those who were included in our study. 54.9% were female, with a mean age of 77.4 (±9.4) years old. The mean Charlson Comorbidity Score was 1.7 (±1.7), 36.7% were considered level 1 or 2 on the Canadian Triage Assessment Scale (CTAS) and 38% were level 3. The medical notes revealed only one case of incident delirium within 24 hours of triage for this group of patients. Table 1 provides details on sociodemographic and environmental variables.

Incidence of delirium

In our cohort, we found that the overall incidence of delirium was 12.1% (n=41) using the SENS method, overall incidence and its distribution across sites are provided in figure 2. Fourteen cases occurred in the ED, while 27 cases occurred on the ward. Our results indicate that the delirium incidence rate was 2.9 cases per 1000 patient-hours. Figure 3 shows a cumulative incidence of delirium curve. Median ED LOS before developing a delirium was 45.2 h (38.0-52.5). Inter-rater agreements were performed at the coordinating site on 12% of the site's participants. A perfect agreement was obtained regarding the incidence of delirium, and agreement for each of the CAM items had Kappa ranging between 0.63 and 1.0.

Hospital length of stay

Median (IQR) hospital LOS was 146.6 (75.2-267.8) hours. On average, adjusted hospital LOS was 209 hours (8.7 days) for non-delirious participants while patients who were found to have incident delirium had a 314.4-hour (13.1 days) hospital stay. The hospital LOS for each site are shown in Figure 4. Mean hospital adjusted LOS was significantly increased by 105.4 hours (4.4 days) in the delirious patients compared to non-delirious patient (p=0.003).

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DISCUSSION

Our study is, to our knowledge, the first large Canadian prospective study aiming to determine the incidence of delirium induced by ED stay in older patients and then to analyze its impacts on the length of in-hospital stay. We found a 12.1% incidence for delirium in our cohort of 338 older patients. Our study determined that there was a statistically significant association between incident delirium and hospital LOS, which was increased by 4.4 days in patients with incident delirium.

Our results confirm the clinical importance of incident delirium in acute medicine care. A previous Canadian retrospective study was conducted by our team(47) using a chart-based CAM,(48) in which an 18% incidence of delirium was found in 200 patients medical charts. Half of those patients developed a delirium within 36 hours of arrival to the ED. It was shown previously that in prevalent delirious older ED patients that delirium is a predictor of prolonged hospital LOS (31). With our results, we confirm that incident delirium also has such result. However, contrary to prevalent delirium, it is possible to change the interventions in hospital to prevent this episode that has been shown to influence hospital LOS and long-term function and cognition (49).

In 2011, the Ministère de la Santé et des Services Sociaux has published its provincial guide "Approche adaptée à la personne âgée en milieu hospitalier",(50) a senior-friendly initiative which aimed to better address the in-hospital care of elders. This initiative stresses the importance of keeping lengths of stay as short as possible for older adults and presents various methods to prevent delirium. Every hospital in the province has implemented these guidelines at different levels. However, our results show that over 4 years post-implementation, ED lengths of stay for older patients are still quite significant in Quebec, increasing their risk of developing delirium according to previous studies. Our results also clearly confirm the fact that patients with incident delirium have longer hospital length of stay, making them more at risk for further complications. We also recorded an important difference in incident delirium across the 4 study sites, varying from 8.3% to 20%. Although inter-site comparisons were not powered by our sample size, many factors could have explained this difference. The different level of implementation of the provincial senior-friendly guidelines at each site could be a possible cause.

This study aimed at assessing the present situation in our Canadian EDs regarding the incidence of delirium induced by a prolonged ED-stay in independent and semi-independent older patients. The high incidence rate and increased hospital LOS are alarming and could have substantial consequences for the patient and for our health care system in general. Delirium itself is an economic burden in the United States as it is estimated to 152$ billion per year.(31)

An interesting solution to this issue might be the use of a short triage tool aiming to identify patients more at risk of developing a delirium during their ED stay. Delaney *et al*. found that implementing an alert into the EMR system for triage nurses to screen every patient over 65 years old for delirium helped ED nurses better identify 23% of patients as potentially positive for delirium.(32) However, more research is needed in order to identify an appropriate tool to be used by triage nurses. A better identification of patients at high risk for delirium could permit to apply some prevention protocols previously proposed (51).

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Our study has some limitations. Our high rate of missed patients is mainly due to logistic constraints. However, after comparing the socio-demographic characteristics and comorbidities, we have found no significant difference between patients who were included and those who were missed. Furthermore, including those missed patients would likely have reinforced our results, resulting in higher delirium rates and longer ED and hospital LOS. Therefore, we believe the likelihood of selection bias is low. Because we have chosen to exclude patients with moderate to severe dementia, those who lived in long-term nursing homes, those with pre-existing psychological conditions and patients who had a lesser functional level, our cohort represents only a portion of the older adults population usually seen in the ED and may not be generalizable to all elders. We have made this decision because we were mainly interested to investigate the impact of delirium on the most robust older patients. The CAM was administered by different research assistants, and therefore this might have underestimated or overestimated the frequency of an acute onset of a new symptom. Misclassification of delirium may have occurred as we excluded patient with delirium using a single first initial assessment with CAM, this pragmatic approach was used to ensure feasibility of the study. This may have introduced an interviewer bias; however, this situation is not any different from real-life clinical practice. We tried to decrease this potential bias by providing research assistants with standardized training, which was proven effective given our good inter-observer agreement. The study coordinator also reviewed every single research file to ensure completeness.

In conclusion, the incidence of delirium was 12.1% in community dwelling older adults enrolled from 4 Canadian EDs. Incident delirium significantly increased hospital length of stay by 4 days and could possibly negatively affect the patient and healthcare system.

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Conflicts of interest: None

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Data sharing statement: Being a prospective observational multicentre study, this project includes other data results to be solely used by our research team. The data use is guide by a public funding agency - FQRS

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TABLES

Table 1. Description of the study population

	Site 1 n(%)	Site 2 n(%)	Site 3 n(%)	Site 4 n(%)	Site comparison p-value	Total
Age						
65-74 y/o	61 (57)	21 (32)	38 (45)	35 (42)	0.001	155 (46)
75-84 y/o	36 (34)	23 (35)	35 (42)	29 (35)		123 (36)
≥85 y/o	9 (9)	21 (32)	11 (13)	19 (23)		60 (18)
Sex						
Female	53 (50)	37 (57)	39 (46)	44 (53)	0.618	173 (51)
CTAS						
1 & 2	39 (37)	25 (38)	25 (30)	18 (22)	0.076	107 (31,7)
3	47 (44)	28 (43)	43 (51)	37 (45)		155 (45,9)
4 & 5	20 (19)	12 (18)	16 (19)	28 (34)		76 (22,5)
Admission diagnostic						
Medical						
Cardiology	15 (14.0)	16 (21.9)	23 (25.2)	16 (18.0)		70 (19.4)
Pneumonology	22 (20.6)	15 (20.5)	26 (28.6)	12 (13.5)		75 (20.8)
Gastroenterology	13 (12.1)	7 (9.6)	8 (8.8)	17 (19.1)		45 (12.5)
Internal medicine	6 (5.6)	8 (11.0)	7 (7.7)	8 (9.0)		29 (8.1)
Neurology	13 (12.1)	7 (9.6)	9 (9.9)	10 (11.2)		39 (10.8)
Other	28 (26.2)	14 (19.2)	14 (15.4)	21 (23.6)		77 (21.4)
Surgical						
Orthopedics	2 (1.9)	6 (8.2)	4 (4.4)	5 (5.6)		17 (4.7)
General surgery	5 (4.7)	0 (0)	0 (0)	0 (0)		5 (1.4)
Other	3 (2.8)	0 (0)	0 (0)	0 (0)		3 (0.8)
Time of day of presentation						
0:00-8:00	18 (16.5)	12 (16.2)	21 (22.1)	5 (5.6)		56 (15.3)
8:00-16:00	66 (60.6)	34 (46.0)	43 (45.3)	54 (60.7)		197 (53.7)
16:00-0:00	25 (22.9)	28 (37.8)	31 (32.6)	30 (33.7)		114 (31.0)
OARS at baseline (mean ± SD)	26.33 ±1.98	26.41 ±2.20	25.95 ±2.60	24.92 ±2.41	<0.001	25.91 ±2.36
TICS-m at baseline (mean ± SD)*	30.36 ±5.68	31.88 ±4.69	29.37 ±5.92	26.81 ±6.70	<0.001	29.53 ±6.08
Charlson (mean ± SD)	1.93 ±1.78	1.65 ±1.69	3.13 ±2.48	1.81 ±1.55	<0.001	2.14 ±1.99
APACHE II (mean ± SD)	10.99 ±3.43	10.77 ±3.37	9.48 ±3.43	8.70 ±3.17	<0.001	10.01 ±3.48
Environmental factors						
Proper lighting [a]	65 (63)	49 (75)	71 (85)	18 (22)	<0.001	203 (61)
Patient hydration						
Fasting	10 (10)	8 (12)	11 (13)	16 (19)	0.369	45 (14)

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Glass of water within reach	70 (72)	55 (85)	52 (65)	71 (86)	0.005	248 (76)
Presence of saliva[¥]	74 (76)	52 (80)	49 (60)	9 (11)	<0.001	184 (56)
Any IV Fluids	75 (77)	58 (89)	78 (95)	65 (78)	0.003	276 (84)
Physical restraints (any)[+]	78 (77)	30 (46)	1 (1)	65 (79)	<0.001	174 (53)
Medical interventions limiting movement						
Bed rest	1 (1)	1 (2)	5 (6)	0 (0,0)	0.071	7 (2)
Urinary catheter	7 (8)	5 (9)	2 (2)	2 (3)	0.217	16 (6)
O2	15 (17)	15 (26)	22 (27)	4 (6)	0.007	56 (19)
Saline-lock Catheter or IV drip	72 (84)	53 (91)	75 (92)	57 (88)	0.377	257 (88)
Other	10 (12)	8 (14)	18 (22)	6 (9)	0.125	42 (14)
Temporal orientation aid[•]	67 (63)	45 (69)	53 (63)	37 (45)	0.010	202 (60)

* Adjusted for level of education

[a] According to the research assistant

[¥] Research assistant verified if the patients had saliva under their tongue

[+] Tablet, bed rails or other

[•] Clock, watch, cell phone, calendar

CTAS: Canadian Triage Assessment Scale; OARS: Older American's Resources and Services; TICS-m: Telephone Interview for Cognitive Status-modified; APACHE II: Acute Physiological and Chronic Health Evaluation II; IV: intravenous injection;

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FIGURES LEGEND

Figure 1. Study flowchart

Figure 2. Distribution of delirium across participating sites

Figure 3. Cumulative incidence of delirium curve

Figure 4. Adjusted length of hospital stay (hours)*

* Length of stay was adjusted for ED LOS, site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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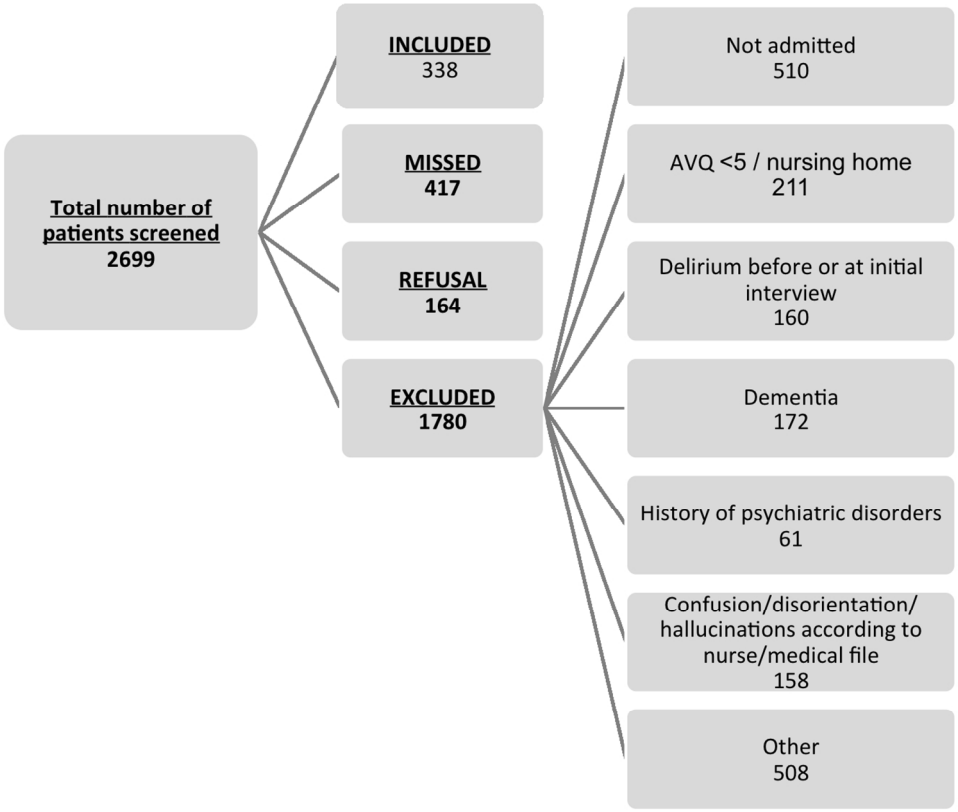

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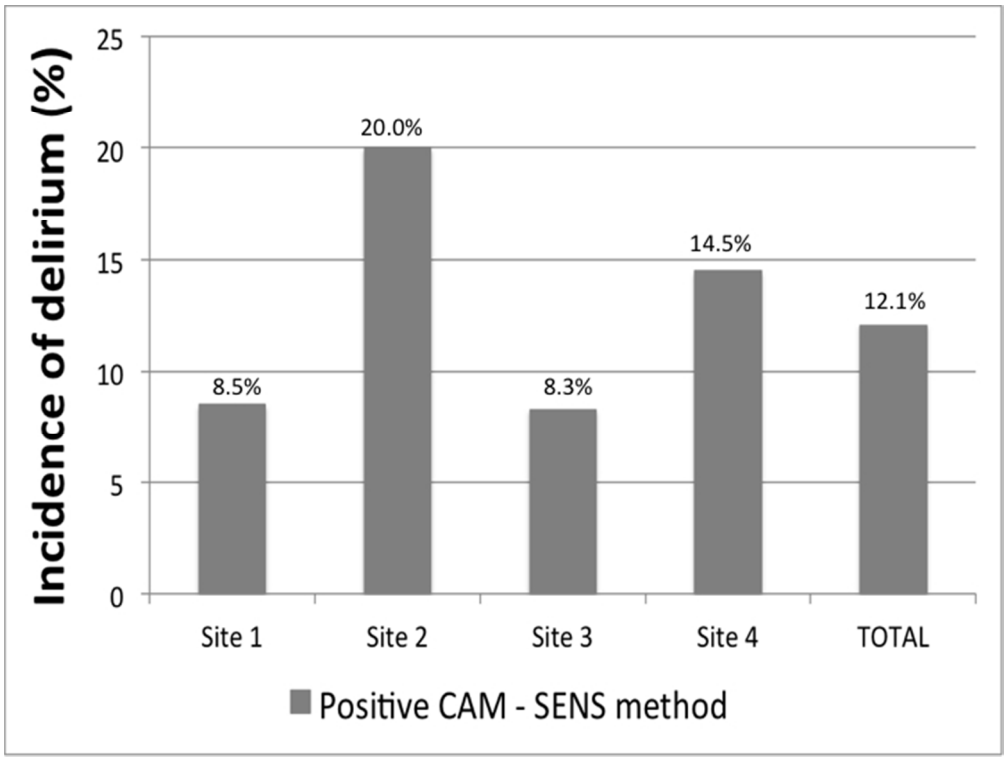
Incidence of delirium (%)
25
20
15
10
5
0
20.0%
14.5%
12.1%
8.5%
8.3%
Site 1
Site 2
Site 3
Site 4
TOTAL
Positive CAM - SENS method

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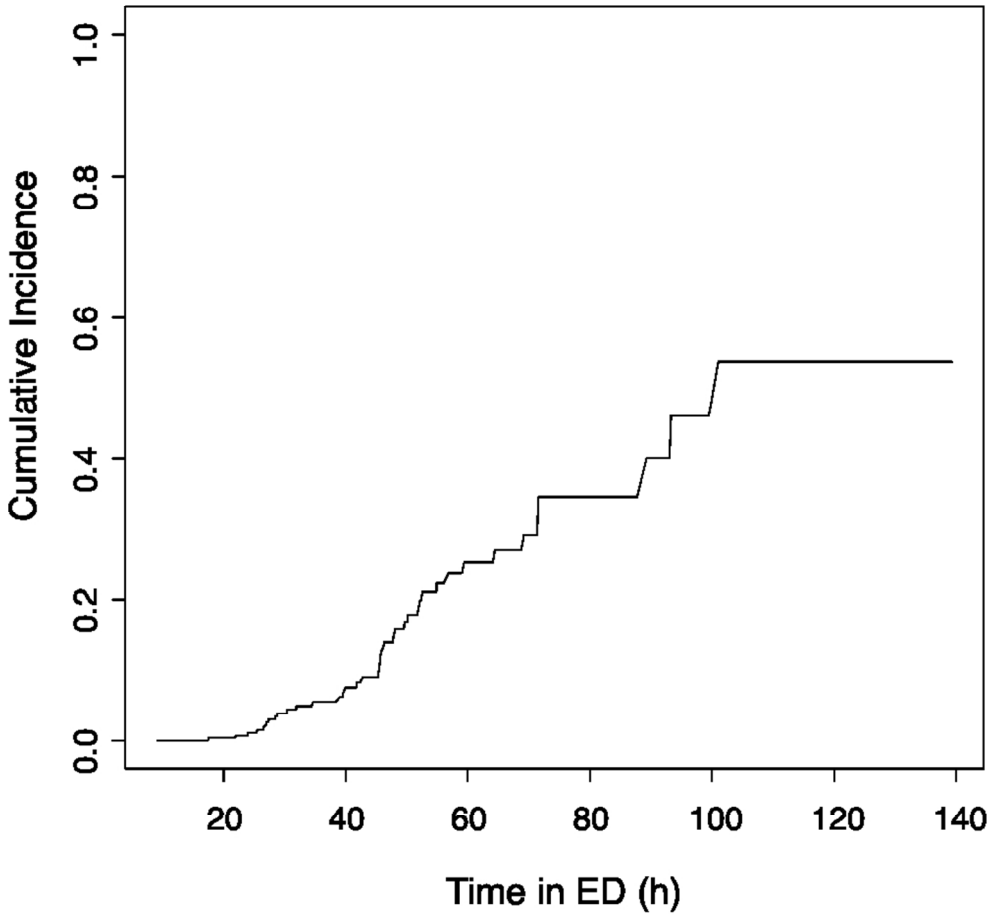
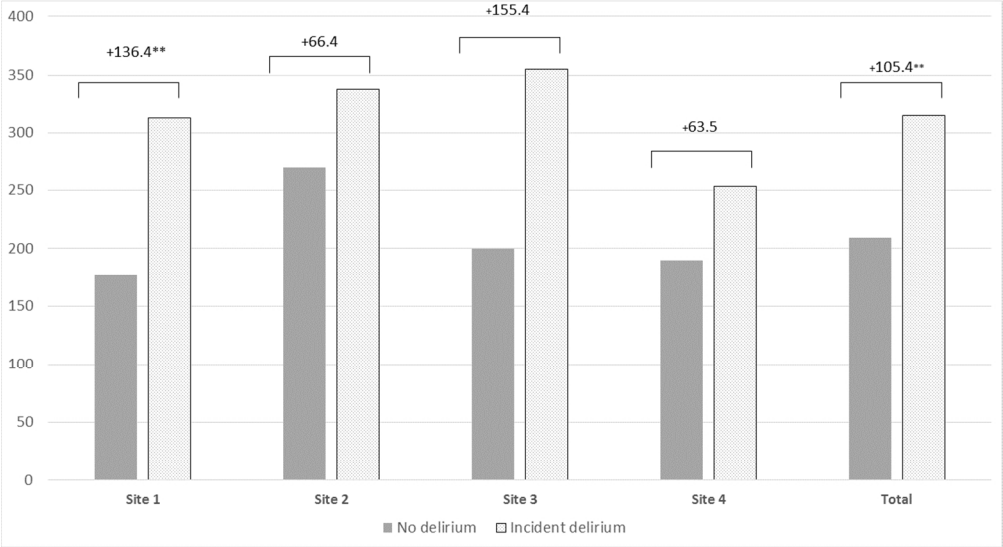

Cumulative Incidence
0.0
0.2
0.4
0.6
0.8
1.0
20
40
60
80
100
120
140
Time in ED (h)



Length of stay was adjusted for site, age, Charlson, APACHE, OARS and TICS-m scores. **: Difference between No delirium and Incident delirium in terms of length of ED stay <0.05

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7-8*
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, explain how loss to follow-up was addressed	N/A
		(*e*) Describe any sensitivity analyses	8
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	Report numbers of outcome events or summary measures over time	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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