JOURNAL OF GERIATRIC EMERGENCY MEDICINE

Fall 2023 | Volume 4 | Issue 4 Article 2 | Original Research

JGEM The Journal of Geriatric Emergency Medicine

ADVOCATE HEALTH GEDC

Describing and Predicting Trajectories of Healthcare Utilization Among Older Adults Presenting to an Emergency Department Using the interRAI Emergency Department Screener

Matthew B Downer, MSc, Kristina M Kokorelias, PhD, Andrew P Costa, PhD, Don Melady, MD, MSc(Ed), Samir K Sinha, MD, DPhil

ABSTRACT

Introduction	Although older adults visit emergency departments (EDs) more than any other age group, the trajectories of healthcare utilization older adults experience post-ED are not well described. Further, whether rapid ED assessment tools can predict trajectories and discharge destinations remains unclear.
Methods	Older adults (≥65 years) who presented to an ED at a large Canadian urban academic hospital were recruited (January 2018-April 2019). The *interRAI ED Screener* (EDS) was completed on presentation. Patients were categorized by EDS risk score (1/2=low, 3/4=moderate, 5/6=high) and had their discharge destinations tracked. Patients admitted to hospital were tracked until their final discharge destination. Crude and age/sex-adjusted odds ratios and c-statistics were obtained to examine associations between EDS scores and discharge destinations.
Results	Of 751 patients (mean/SD age 77.68/8.43; 41.3% male), 200/26.6% had a high-risk EDS score. 58.3% were discharged home, 39.7% were admitted to hospital, and 2.0% were discharged to rehabilitation/long-term care (LTC) settings directly from the ED. The high-risk group had lower odds of home discharge (aOR=0.47, 95%CI 0.31-0.71, p<0.001) and therefore greater odds of hospital admission (aOR=1.84, 1.23-2.76, p<0.001). Of those admitted, 75.4% were discharged home, 16.4% were discharged to a rehabilitation/LTC setting, 5.6% transferred institutions (psychiatric, oncology, etc.), and 2.7% died in-hospital. The high-risk group were more likely to stay ≥1 week on inpatient units (aOR=2.11, 1.04-4.31, p=0.038) and have a geriatrician consulted (aOR=3.72, 1.17-11.86, p=0.026). The EDS had poor prediction of post-ED hospitalization (C-statistic=0.58, 95%CI 0.54-0.62), but reasonable prediction of post-ED LTC home/rehabilitation centre admission (0.75, 0.63-0.87), albeit the number of these outcomes were small (n=15).
Conclusion	We describe a range of healthcare trajectories older adults experience following ED presentation. Stratification by EDS risk groups could help to proactively identify the need for geriatric consultation earlier and resource utilization trajectories after an index ED visit, which could better enable the planning and organization of acute healthcare services for older adults.

INTRODUCTION

While older adults constitute a minority of the overall population, they are the most frequent users of emergency departments (EDs) on a global scale.[1-3] The Canadian Institute for Health Information reported that in the year 2021-2022, older adults (age ≥65) accounted for 3,399,441 ED visits[4] or 24.3% of all ED visits that year[4]. This is notable, especially considering older adults only

comprise 19% of the Canadian population.[5] With populations rapidly ageing worldwide, the high volumes older adults present to EDs is predicted to continue to rise in the coming decades.[6, 7]

Despite the disproportionately high and growing volume of older adults using ED services, little work has detailed the proportions of older adults sent to various care settings following an index ED visit, and key predictors of various discharge destinations thereafter remain unclear. Such destinations may include being discharged home (with or without home care supports), admitted to hospital, an inpatient rehabilitation centre, or being sent directly to a long-term care (LTC) home. An improved understanding of healthcare trajectories following ED visits could have implications for future planning and organization of healthcare services for older adults.

In response to the high rates of ED presentations, various tools have been developed to help triage older patients.[8] One example is the interRAI ED assessment system, which was developed to assess older adults in EDs worldwide.[9] The interRAI ED assessment system includes the interRAI *Emergency Department Screener* (interRAI EDS), a tool designed to rapidly identify older patients at high risk of adverse outcomes that would benefit from a comprehensive geriatric assessment. The interRAI EDS has been explored in various settings and has been used to attempt to predict various outcomes following ED visits in older adults, including need for geriatric assessment, ED re-presentation, hospital admission, and hospital length of stay.[9-12] However, there has been little investigation into the prediction of other discharge destinations and trajectories of healthcare utilization of older adults following an index ED visit.

Therefore, the aims of this study were twofold. First, we aimed to describe the discharge destinations and healthcare trajectories of older adults that presented to an urban ED. Second, we aimed to examine whether the interRAI EDS could predict discharge destinations from both the ED and acute care settings.

METHODS

Study Background

This study was part of a multi-center research program based out of the University of Waterloo in collaboration with the University of Toronto and Mount Sinai Hospital, which hosts a large geriatric program. It was approved by the research ethics board at Mount Sinai Hospital in Toronto (#17-0260-E).

Research staff at the University of Waterloo trained relevant ED-based research staff at Mount Sinai Hospital on the administration of the interRAI EDS.

Emergency Department Assessment Protocol

Older adults aged 65 or older who attended the ED at Mount Sinai Hospital from January 2018 to April 2019 were eligible to participate. The Mount Sinai ED serves a large urban population in downtown Toronto, with patients from a wide range of age groups, backgrounds, races, and ethnicities in Canada's largest and most diverse city.[13] Recruitment was done using convenience sampling predominantly occurring during weekday hours, when older adults tend to present to EDs.[13] Written informed consent was obtained from all participants, or assent was obtained from relatives if written informed consent was not possible.

All baseline data and demographics (age/sex) were collected upon ED presentation. The interRAI EDS was completed on all enrolled patients using a smartphone app. This required ~1 minute to complete and provides an *Assessment Urgency Algorithm* (AUA) (scale: 1-6) score. This score is calculated by the interRAI EDS algorithm, outputs a an AUA score that predicts need for a more comprehensive geriatric assessment.[9] Questions include determining if current daily challenges exist for a patient in the following areas: activities of daily living (hygiene, locomotion, bathing, dressing lower

body), cognition, caregiver burden, self-rated health, stability of prior conditions, dyspnea, and depression.

Any patients who received an AUA score ≥3 but who were discharged home had a home care referral recommended to the ED team (if not already in place). However, this recommendation was made following discharge, and did not influence study follow-up.

Mapping Healthcare Trajectories

To track healthcare destinations after the ED, patients admitted to hospital were accompanied by a tracking form and study ID that was assigned during the initial assessment. Where possible, all patients were subsequently tracked using the study ID and electronic patient records.

For patients discharged home from the ED, information was collected on whether they were previously receiving home care services or if they were discharged with a home care (HC) referral. HC services include any nursing or *other professional support services that allow a person to live safely in their home*. Data was also collected on patients discharged from the ED to a rehabilitation centre or LTC home.

For patients admitted to hospital (either an inpatient or intensive care unit (ICU)), their study tracking form/ID were included in their charts to track discharge destinations. Length of stay, geriatrician consultation, alternate level of care (ALC) status (and ALC days) was also recorded. An ALC designation typically indicates that a patient spent part of an inpatient stay waiting additional days in-hospital for another service to become available before being discharged (i.e., rehabilitation centre, LTC home, HC, etc.).

Any deaths in the ED or in-hospital were also recorded.

Statistical Analyses

Patients with incomplete or missing data were excluded from the present analysis. Only complete case analysis was performed, and no data were imputed.

Patients were categorized into the following groups based on their EDS scores: low-risk (1-2), moderate-risk (3-4), or high-risk (5-6). Discharges to retirement homes (also known as assisted living) were included in the LTC home category for all analyses (n=2 retirement home discharges were recorded). All patients were followed until discharge regardless of EDS score.

Continuous data are presented as either mean (standard deviation) or median (interquartile range), as appropriate. Categorical or binary data are presented as count (percentage).

To explore potential differences regarding demographics and discharge destinations between EDS groups, Chi-Squared and Kruskal-Wallis tests were used, as appropriate.

To explore potential associations between EDS groups and discharge destinations, crude and adjusted (age/sex) logistic regression models were used, with the low-risk group acting as the baseline group. To examine prediction of discharge destinations, C-statistics representing the area under the receiver operating characteristic curve were obtained using the full ordinal EDS score. Models were first run including only EDS, followed by age/sex.

Where some patients previously lived in an LTC home before their index ED visit, we performed a set of sensitivity analyses where we excluded patients previously living in LTC homes.

All analyses were completed using Stata (V16, College Station, TX: StataCorp LLC). The figure was created using a free online software (https://sankeymatic.com/). Significance was set at $p<0.05$.

RESULTS

ED Visits and Discharge Destinations

755 patients were identified for participation. Four did not consent to participate or had missing data on discharge destination, leaving 751 in the cohort for analysis.

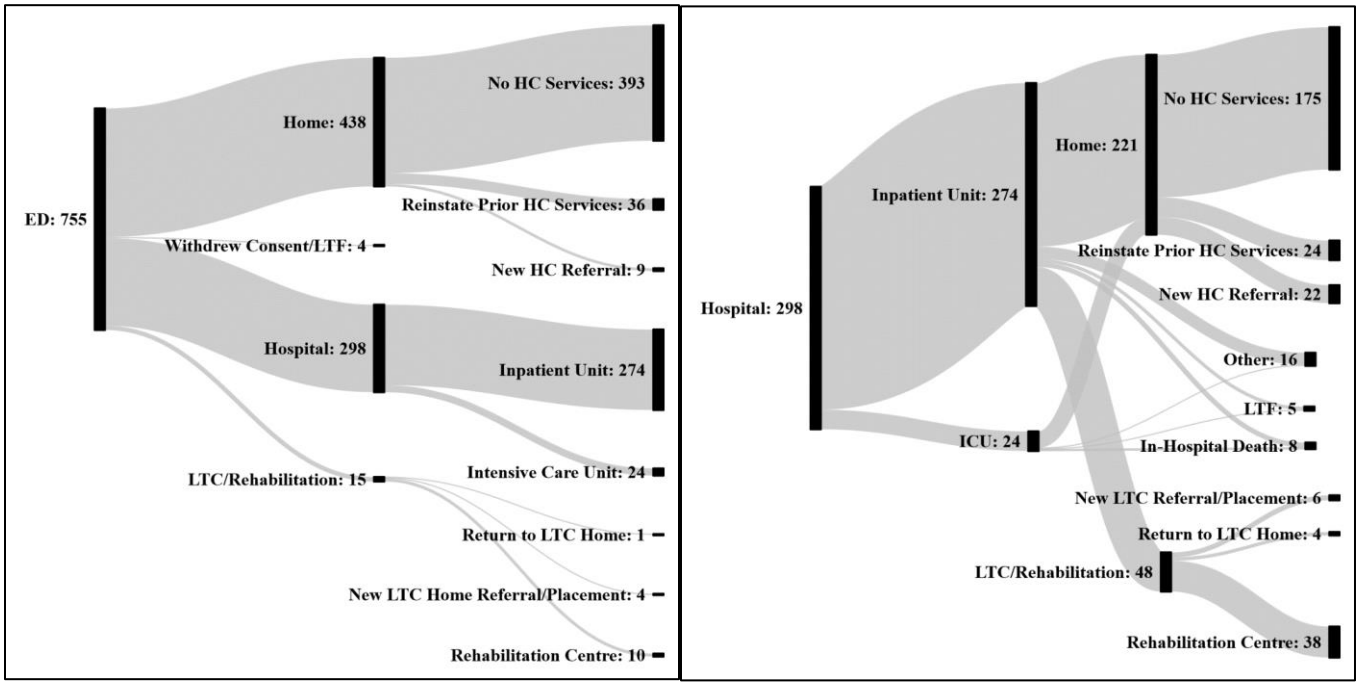
The mean age was 77.6 years (SD 8.4) and 310/41.3% were male. 200/26.6% had a high-risk EDS score. 438/58.3% were discharged home with varying levels of home care support, 298/39.7% patients (39.7%) were admitted to hospital, 10/1.3% were discharged to a rehabilitation centre, and 5/0.7% were discharged to a LTC home directly from the ED (**Table 1**). There were no deaths in the ED.

Table 1: Patient demographics and Emergency Department Discharge Destinations, by ED Screener Risk Category

Demographic Characteristic/Discharge Location	Total (N=751)	Low Risk (N=222)	Moderate Risk (N=329)	High Risk (N=200)	*p*-value
Age (mean; SD)	77.68 (8.43)	75.55 (7.44)	76.95 (7.98)	81.24 (9.09)	<0.001
Male Sex (N; %)	310 (41.3%)	101 (45.5%)	140 (42.6%)	69 (34.5%)	0.060
Home	**438 (58.3%)**	**140 (63.1%)**	**214 (65.0%)**	**84 (42.0%)**	**<0.001**
Home (No Home Care)	393 (52.3%)	136 (61.3%)	202 (61.4%)	55 (27.5%)	<0.001
Home (Home Care Services Previously in Place)	36 (4.8%)	4 (1.8%)	8 (2.4%)	24 (12.0%)	<0.001
Home (Referral to Home Care)	9 (1.2%)	0 (0.0%)	4 (1.2%)	5 (2.5%)	0.044
Hospital Admission (Any)	**298 (39.7%)**	**81 (36.5%)**	**112 (34.0%)**	**105 (52.5%)**	**<0.001**
Inpatient Unit	274 (36.5%)	70 (31.5%)	107 (32.5%)	97 (48.5%)	<0.001
Intensive Care Unit	24 (3.2%)	11 (5.0%)	5 (1.5%)	8 (4.0%)	0.052
Any Long-Term Health Care Facility	**15 (2.0%)**	**1 (0.5%)**	**3 (0.9%)**	**11 (5.5%)**	**<0.001**
All Long-Term Care Home Discharges	5 (0.7%)	0 (0.0%)	0 (0.0%)	5 (2.5%)	0.001
Previously in Long-Term Care Home	1 (0.1%)	0 (0.0%)	0 (0.0%)	1 (0.5%)	0.27
New Long-Term Care Home Referral/Discharge	4 (0.5%)	0 (0.0%)	0 (0.0%)	4 (2.0%)	0.005
Rehabilitation Centre	10 (1.3%)	1 (0.5%)	3 (0.9%)	6 (3.0%)	0.076

Data presented as either mean (SD) or count (percentage)

Figure 1. Discharge destination of older adults presenting to the emergency department (Panel A) or following admission to hospital (Panel B)



ED: emergency department; HC: home care; LTF: loss to follow-up; LTC home: long-term care home

Compared to the low-risk group, the moderate-risk group did not differ across any discharge destination. However, after adjustment for age and sex, high-risk patients had 53% lower odds to be discharged home (95%CI 0.31-0.71, p<0.001) and 71% lower odds to be discharged home without any home care supports (0.19-0.43, p<0.001), and therefore also more likely to be admitted to hospital (aOR=1.92, 1.30-2.84, p<0.001; **Table 2**).

Table 2: Associations between interRAI ED Screener Risk Category and Emergency Department Discharge Destinations

ED Discharge Destination / Model (*Crude/Adj.*)	Low-risk	Moderate-risk	High-risk
Any Home Discharge			
Crude	1.00	1.08 (0.76-1.53)	0.42 (0.29-0.63)***
Adjusted Age/Sex	1.00	1.11 (0.78-1.58)	0.47 (0.31-0.71)***
Home (No Home Care)			
Crude	1.00	1.06 (0.71-1.43)	0.24 (0.16-0.36)***
Adjusted Age/Sex	1.00	1.06 (0.75-1.52)	0.29 (0.19-0.43)***
Any Hospital Admission			
Crude	1.00	0.90 (0.63-1.28)	1.92 (1.30-2.84)**
Adjusted Age/Sex	1.00	0.89 (0.62-1.27)	1.84 (1.23-2.76)**
Inpatient Admission			
Crude	1.00	1.05 (0.73-1.51)	2.04 (1.38-3.04)***
Adjusted Age/Sex	1.00	1.04 (0.72-1.50)	1.97 (1.30-2.97)**
LTC Home or Rehabilitation Centre			
Crude	1.00	2.03 (0.21-19.67)	12.86 (1.65-100.55)*
Adjusted Age/Sex	1.00	1.65 (0.17-16.17)	5.57 (0.67-46.10)

*Data expressed as odds ratio (95%CI), *p<0.05 **p<0.01 ***p<0.001*
ED: emergency department; LTC: Long-Term Care

Before adjustment, the high-risk group had 12.9 times greater odds of being discharged from the ED to a rehabilitation centre/LTC home (1.65-100.55, p=0.015) compared to the low-risk group. However, the numbers of rehabilitation centre/LTC home discharges were small (n=15) and the association was not robust to adjustment (aOR=5.57, 0.67-46.10, p=0.11). Additional analyses excluding the patient already living in an LTC home (n=1) provided similar estimates (results not shown).

Patients Admitted to Hospital Following an Index ED Visit

Of 751 patients who presented to the ED, 24 (3.2%) were admitted to the ICU and 274 (36.5%) were admitted to inpatient units. Data was unavailable for one patient in the ICU patient/four on inpatient units.

Of 23 patients admitted to the ICU with data available, 20 (or 87%) were discharged home (13/56.4% no HC, 2/8.7% prior HC services reinstated, 5/21.7% HC referrals), 1 (4.4%) were transferred to another institution to receive specialized care, and 2 (8.7%) died. The median length of ICU stay was 5 days (3-10). One had a geriatrician consulted, and one had an ALC designation (23 days) before being discharged home.

Of the 270 hospital inpatients for whom data was available, 201 (74.4%) were discharged home, 38 (14.1%) were sent to rehabilitation centres, 10 (or 3.7%) went to an LTC home (including 4 who returned to their respective LTC homes), 15 (or 5.6%) were transferred to different institutions, and 4 (1.7%) passed away during their stay (as detailed in **Table 3**). The median length of stay was 4 days

(IQR 2-8). Geriatricians were consulted in the care of 27 patients, representing 11.2% of the cohort. An Alternate Level of Care (ALC) designation was given to 32 patients (11.9%), with a median of 5 ALC days (IQR of 3-9 days). Of those designated ALC, 3 (9.4%) were awaiting discharge to a new LTC home, 16 (50.0%) awaited discharge to a rehabilitation centre, and another 3 (9.4%) were awaiting a home care referral.

Table 3: Patient discharge destinations and outcomes of (A) all hospital stays or (B) all inpatient stays, by ED Screener AUA Score

3A: *All Hospital Admissions*

Location of Discharge/	**Low-Risk**	**Moderate-Risk**	**High-Risk**	**Total**	***p*-value**
Outcome of Inpatient Stay	N=79	N=112	N=102	N=293	
Discharged Home	67 (84.8%)	90 (80.4%)	64 (62.7%)	221 (75.4%)	0.001
No Home Care	62 (78.5%)	81 (72.3%)	32 (31.4%)	175 (59.7%)	<0.001
Continue Home Care Previously in Place	2 (2.5%)	6 (5.4%)	16 (15.7%)	24 (8.2%)	0.004
Referral to Home Care	3 (3.8%)	3 (2.7%)	16 (15.7%)	22 (7.5%)	<0.001
Discharged to LTC Home	3 (3.8%)	2 (1.8%)	5 (4.9%)	10 (3.4%)	0.47
Discharged Back to LTC Home	2 (2.5%)	0 (0.0%)	2 (2.0%)	4 (1.4%)	0.19
Discharged To LTC Home – New Placement	1 (1.3%)	2 (1.8%)	3 (2.9%)	6 (2.0%)	0.77
Discharged to Rehabilitation Centre	6 (7.6%)	11 (9.8%)	21 (20.6%)	38 (13.0%)	0.021
Discharged to LTC Home or Rehabilitation Centre	9 (11.4%)	13 (11.6%)	26 (25.5%)	48 (16.4%)	0.013
Transferred To Other Institution	3 (3.8%)	7 (6.3%)	6 (5.9%)	16 (5.5%)	0.81
In-Hospital Death	0 (0.0%)	2 (1.8%)	6 (5.9%)	8 (2.7%)	0.049
Length Of Inpatient Stay	4 (2-7)	4 (2-6)	5 (3-11)	4 (2-8)	0.004
ALC Designation During Inpatient Stay	5 (6.3%)	10 (8.9%)	18 (17.6%)	33 (11.3%)	0.043
Geriatric Consult During Inpatient Stay	5 (6.3%)	7 (6.3%)	20 (19.6%)	32 (10.9%)	0.004

3B: *Inpatient Stays Only (ICU Excluded)*

Location of Discharge/	**Low-Risk**	**Moderate-Risk**	**High-Risk**	**Total**	***p*-value**
Outcome of Inpatient Stay	N=69	N=107	N=94	N=270	
Discharged Home	57 (82.6%)	86 (80.4%)	58 (61.7%)	201 (74.4%)	0.003
No Home Care	55 (79.7%)	77 (72.0%)	30 (31.9%)	162 (60.0%)	<0.001
Continue Home Care Previously in Place	1 (1.4%)	6 (5.6%)	15 (16.0%)	22 (8.1%)	0.002
Referral to Home Care	1 (1.4%)	3 (2.8%)	13 (13.8%)	17 (6.3%)	0.002
Discharged to LTC Home	3 (4.3%)	2 (1.9%)	5 (5.3%)	10 (3.7%)	0.36
Discharged Back to LTC Home	2 (2.9%)	0 (0.0%)	2 (2.1%)	4 (1.5%)	0.18
Discharged To LTC Home – New Placement	1 (1.4%)	2 (1.9%)	3 (3.2%)	6 (2.2%)	0.77
Discharged to Rehabilitation Centre	6 (8.7%)	11 (10.3%)	21 (22.3%)	38 (14.1%)	0.024
Discharged to LTC Home or Rehabilitation Centre	9 (13.0%)	13 (12.1%)	26 (27.7%)	48 (17.8%)	0.011
Transferred To Other Institution	3 (4.3%)	7 (6.5%)	5 (5.3%)	15 (5.6%)	0.89
In-Hospital Death	0 (0.0%)	1 (0.9%)	5 (5.3%)	6 (2.2%)	0.046
Length Of Inpatient Stay	4 (2-6.5)	3.5 (2-6)	5 (3-11)	4 (2-8)	0.002
ALC Designation During Inpatient Stay	4 (5.8%)	10 (9.3%)	18 (19.1%)	32 (11.9%)	0.025
Geriatric Consult During Inpatient Stay	4 (5.8%)	7 (6.5%)	20 (21.3%)	31 (11.5%)	0.002

AUA: Assessment Urgency Algorithm; LTC: Long-Term Care

Compared to the low-risk group, the moderate-risk group did not differ with regards to odds of any discharge location or outcomes (**Table 4**). However, after adjustment, the high-risk group was 57% less likely to be discharged home (95%CI 0.20-0.94, p=0.034). This group was also more likely to have an inpatient stay ≥ 1 week and have a geriatrician consulted as part of their care. Further, the high-risk group had greater odds of discharge to a LTC home or rehabilitation centre and ALC designation, but

associations were attenuated following adjustment (**Table 4**; additional analyses excluding prior LTC home residence provided similar estimates-results not shown).

Table 4: Associations between EDS Risk Category and Hospital Discharge Destinations/Outcomes

4A: All Hospital Admissions

Discharge or Outcome	Low-Risk	Moderate-Risk	High-Risk
Any Home Discharge			
Crude	1.00	0.73 (0.34-1.58)	0.30 (1.44-0.63)**
Adjusted Age/Sex	1.00	0.81 (0.37-1.78)	0.36 (0.17-0.78)**
Home (No Home Care)			
Crude	1.00	0.72 (0.36-1.41)	0.13 (0.06-0.25)***
Adjusted Age/Sex	1.00	0.82 (0.41-1.65)	0.15 (0.08-0.31)***
LTC Home or Rehabilitation Centre			
Crude	1.00	1.02 (0.41-2.52)	2.66 (1.17-6.10)*
Adjusted Age/Sex	1.00	0.89 (0.35-2.23)	2.05 (0.87-4.86)
Rehabilitation Centre			
Crude	1.00	1.32 (0.47-3.75)	3.15 (1.21-8.24)*
Adjusted Age/Sex	1.00	1.18 (0.41-3.37)	2.54 (0.94-6.84)
Inpatient Stay ≥ 1 week			
Crude	1.00	0.83 (0.43-1.62)	1.90 (1.01-3.59)*
Adjusted Age/Sex	1.00	0.79 (0.40-1.55)	1.72 (0.89-3.31)
Geriatrician Consulted			
Crude	1.00	0.99 (0.30-3.22)	3.61 (1.29-10.10)*
Adjusted Age/Sex	1.00	0.96 (0.29-3.16)	3.25 (1.12-9.39)*
ALC Designation			
Crude	1.00	1.45 (0.48-4.22)	3.17 (1.12-8.96)*
Adjusted Age/Sex	1.00	1.34 (0.44-4.10)	2.62 (0.90-7.60)

4B: Inpatients Only (ICU excluded)

Discharge or Outcome	Low-Risk	Moderate-Risk	High-Risk
Any Home Discharge			
Crude	1.00	0.86 (0.39-1.89)	0.34 (0.16-0.72)**
Adjusted Age/Sex	1.00	0.99 (0.44-2.21)	0.43 (0.20-0.94)*
Home (No Home Care)			
Crude	1.00	0.65 (0.32-1.35)	0.12 (0.06-0.25)***
Adjusted Age/Sex	1.00	0.75 (0.36-1.58)	0.15 (0.07-0.31)***
LTC Home or Rehabilitation Centre			
Crude	1.00	0.92 (0.37-2.29)	2.55 (1.11-5.87)*
Adjusted Age/Sex	1.00	0.78 (0.31-1.97)	1.90 (0.79-4.59)
Rehabilitation Centre			
Crude	1.00	1.20 (0.42-3.42)	3.02 (1.15-7.95)*
Adjusted Age/Sex	1.00	1.05 (0.36-3.03)	2.37 (0.87-6.50)
Inpatient Stay ≥ 1 week			
Crude	1.00	0.88 (0.43-1.79)	2.22 (1.12-4.41)*
Adjusted Age/Sex	1.00	0.85 (0.41-1.74)	2.11 (1.044.31)*
Geriatrician Consulted			
Crude	1.00	1.14 (0.32-4.04)	1.09 (0.30-3.89)
Adjusted Age/Sex	1.00	4.39 (1.43-13.51)**	3.72 (1.17-11.86)*
ALC Designation			

Crude	1.00	1.68 (0.50-5.57)	3.85 (1.24-11.95)*
Adjusted Age/Sex	1.00	1.52 (0.45-5.09)	3.11 (0.97-9.97)
*Expressed as odds ratio (95%CI), *p<0.05 **p<0.001* *AUA: Assessment Urgency Algorithm; LTC: Long-Term Care; ALC: alternate level of care*			

Using the InterRAI EDS in a predictive model for determining discharge destinations

From the ED, EDS scores yielded poor prediction of hospital admission (C-statistic=0.58, 95%CI 0.54-0.62). However, the EDS demonstrated good prediction of admission to rehabilitation or LTC homes (EDS=0.75, 0.63-0.87; EDS/Age/Sex=0.86; 0.79-0.94; **Table 5**). Results were similar after excluding patients living in LTC homes before ED presentation (n=1 excluded; data not shown).

Table 5: C-Statistics for the prediction of discharge destination using the InterRAI ED Screener

Cohort (N)	**Discharge Location**	**Model 1** ***EDS***	**Model 2** ***EDS, Age, Sex***
Emergency Department **N=751**	Any Hospital Admission	0.58 (0.54-0.62)	0.59 (0.55-0.64)
	Inpatient Admission	0.58 (0.54-0.63)	0.59 (0.55-0.63)
	LTC Home or Rehabilitation Centre	0.75 (0.63-0.87)	0.86 (0.79-0.94)
	Rehabilitation Centre	0.71 (0.54-0.87)	0.86 (0.75-0.96)
	LTC Home	0.83 (0.76-0.90)	0.80 (0.73-0.87)
All Hospital Admissions **N=293**	LTC Home or Rehabilitation Centre	0.63 (0.54-0.71)	0.71 (0.63-0.79)
Inpatient Units Only **N=270**	LTC Home or Rehabilitation Centre	0.63 (0.54-0.72)	0.71 (0.62-0.79)

Note: ED Screener AUA was entered as a continuous variable. Data is presented as C-statistic (95%CI). The C-statistic represents the 'goodness of fit' of the logistic regression models for predicting binary outcome, whereby a value of 0.5 indicates that a model is equal to random chance and a value of 1.0 is perfect prediction of the outcome. Models over 0.7 are often considered good, with models over 0.8 considered excellent.
The ROC curves are provided in the Supplementary material.
EDS: InterRAI ED Screener; LTC: Long-Term Care.

Following hospital admission, the EDS showed modest prediction of patients discharged to rehabilitation or LTC homes (EDS: 0.63, 0.54-0.71; EDS+Age+Sex: 0.71, 0.63-0.79) but, again, numbers were small (n=48). Sensitivity analyses excluding prior LTC home residence provided similar estimates (n=4 excluded; results not shown).

DISCUSSION

We demonstrate a wide range of healthcare trajectories and resource utilization experienced by older adults attending the ED of a large Canadian urban academic health sciences centre. Older patients classified as high-risk using the interRAI EDS were at greater risk of hospital admission from the ED, and subsequently used more healthcare resources (longer stay, more geriatrician consults) compared to the low-risk group.

To the best of our knowledge, this study is among the first to quantify healthcare trajectories older adults experience following an index ED visit. Most studies have focused on risk factors for hospital admission in older adults following an index ED visit[15-17] or ED re-presentation following discharge.[17-19] A Dutch study using administrative data followed older adults after any admission to

hospital (n=21,258) or for a hip fracture (n=814).[18] 39.1% received home care, 14.3% were discharged to a LTC home within 90 days of admission, and approximately a third did not receive any care after their hospitalization. They found patients who received home care within 90-days were less likely to be re-admitted or die within the same time-period.[18] However, little work has explored healthcare trajectories of older adults after an ED visit. Such investigation is important, as ED visits are a prognostic marker for negative health outcomes in older adults. A study of community-dwelling older adults (n=754) in the US matched 813 individuals experiencing ED visits to controls (no ED visit) and found those who visited the ED experienced greater disability, LTC home admissions, and mortality at 6-months, and associations remained after excluding patients admitted to hospital, highlighting how health complaints resulting in an ED visit alone is a key risk factor for negative health outcomes in older adults.[21]

Our findings have some implications for healthcare systems and secondary prevention efforts for older adults following an ED visit.

First, health systems must plan accordingly in anticipation of the predicted volumes of older patients that will be sent from EDs to inpatient units, ICUs, rehabilitation centres, LTC homes, or home with varying levels of support. Understanding current care trajectories and discharge destinations can play an important role in healthcare system organization and planning. This study captures an important snapshot of healthcare trajectories experienced by older adults presenting to an urban Canadian ED. This information on common discharge pathways can help design better hospital-based approaches and ensure necessary transitions are supported and not delayed. Further work is needed to explore trajectories in other settings.

Second, there are important implications for continuity of care and prevention of re-presentations or hospitalizations for older adults after an index ED visit. In our study, 4.8% of patients discharged home had prior home care services and 1.2% received an immediate new referral for home care services. This suggests a substantial proportion of older adults are being discharged home from the ED without additional home care supports, despite evidence that an ED visit alone is a high-risk event for future poor health outcomes.[21, 22] After hospital admission, 8.2% of those discharged home had existing home care services while 7.5% received a referral. This reflects a high proportion of patients discharged home following a hospital admission without additional home care supports. Multiple studies have shown home care initiation following an ED visit or discharge from hospital is associated with lower rates of subsequent re-presentation or re-admission to hospital.[23-27] Although many patients were likely assessed as not requiring additional home care supports upon discharge, greater initiation of home care services may help prevent or delay future ED visits, hospital readmissions, or other negative health outcomes.

This study is among the first to examine the use of the interRAI EDS to predict healthcare trajectories and discharge destinations. The EDS was designed to rapidly assess older adults in the ED to determine patients that may benefit from a comprehensive geriatric assessment and referral for additional support.[9] A Canadian study (N=2,801; mean age=79.7) examining the use of the EDS by paramedics during 911 calls found high-risk EDS scores (31.9%) were crudely associated with hospitalization, longer hospital stays, future home care requirements, and mortality, but not ED re-presentation.[9] An Australian study (n=687; age≥70) reported low predictive validity of the EDS for ED re-presentation (C-statistic=0.55).[12] A prospective Belgian study (n=794; age ≥70 years) compared the EDS to two other ED screeners for older adults (Identification of Seniors at Risk [ISAR]; Triage Risk Screening Tool [TRST]) for predicting ED lengths of stay, hospitalization, and ED re-presentation at 30 or 90 days.[10] While all three tools performed comparably, none were independently accurate for any outcomes considered.[10] A recent Canadian study (n=1855, mean age=84) found the EDS had fair agreement to two other tools (ER^2 and PRISMA-7) and, while it was not as sensitive as the others, the EDS was the best at identifying older patients at highest risk of hospital admission.[28] However, in the present study, we report the high-risk EDS category independently had increased odds for hospital

admissions following their ED visits and greater inpatient healthcare resource utilization (longer stays/more geriatrician consults). Our work is, to the best of our knowledge, to show the use of the EDS to predict healthcare trajectories from the ER and inpatient units. Through this, we also show that the EDS was poor at independently predicting hospital admissions. A recent systematic review of screening tools for older adults in EDs has outlined the many challenges of creating a rapid assessment tool to accurately stratify patients.[8] Moving forward, better consensus on time-periods to examine outcomes following ED presentation (such as 30 or 90 days) and use of ED screeners could improve understanding of the heterogeneity across studies.

The heterogeneity and conflicting findings reported can at least in part be attributed to the fact that many discharge outcomes are both site and system dependent, whereby an older adult who is admitted at one centre may not be admitted at another. Furthermore, the characteristics of patients that present also differ between centres. Therefore, some screening instruments are likely to more sensitive for certain outcomes in particular centres, and less sensitive in others. As discussed, the interRAI EDS was designed to identify patients who could benefit from a comprehensive geriatric assessment and referral for additional support,[9] particularly identifying patients with cognitive decline, trouble performing activities of daily living, or evidence of patient/family coping challenges. However, these are separate constructs to medical acuity or instability in a patient requiring urgent medical attention. Our present work was exploratory to examine the use of the interRAI EDS to predict healthcare trajectories and discharge destinations. Further work is needed to improve prediction of outcomes in older adults presenting to EDs.

Interestingly, the EDS demonstrated a strong ability to predict discharges to rehabilitation centres or LTC homes. However, the overall number of rehabilitation centre/LTC home discharges were small, therefore this finding requires replication and validation in a larger dataset. The utility of the EDS to predict discharge destination beyond hospital admissions or re-presentations to the ED as an outcome could be a useful tool to rapidly implement referral systems and more responsive services in busy clinical practice settings. Further, the EDS independently predicted geriatrician involvement on the inpatient unit and longer lengths of stay, and crudely predicted ALC designation, further highlighting its potential utility for healthcare resource utilization and care pathway planning.

Our study has some limitations. First, it was based on the single-centre experience of an ED at a large Canadian urban academic health sciences centre and may not reflect the population of older adults in other nations, or in more rural or non-academic settings. Second, we did not have data related to ED or hospital re-presentations for our study population. Third, due to the small number of patients admitted to either an LTC home or a rehabilitation centre, we were unable to conduct dedicated analyses for both destinations. Fourth, we used only one rapid ED assessment scale in this study. Fifth, we did not have data on other covariates beyond age and sex, and therefore the reported associations may be biased by residual confounding. Finally, we had a convenience sample that were recruited during mostly weekday hours, which biased participation to those who arrived during those recruitment windows. However, older adults tend to present to EDs during this time, and we had a 99.5% recruitment rate in the ED. The many strengths of our study include a large sample of over 750 patients, and high rates of complete data documenting immediate post-ED visit care journeys.

CONCLUSION

We outlined the healthcare trajectories and discharge destinations of a large sample of older adults presenting to a large urban ED. From the ED, roughly half were discharged home with the vast majority receiving no post-discharge home care supports. This may suggest a need for improved home care referral rates after an ED visit. Further, while the EDS high-risk group was associated with a greater risk of admission to hospital, the independent prediction of this using C-statistics was poor. Interestingly, the EDS showed a stronger ability to predict discharge to LTC homes and rehabilitation

centres. Such findings would benefit from greater examination. Overall, this study provides important insights for future healthcare system design and planning for the many older patients that experience various care trajectories following an ED visit.

KEYWORDS

Geriatrics, emergency medicine, interRAI, discharge destinations, older adults

AFFILIATIONS

Matthew B Downer, MSc	Section of Geriatric Medicine, Department of Medicine, Sinai Health and University Health Network, Toronto, ON, Canada; National Institute on Ageing, Toronto Metropolitan University, Toronto, ON, Canada; Memorial University of Newfoundland, Faculty of Medicine, St. John's, NL, Canada
Kristina M Kokorelias, PhD	Section of Geriatric Medicine, Department of Medicine, Sinai Health and University Health Network, Toronto, ON, Canada; National Institute on Ageing, Toronto Metropolitan University, Toronto, ON, Canada; [4]Department of Occupational Science & Occupational Therapy, Temerty Faculty of Medicine, University of Toronto, Toronto, ON, Canada; Rehabilitation Sciences Institute, Temerty Faculty of Medicine, University of Toronto, Toronto, ON, Canada
Andrew P Costa, PhD	Department of Health Research Methods, Evidence, and Impact, McMaster University, Hamilton, ON, Canada; ICES, Toronto, ON, Canada; Schlegel Research Institute for Aging, Waterloo, ON, Canada; Centre for Integrated Care, St. Joseph's Health System, Hamilton, ON, Canada; Department of Medicine, McMaster University, Hamilton, ON, Canada
Don Melady, MD, MSc(ED)	Schwartz/Reisman Emergency Medicine Institute, Sinai Health, Toronto, ON, Canada; Division of Emergency Medicine, Department of Family and Community Medicine, Temerty Faculty of Medicine, University of Toronto, ON, Canada
Samir K Sinha, MD, DPhil	Section of Geriatric Medicine, Department of Medicine, Sinai Health and University Health Network, Toronto, ON, Canada; National Institute on Ageing, Toronto Metropolitan University, Toronto, ON, Canada; Division of Geriatric Medicine, Department of Medicine, Termerty Faculty of Medicine, University of Toronto, Toronto, ON

CORRESPONDING AUTHOR

Dr. Samir K. Sinha, MD, DPhil, FRCPC, AGSP (Samir.Sinha@sinaihealth.ca)
Peter and Shelagh Godsoe Chair of Geriatrics and Director of Geriatrics
Sinai Health System and the University Health Network
Mount Sinai Hospital
Suite 475 – 600 University Avenue
Toronto, Ontario, Canada. M5G 1X5

CONFLICTS OF INTEREST

The authors have no conflicts of interest to report.

ACKNOWLEDGMENTS

Sponsors and Funding: Funding for this project was provided by a *Canadian Frailty Network* Summer Student Award to MBD. MBD also receives PhD funding from the Rhodes Trust, the Clarendon Fund at the

University of Oxford, and the Canadian Institutes of Health Research Doctoral Foreign Study Award (DFD-175796). No other authors report any funding relevant to this study.

REFERENCES

1. Aminzadeh F, Dalziel WB. Older adults in the emergency department: a systematic review of patterns of use, adverse outcomes, and effectiveness of interventions. Ann Emerg Med. 2002;39(3):238-47. DOI: 10.1067/mem.2002.121523
2. Gruneir A, Silver MJ, Rochon PA. Emergency department use by older adults: a literature review on trends, appropriateness, and consequences of unmet health care needs. Medical Care Research and Review. 2011;68(2):131-55. DOI: 10.1177/1077558710379422
3. Samaras N, Chevalley T, Samaras D, Gold G. Older patients in the emergency department: a review. Ann Emerg Med. 2010;56(3):261-9. DOI: 10.1016/j.annemergmed.2010.04.015
4. Canadian Institute for Health Information. NACRS Emergency Department Visits: Volumes and Median Lengths of Stay, 2003–2004 to 2021–2022 — Supplementary Statistics. Ottawa, ON: CIHI; 2022.
5. Statistics Canada. Table 17-10-0009-01 Population estimates, quarterly DOI: 10.25318/1710000901-eng6.
6. Pallin DJ, Allen MB, Espinola JA, Camargo CA, Jr., Bohan JS. Population aging and emergency departments: visits will not increase, lengths-of-stay and hospitalizations will. Health Aff (Millwood). 2013;32(7):1306-12. DOI: 10.1377/hlthaff.2012.0951.
7. Ukkonen M, Jämsen E, Zeitlin R, Pauniaho S-L. Emergency department visits in older patients: a population-based survey. BMC Emergency Medicine. 2019;19(1):20. DOI: 10.1186/s12873-019-0236-3
8. Carpenter CR, Shelton E, Fowler S, Suffoletto B, Platts-Mills TF, Rothman RE, et al. Risk factors and screening instruments to predict adverse outcomes for undifferentiated older emergency department patients: a systematic review and meta-analysis. Acad Emerg Med. 2015;22(1):1-21. DOI: 10.1111/acem.12569
9. Whate A, Elliott J, Carter D, Stolee P. Performance of the interRAI ED Screener for Risk-Screening in Older Adults Accessing Paramedic Services. Canadian Geriatrics Journal. 2021;24(1):8. DOI: 10.5770/cgj.24.451
10. Heeren P, Devriendt E, Wellens NI, Deschodt M, Flamaing J, Sabbe M, et al. Old and new geriatric screening tools in a Belgian emergency department: a diagnostic accuracy study. Journal of the American Geriatrics Society. 2020;68(7):1454-61. DOI: 10.1111/jgs.16503
11. Michalski-Monnerat C, Carron PN, Nguyen S, Büla C, Mabire C. Assessing Older Patients' Vulnerability in the Emergency Department: A Study of InterRAI ED Screener Accuracy. J Am Geriatr Soc. 2020;68(12):2914-20. DOI: 10.1111/jgs.16829
12. Taylor A, Broadbent M, Wallis M, Marsden E. The predictive validity of the interRAI ED screener for predicting re-presentation within 28 days for older adults at a regional hospital emergency department. Australasian emergency care. 2019;22(3):149-55. DOI: 10.1016/j.auec.2019.04.005
13. Ahmadi D. Is diversity our strength? An analysis of the facts and fancies of diversity in Toronto. City, Culture and Society. 2018;13, 64-72.
14. Ogliari G, Coffey F, Keillor L, Aw D, Azad MY, Allaboudy M, et al. Emergency department use and length of stay by younger and older adults: Nottingham cohort study in the emergency department (NOCED). Aging Clinical and Experimental Research. 2022;34(11):2873-85. DOI: 10.1007/s40520-022-02226-5
15. Earl-Royal EC, Kaufman EJ, Hanlon AL, Holena DN, Rising KL, Kit Delgado M. Factors associated with hospital admission after an emergency department treat and release visit for older adults with injuries. Am J Emerg Med. 2017;35(9):1252-7. DOI: 10.1016/j.ajem.2017.03.051
16. García-Peña C, Pérez-Zepeda MU, Robles-Jiménez LV, Sánchez-García S, Ramírez-Aldana R, Tella-Vega P. Mortality and associated risk factors for older adults admitted to the emergency department: a hospital cohort. BMC Geriatrics. 2018;18(1):144. DOI: 10.1186/s12877-018-0833-0

17. Lo AX, Flood KL, Biese K, Platts-Mills TF, Donnelly JP, Carpenter CR. Factors Associated With Hospital Admission for Older Adults Receiving Care in U.S. Emergency Departments. The Journals of Gerontology: Series A. 2017;72(8):1105-9. DOI: 10.1093/gerona/glw207
18. de Man Y, Atsma F, Jonkers W, de Rooij S, Westert GP, Jeurissen PPT, et al. Care trajectories of chronically ill older adult patients discharged from hospital: a quantitative cross-sectional study using health insurance claims data. BMC Geriatr. 2019;19(1):266. DOI: 10.1186/s12877-019-1302-0
19. Lowthian J, Straney LD, Brand CA, Barker AL, Smit PdV, Newnham H, et al. Unplanned early return to the emergency department by older patients: the Safe Elderly Emergency Department Discharge (SEED) project. Age and Ageing. 2016;45(2):255-61. DOI: 10.1093/ageing/afv198
20. McCusker J, Cardin S, Bellavance Fo, Belzile É. Return to the Emergency Department among Elders: Patterns And Predictors. Academic Emergency Medicine. 2000;7(3):249-59. DOI: 10.1111/j.1553-2712.2000.tb01070.x
21. Nagurney JM, Fleischman W, Han L, Leo-Summers L, Allore HG, Gill TM. Emergency Department Visits Without Hospitalization Are Associated With Functional Decline in Older Persons. Ann Emerg Med. 2017;69(4):426-33. DOI: 10.1016/j.annemergmed.2016.09.018
22. Hastings SN, Schmader KE, Sloane RJ, Weinberger M, Goldberg KC, Oddone EZ. Adverse Health Outcomes After Discharge from the Emergency Department—Incidence and Risk Factors in a Veteran Population. Journal of General Internal Medicine. 2007;22(11):1527-31. DOI: 10.1007/s11606-007-0343-9
23. Rasmussen LF, Grode LB, Lange J, Barat I, Gregersen M. Impact of transitional care interventions on hospital readmissions in older medical patients: a systematic review. BMJ Open. 2021;11(1):e040057. DOI: 10.1136/bmjopen-2020-040057
24. Campagna S, Conti A, Dimonte V, Berchialla P, Borraccino A, Gianino MM. Emergency Department Visits Before, After and During Integrated Home Care: A Time Series Analyses in Italy. Int J Health Policy Manag. 2022;11(12):3012-8. DOI: 10.34172/ijhpm.2022.6662
25. Leppin AL, Gionfriddo MR, Kessler M, Brito JP, Mair FS, Gallacher K, et al. Preventing 30-Day Hospital Readmissions: A Systematic Review and Meta-analysis of Randomized Trials. JAMA Internal Medicine. 2014;174(7):1095-107. DOI: 10.1001/jamainternmed.2014.1608
26. Feltner C, Jones CD, Cené CW, Zheng ZJ, Sueta CA, Coker-Schwimmer EJ, et al. Transitional care interventions to prevent readmissions for persons with heart failure: a systematic review and meta-analysis. Ann Intern Med. 2014;160(11):774-84. DOI: 10.7326/M14-0083
27. Siclovan DM. The effectiveness of home health care for reducing readmissions: an integrative review. Home Health Care Services Quarterly. 2018;37(3):187-210. DOI: 10.1080/01621424.2018.1472702
28. Mowbray FI, Heckman G, Hirdes JP, Costa AP, Beauchet O, Archambault P, et al. Agreement and prognostic accuracy of three ED vulnerability screeners: findings from a prospective multi-site cohort study. Canadian Journal of Emergency Medicine. 2023;25(3):209-17. DOI: 10.1007/s43678-023-00458-6