Appendix 1 (as supplied by the authors): Supplemental data

Methods 1. Identifying patients cared for by GIM.

We identified patients cared for by GIM based on their admitting service as documented at each hospital except Trillium Health Partners where admitting service was not recorded by the hospital. At Trillium Health Partners, patients were included in the cohort if a physician who attends on the GIM service was their 'most responsible physician', which is defined by the Canadian Institute for Health Information (CIHI) as, the "physician who is responsible for the care and treatment of the patient for the majority of the visit".(1) To address possible inaccuracies in the admitting service codes, we manually reviewed the list of physicians and included only patients who were admitted or discharged by a physician who attends on the GIM service.

Methods 2. Structure of General Internal Medicine Services at GEMINI hospitals

St. Michael's Hospital

- Clinical Teaching Unit – 4 Teams
- Hospitalist Service – 1 Team
- General Internists are the attending physicians on all teams

University Health Network - Toronto General Hospital

- Clinical Teaching Unit – 4 Teams
- Hospitalist Service – 1 Team
- Internal Medicine Cancer Service – 1 Team (started in September 2014)
- General Internists and subspecialists in other areas of Internal Medicine are the attending physicians on all teams

University Health Network - Toronto Western Hospital

- Clinical Teaching Unit – 4 Teams
- Hospitalist Service – 1 Team
- Family Medicine Hospitalist Service – 1 Team
- General Internists and subspecialists in other areas of Internal Medicine are the attending physicians on all teams except for the family medicine hospitalist service, which is run by family physicians.

Sinai Health System

- Clinical Teaching Unit – 4 Teams
- General Internists, subspecialists in other areas of Internal Medicine, and one family physician-hospitalist are the attending physicians on all teams

Sunnybrook Health Sciences Centre

- Clinical Teaching Unit – 4 Teams
- Short Stay Unit – 1 Team
- Hospitalist Service – 1 Team
- General Internists and subspecialists in other areas of Internal Medicine are the attending physicians on all teams

Trillium Health Partners - Credit Valley Hospital

- Clinical Teaching Unit – 2 Teams
- Hospitalist Service (GIM) – 3 additional teams
- Hospitalist Service (Family Medicine) – 4 teams
- Clinical Teaching Unit and Hospitalist Service (GIM) teams are staffed by general internists and subspecialists in other areas of Internal Medicine. Hospitalist (family medicine) teams are staffed by family medicine hospitalist physicians and include the Family Medicine Teaching Unit.

Trillium Health Partners - Mississauga Hospital

- Clinical Teaching Unit – 2 Teams
- Hospitalist Service (GIM) – variable (2 intake teams per week with other teams continuing to care for admitted patients; maximum of 16 teams in operation at a time)
- General Internists attend on both Clinical Teaching Unit and Hospitalist teams. A small number of Internal Medicine subspecialists attend on Clinical Teaching Unit teams. Data for GEMINI was collected only for General Internists because for subspecialists it was not possible to distinguish between their patients cared for on subspecialty services and general medicine services.

Methods 3. Determining the proportion of hospital resources used by GIM.

To determine the proportion of hospital resources that were used by GIM patients, we compared the number of hospitalizations, admissions to hospital from the emergency department (which we refer to as 'emergency admissions'), and total bed-days for patients in the GEMINI cohort to overall hospital values.

Data regarding total hospital utilization were obtained from the decision support department at each hospital. For the two hospital sites at Trillium Health Partners, this data could only be obtained for April 1, 2012 to March 31, 2015 (excluding the first two years of the study) because the hospital underwent a merger at that time. For Mount Sinai Hospital, data were unavailable for the fourth quarter of fiscal year 2011. Therefore, we excluded all of 2011 data from Mount Sinai Hospital for this calculation. The percentage of bed days attributable to GIM at Mount Sinai Hospital was 19.5% in fiscal year 2010 and 20.1% in fiscal years 2012-2014. Thus, excluding fiscal year 2011 is unlikely to have substantially changed our estimate.

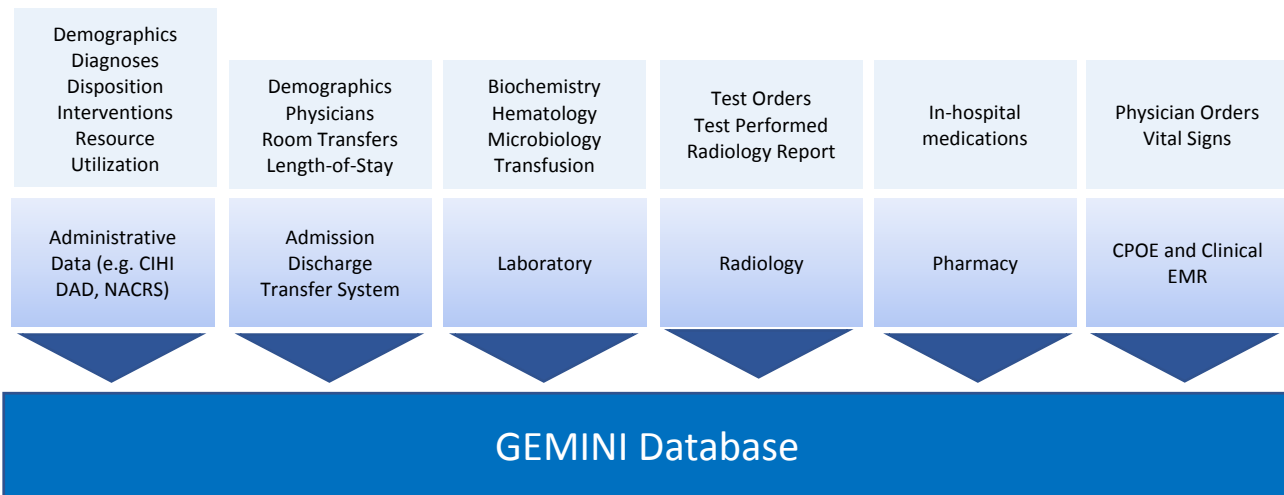**Figure 1.** GEMINI cohort study data collection schematic.

Demographics Diagnoses Disposition Interventions Resource Utilization	Demographics Physicians Room Transfers Length-of-Stay	Biochemistry Hematology Microbiology Transfusion	Test Orders Test Performed Radiology Report	In-hospital medications	Physician Orders Vital Signs
Administrative Data (e.g. CIHI DAD, NACRS)	Admission Discharge Transfer System	Laboratory	Radiology	Pharmacy	CPOE and Clinical EMR

GEMINI Database

Figure 2. Distribution of age, number of comorbidities, length-of-stay, and cost in the GEMINI cohort.
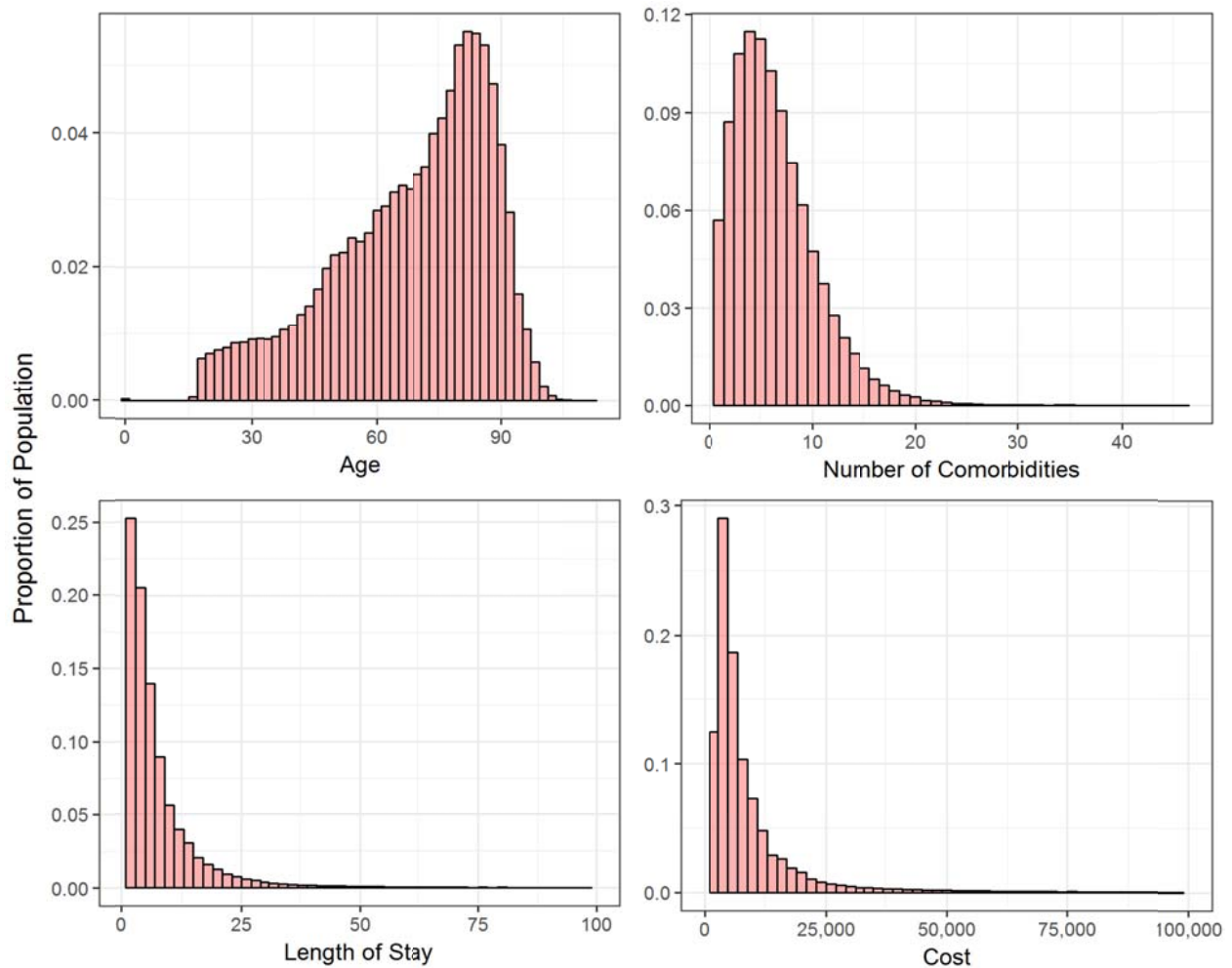

Figure 2: Age is expressed in years, length-of-stay in days, and cost in Canadian dollars. The length-of-stay and cost figures have had the x-axis truncated. For length-of-stay, 276 cases had a length-of-stay between 100 and 1,653 days. For cost, 1,240 cases had a cost between $100,000 and $2,443,417.

Table 1. Data availability for each GEMINI site.

Data Source	SMH	UHN – TGH/TWH	MSH	SBK	THP – CVH/M
CIHI DAD/NACRS	Available	Available	Available	Available	Available
In-Hospital Transfers	Available	Available	Available	Available	Not Available
Case Cost	Available	Available	Available	Available	Available
Cardiology ECG and Echo	Available	Partially Available	Partially Available	Available	Partially Available
Microbiology	Available	Available	Available	Available	Available
Biochemistry/Hematology	Available	Available	Available	Available	Available
Blood Transfusions	Available	Available	Available	Available	Available
Pharmacy	Available	Available	Available	Available	Available
Radiology	Available	Available	Available	Available	Available
Vital Signs	Available	Not Available	Available	Not Available	Available
Clinical Documentation (Diet Orders, Confusion Assessment Method Score, Pain Score, Weight)	Available	Not Available	Available	Not Available	Partially Available

Table 2. Overall trends in GIM by fiscal year.

	2010-11	2011-12	2012-13	2013-14	2014-15
Number of hospitalizations	23,475	25,988	27,140	28,527	31,078
Length-of-stay (days – median, 25%, 75%)	4.6 (2.5, 8.6)	4.7 (2.5, 8.8)	4.6 (2.5, 8.6)	4.6 (2.5, 8.6)	4.6 (2.5, 8.5)
30-day Readmission* (N, %)	2,440 (10.5)	2,739 (10.7)	2,856 (10.6)	3,160 (11.2)	3,192 (11.3)
Cost (median, 25%, 75%)	5,808 (3,888, 10,128)	5,779 (3,857, 10,095)	5,762 (3,898, 10,039)	5,977 (4,027, 10,255)	5,813 (3,914, 9,824)
Patients receiving at least 1 of: Ultrasound, CT scan, or MRI (N, %)	12,573 (66.9)	13,257 (66.7)	13,213 (65.3)	13,407 (64.4)	13,942 (63.3)
Patients receiving at least 1 Ultrasound (N,%)	5,791 (30.8)	6,053 (30.4)	5,707 (28.2)	5,706 (27.4)	5,636 (25.6)
Patients receiving at least 1 CT scan (N, %)	10,103 (53.8)	10,540 (53.0)	10,566 (52.2)	10,679 (51.3)	11,237 (51.0)
Patients receiving at least 1 MRI (N, %)	2,357 (12.5)	2,398 (12.1)	2,221 (11.0)	2,254 (10.8)	2,419 (11.0)
Age (years)	68.8	68.7	68.6	68.5	69.0
Sex Female (N, %)	50.2	51.0	50.7	50.2	51.0
High Comorbidity^ (N, %)	9,759 (41.6)	10,766 (41.4)	11,408 (42.0)	12,323 (43.2)	13,075 (42.1)
Number of Coexisting Conditions (N)	6.4	6.3	6.5	6.6	6.4

Table 2: *30-day readmission represents readmission to GIM at one of the participating GEMINI hospitals within 30 days of discharge. ^High comorbidity was defined as a Charlson score of 2 or greater. There were 48 hospitalizations with missing cost data and they were excluded from the analysis of cost. Radiology data were unavailable for 34,453 patients from Trillium Health Partners at the time of submission.

Table 3: Comparison of CIHI Case Mix Groups with validated cohort definitions using combinations of ICD-10-CA codes.

Cohort	CMG Group	Number of Hospitalizations	Validated Cohort Definition ICD-10-CA Codes	Number Of Hospitalizations	Sensitivity (%)	Specificity (%)
COPD	139	5574	J41-44(2)	5588	99.23	99.98
Pneumonia	138	6804	J10-18(3)	7229	93.17	99.95
Heart Failure	196	6341	I50, I25.5., I40-I43, I11+I50, I13+I50(4)	6677	94.64	99.98
Stroke	26	4912	I63, I64, H34(5)	5535	88.74	100.00
UTI	487	5466	N10, N12, N151, N300, N308, N309, N410, N412, N413, N510(6)	6794	80.38	100.00

Legend: Sensitivity and Specificity of CIHI CMG compared with validated cohort definitions. 48 hospitalizations had missing CMG designation and were excluded from this table. Validation studies of administrative codes report moderate to excellent sensitivity and specificity for the diagnoses of COPD, pneumonia, heart failure, stroke, and UTI. COPD: Detailed chart review of patients hospitalized with an administrative discharge diagnosis of COPD found that 50% had spirometry-confirmed COPD, 31% had no formal confirmation of COPD, and 19% did not have a diagnosis of COPD.(7) Pneumonia: Sensitivity of diagnostic codes ranged from 89 to 98% and specificity ranged from 62 to 97%.(8) Heart Failure: Sensitivity of diagnostic codes in Canada ranged from 59% to 79%, specificity was 97% and positive predictive value ranged from 65% to 94%.(9) Stroke: Sensitivity of diagnostic codes was 82% and positive predictive value ranged from 69% to 97%.(5,10) UTI: Sensitivity of diagnostic codes was 61% and specificity was 95%.(11) CMG: Case-Mix Group. COPD: Chronic Obstructive Pulmonary Disease; UTI: Urinary Tract Infection.

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