

mHOMR: a feasibility study of an automated system for identifying inpatients having an elevated risk of 1-year mortality

Appendices

Appendix A—Site details

The University Health Network (UHN, Site 1) and the Sinai Health System (SHS, Site 2) are quaternary health sciences centres affiliated with the University of Toronto. The UHN includes four hospitals (Toronto General Hospital, Toronto Western Hospital, Princess Margaret Cancer Centre, and Toronto Rehabilitation Institute) with approximately 1,300 patient beds and 115,000 emergency department visits per year. The UHN employs 14,000 staff, including 4,000 nurses and 770 physicians, with an annual budget of more than \$2 billion. The medical ward is spread among 2 sites (Toronto General Hospital and Toronto Western Hospital), covered by 11 multidisciplinary teams that include attending physicians, trainees, pharmacists, social workers, physiotherapists, and occupational therapists.

The SHS includes two hospitals (Mount Sinai Hospital and Bridgepoint Active Healthcare) with approximately 850 beds and 60,000 emergency department visits per year. The SHS employs 4,500 staff, including 1,400 nurses and 333 physicians. The medical ward is located at Mount Sinai and is covered by 4 multidisciplinary teams.

The UHN and SHS are located in the Toronto Central Local Health Integration Network region (population 2.5 million), but they provide care to a large proportion of the population in the Greater Toronto Area, and the Intensive Care Units and Organ Transplant services provide coverage across Ontario and even to other provinces throughout Eastern Canada. At all the sites where the medical wards are located, there is an inpatient palliative care (PC) consultation service available during the daytime seven days a week, staffed by physicians and a clinical nurse specialist. Outpatient PC clinics are available for some specific illnesses such as cancer, and many patients with advanced cancer who are admitted to the medical ward would already be followed by a PC consultant prior to their admission.

Appendix B—HOMR and mHOMR scores

Variable	mHOMR		HOMR	
	Estimate	Std. Error	Estimate	Std. Error
Intercept	-7.069	0.040	-10.610	0.184
$\sqrt{\text{Patient Age}}$	0.872	0.003	0.982	0.018
Patient is male	0.308	0.005	0.197	0.014
Admitting service				
Cardiology	-1.724	0.028	-0.367	0.027
Cardiovascular surgery	-1.585	0.026	-0.200	0.052
Gastroenterology / nephrology / neurology	-0.139	0.029	-0.236	0.028
General surgery	-1.468	0.018	-0.480	0.031
Gynecology	-2.180	0.035	-0.520	0.093
Hematology/oncology	0.482	0.019	0.739	0.034
Neurosurgery	-0.959	0.035	0.077	0.064
Obstetrics	-4.178	0.092	-2.068	0.265
Orthopedic surgery	-2.771	0.027	-0.634	0.037
Palliative care	4.812	0.139	3.595	0.118
Plastic surgery	-1.879	0.039	-0.560	0.085
Thoracic surgery	-0.080	0.033	-0.676	0.082
Trauma	-1.928	0.125	-0.351	0.059
Urology	-1.790	0.024	-0.742	0.047
Admission is an urgent 30-day readmission	0.111	0.014	0.153	0.026
$\frac{1}{\sqrt{\text{Total number of ED visits in the past 12 months} + 1}}$	-0.640	0.012	-0.327	0.033
$\frac{1}{\text{Total number of admissions by ambulance in past 12 months} + 1}$	-1.566	0.030	-1.117	0.091
Living status (patient admitted from...)				
Rehabilitation facility	-0.007	0.187	0.357	0.275
At home with home care	-1.204	0.059	0.511	0.061
Nursing home	0.155	0.046	0.595	0.076
Chronic care hospital	0.379	0.132	0.782	0.204
Urgency of the current admission				
ED without ambulance	-0.799	0.037	-0.268	0.100
ED with ambulance	-0.579	0.034	-0.227	0.086
Current admission was directly to the ICU	0.506	0.007	0.377	0.023
Living Status $\times \frac{1}{\text{Total number of admissions by ambulance in past 12 months} + 1}$				
Rehabilitation facility	0.396	0.272	0.280	0.316
At home with home care	1.752	0.061	0.280	0.245
Nursing home	0.605	0.048	0.310	0.289
Chronic care hospital	0.916	0.155	0.710	0.728
Admission Urgency $\times \frac{1}{\text{Total number of admissions by ambulance in past 12 months} + 1}$				
ED without ambulance	0.504	0.038	0.850	0.890
ED with ambulance	0.803	0.035	1.210	1.245

mHOMR: a feasibility study of an automated system for identifying inpatients having an elevated risk of 1-year mortality

Admitting Service × Admission Urgency			—	—
Cardiology × ED without ambulance	1.156	0.032	—	—
Cardiology × ED with ambulance	1.125	0.031	—	—
Cardiovascular surgery × ED without ambulance	1.729	0.051	—	—
Cardiovascular surgery × ED with ambulance	0.948	0.039	—	—
Gastroenterology / nephrology / neurology × ED without ambulance	0.070	0.033	—	—
Gastroenterology / nephrology / neurology × ED with ambulance	0.159	0.032	—	—
General surgery × ED without ambulance	0.953	0.024	—	—
General surgery × ED with ambulance	1.030	0.024	—	—
Gynecology × ED without ambulance	2.106	0.069	—	—
Gynecology × ED with ambulance	2.333	0.087	—	—
Hematology/oncology × ED without ambulance	2.026	0.026	—	—
Hematology/oncology × ED with ambulance	1.919	0.032	—	—
Neurosurgery × ED without ambulance	1.729	0.058	—	—
Neurosurgery × ED with ambulance	1.466	0.044	—	—
Obstetrics × ED without ambulance	1.175	0.283	—	—
Obstetrics × ED with ambulance	1.887	0.232	—	—
Orthopedic surgery × ED without ambulance	1.960	0.042	—	—
Orthopedic surgery × ED with ambulance	1.910	0.031	—	—
Palliative care × ED without ambulance	0.042	0.194	—	—
Palliative care × ED with ambulance	-0.004	0.174	—	—
Plastic surgery × ED without ambulance	0.667	0.081	—	—
Plastic surgery × ED with ambulance	0.818	0.078	—	—
Thoracics × ED without ambulance	0.798	0.084	—	—
Thoracics × ED with ambulance	0.115	0.085	—	—
Trauma × ED without ambulance	1.330	0.134	—	—
Trauma × ED with ambulance	1.385	0.127	—	—
Urology × ED without ambulance	1.086	0.041	—	—
Urology × ED with ambulance	1.333	0.040	—	—
Diagnostic risk score increased by 1	—	—	0.198	0.002
log(Charlson Comorbidity Index score + 1)	—	—	3.922	0.112
Home oxygen use	—	—	0.829	0.029
$\sqrt{\text{Patient Age}} \times \log(\text{Charlson Comorbidity Index score} + 1)$	—	—	-0.336	0.013

Appendix C—Example mHOMR score calculation

Scenario: A 70-year-old female arrives from a nursing home by ambulance to the emergency department (ED) and is admitted by cardiology. She has been to the ED twice in the past 12 months and was admitted once by ambulance in that time. The current admission is not an urgent 30-day readmission and she does not go to the ICU for the current admission. According to the mHOMR model, she would have a 22% chance of death in the next 12 months.

Covariate	Weight	Estimate	Value (Weight × Estimate)
Intercept	1	-7.063915192	-7.063915192
Age	$\sqrt{70}$	0.871636062	7.292630508
Sex	0	0.308462457	0
Admitting service <i>Cardiology</i>	1	-1.724503732	-1.724503732
Was the current admission an urgent 30-day readmission?	0	0.110983695	0
Number of ED visits in the past 12 months	$\frac{1}{\sqrt{3}}$	-0.640014591	-0.369512596
Number of admissions by ambulance in the past 12 months	$\frac{1}{2}$	-1.566596305	-0.783298153
Patient's living status <i>Nursing home</i>	1	0.155148147	0.155148147
Admission urgency of current admission <i>ED with ambulance</i>	1	-0.578781696	-0.578781696
Was the current admission directly to the ICU?	0	0.506184712	0

If the patient has been admitted by ambulance 1 or more times in the previous 12 months, what was their living status?

mHOMR: a feasibility study of an automated system for identifying inpatients having an elevated risk of 1-year mortality

<i>Nursing home</i>	$\frac{1}{2}$	0.605470559	0.302735280
If the patient is currently being admitted from the ED by ambulance...			
How many times have they been admitted by ambulance in the previous 12 months?	$\frac{1}{2}$	0.803525355	0.401762678
What is the current admitting service?			
<i>Cardiology</i>	1	1.124894205	1.124894205
		Total of all values (logit)	-1.242840552
Probability of death in the next 12 months			0.223941934

Appendix D—Text of notifications

To: *[Doctor's Last and First Name]*, MD

Notification Details:

PATIENT

MRN: *[MRN]*;

Name: *[Patient Last, First Name]*;

Admitted on: *[DATE]*

This patient has been identified as being at elevated risk of death or deterioration in the next 12 months. If you agree that this patient is at risk of death in the next year, please assess the current care and future care plan to determine whether any changes may be appropriate.

WHAT SHOULD I DO NOW?

Patients nearing the end of their life may benefit from one or more of the following actions:

- Assess¹ and treat² uncontrolled pain and other symptoms.
- Determine if an Advance Care Plan³ is in place, and whether this plan seems appropriate given the clinical picture. A workbook⁴ may be helpful for patients and family members.
- If deterioration seems likely on this admission, please discuss your patient's goals of care⁵ and ensure that the treatment plan for that deterioration is consistent with the patient's values and is appropriate for the clinical picture.
- Review current medications and consider stopping any medication that would have little or no benefit (and possible harm) for patients nearing the end of their life. The Beers criteria⁶ or the STOPP/START⁷ criteria may be helpful.
- Ensure that the disposition plan is appropriate for someone nearing the end of their life.
- The Palliative Care consult team is available to assist for any of these patients as needed.

¹ Link to Edmonton Symptom Assessment System: <https://www.cancercareontario.ca/sites/ccocancercare/files/assets/CCOESAS-English.pdf>

² Link to Symptom Management Guidelines: <https://smg.cancercare.on.ca/>

³ Link to Symptom Management Guidelines: <https://smg.cancercare.on.ca/>

⁴ Link to Advance Care Planning workbook: http://www.advancedcareplanning.ca/wp-content/uploads/2015/09/acp_ontario_workbook_-_03.2015_colour_final-web-form.pdf

⁵ Link to communication module: <http://goalsofcareblog.wordpress.com/>

⁶ Link to Beers criteria:

<http://onlinelibrary.wiley.com/doi/10.1111/jgs.13702/abstract;jsessionid=B9B42C82B6961225F6DBC1D6F3C169DA.fo4to4>

⁷ Link to STOPP/START criteria: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4339726/>

mHOMR: a feasibility study of an automated system for identifying inpatients having an elevated risk of 1-year mortality

HOW WAS THIS PREDICTION MADE?

We used a modified version of the Hospital One-Year Mortality Risk score (DOI:10.1503/cmaj.150209), a tool that uses simple demographic variables (e.g. age, sex) and administrative information (e.g. admitting service, urgent readmission, number of admissions in the past 12 months). It is not a perfect test, but it is more accurate than any published prognostic tool that uses clinical information or clinician judgment.

WHAT IF I DISAGREE WITH THIS PREDICTION?

This message is intended simply as a notification or reminder to address potential unmet palliative needs. An elevated risk of mortality does not mean that mortality is certain in this timeframe, or that therapies will be ineffective for prolonging life. There are other published indicators that can identify patients at risk of deterioration and death including the Supportive and Palliative Care Indicators Tool (SPICT™). Unfortunately, there are no perfect tools for predicting death, and it is up to your clinical judgment to determine whether to act on this notification.

If you have any questions/concerns about this notification, please contact XXXX at XXXXX.