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Impact of deprivation and comorbidity on outcomes in emergency general surgery: an epidemiological study

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ABSTRACT

Background The impact of socioeconomic deprivation and comorbidities on the outcome of patients who require emergency general surgery (EGS) admission is poorly understood. The aim of this study was to examine the effect of deprivation and comorbidity on mortality, discharge destination and length of hospital stay (LOS) in patients undergoing EGS in Scotland.

Methods Prospectively collected data from all Scottish adult patients (aged >15 years) requiring EGS admitted between 1997 and 2016 were obtained from the Scottish Government. Data included age, sex, Scottish Index of Multiple Deprivation (SIMD), 5-year Charlson Comorbidity Index (CCI), whether an operation took place and outcomes including mortality, discharge destination and LOS. Logistic regression was used for the analysis of mortality and discharge destination and Poisson regression was used for LOS.

Results 1 477 810 EGS admissions were analyzed. 16.2% were in the most deprived SIMD decile and 5.6% in the least deprived SIMD decile. 75.6% had no comorbidity, 20.3% had mild comorbidity, 2.5% had moderate comorbidity and 1.6% had severe comorbidity. 78.6% were discharged directly home. Inpatient, 30-day, 90-day and 1-year crude mortality was 1.7%, 3.7%, 7.2% and 12.4%, respectively. Logistic regression showed that severe comorbidity was associated with not being discharged directly to home (OR 0.38, 95% CI 0.37 to 0.39) and higher inpatient mortality (OR 13.74, 95% CI 13.09 to 14.42). Compared with the most affluent population, the most deprived population were less likely to be discharged directly to home (OR 0.97, 95% CI 0.95 to 0.99) and had higher inpatient mortality (OR 1.36, 95% CI 1.8 to 1.46). Poisson analysis showed that severe comorbidity (OR 1.69, 95% CI 1.68 to 1.69) and socioeconomic deprivation (OR 1.11, 95% CI 1.11 to 1.12) were associated with longer LOS.

Discussion Increased levels of comorbidity and, to a lesser extent, socioeconomic deprivation are key drivers of mortality, discharge destination and LOS following admission to an EGS service.

Level of evidence III (prospective/retrospective with up to two negative criteria).

Study type Epidemiological/prognostic.

BACKGROUND

Health inequalities exist between the most deprived and most affluent populations.[1–8] In particular, socioeconomic deprivation is associated with an increased risk of cardiovascular disease,[1] poor cognitive function,[2] postoperative mortality,[3 5–8] morbidity[4 6 7] and increased hospital stay[7] for both elective and emergency operations. The reasons for this are likely multifactorial, but poorly understood. In addition, it is now recognized that many patients admitted to emergency general services are managed non-operatively,[9] and it is not known whether all deprived patients, rather than only those who undergo an operation, are at a health disadvantage. Socioeconomic deprivation is not a hard barrier to healthcare access in the UK, as NHS healthcare is provided free at the point of care regardless of insurance status. However, deprivation may present a barrier to healthcare in other 'unseen' ways, which could lead to poorer outcomes.

Outcomes are also affected by comorbidities. Multiply comorbid patients undergoing emergency general surgery (EGS) procedures have an increased mortality risk,[10] which is exacerbated if the patient undergoes a high-risk EGS procedure.[8] Frailty is a predictor of perioperative complications, length of hospital stay,[11] mortality, institutional discharge and cost[12] in patients undergoing EGS. Although they are not synonymous, frailty and comorbidity are related in that frail patients are likely to be more comorbid.[12]

Although the impact of socioeconomic deprivation and comorbidity has been established, their combined impact is not known. We hypothesized that deprivation and comorbidity could have an additive or multiplicative effect on adverse outcomes. The aim of this study was to examine the impact of deprivation and comorbidity on mortality, discharge destination and length of hospital stay in patients undergoing EGS in Scotland.

METHODS

This was a population-based retrospective cohort study.

Case definition and data sources

Data were obtained of all Scottish EGS admissions between 1997 and 2016 involving persons aged >15 years. These data were sourced by querying the prospectively collected database held by the Information Services Division (ISD) of the Scottish Government,[13] to identify all patients within our study timeframe who were admitted as an emergency to a Scottish hospital under the care of a consultant (attending) general surgeon. Patients who are over 15 years of age in Scotland are admitted under adult general surgery services. The conditions treated by general surgeons in Scotland include undifferentiated abdominal pain, oesophago-gastric, hepatico-pancreatico-biliary, colorectal and acute breast conditions, and abdominal trauma. This includes conditions such as choledocholithiasis, diverticulitis and acute pancreatitis which may, in other countries, be managed by doctors other than surgeons. Surgeons in smaller hospitals may also treat patients with urological conditions, minor head injuries and thoracic trauma. ISD data are coded using the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10). Anonymised data were hosted by the University of Aberdeen Data Safehaven in an Excel database (Microsoft Corporation, Redmond, Washington, USA).

The Scottish Index of Multiple Deprivation (SIMD) is a tool created by the Scottish Government which identifies small area concentrations of multiple deprivation in a consistent way. It identifies areas of poverty, inequality and decreased opportunity based on income, employment, education, health, access to services, crime and housing domains. It divides Scotland into 6976 data zones, each with a roughly equal population (approximately 760 residents per data zone).[14]

Extracted data for each EGS admission included patient age, sex, SIMD deciles (1=most deprived; 10=least deprived), 5-year Charlson Comorbidity Index (CCI),[15] whether patients had a surgical operation and outcome of the admission including mortality (inpatient, 30-day, 90-day and 1-year), discharge destination and length of hospital stay (LOS). CCI was described as no comorbidity (CCI 0), mild comorbidity (CCI 1 to 2), moderate comorbidity (CCI 3 to 4) and severe comorbidity (CCI >4), in a similar fashion to several other publications.[16 17]

Analysis of data

Binomial logistic regression was used to analyse discharge destination and inpatient, 30-day, 90-day and 1-year mortality. Poisson regression was used to analyse LOS. Statistical analysis was repeated for the subgroup of patients who underwent a surgical operation. All statistical analyses were conducted using SPSS (IBM Corporation, Armonk, New York, USA).

Ethical approval

This project was registered with the research governance department of NHS Grampian and the University of Aberdeen, and approved by the Public Benefit and Privacy Panel (PBPP) of NHS Scotland (Ref 1617–0207).

RESULTS

Demographics

A total of 1477810 EGS admissions meeting our inclusion criteria were identified (figure 1); 237824 (16.2%) were in SIMD decile 1 (most deprived) and 81830 (5.6%) were in SIMD decile 10 (least deprived) (table 1). Of the total, 1116808 (75.6%) had no comorbidity (CCI 0), 299657 (20.3%) had mild comorbidity (CCI 1 to 2), 37558 (2.5%) had moderate comorbidity (CCI 3 to 4) and 23787 (1.6%) had severe comorbidity (CCI >4).

The subgroup of patients who underwent an operative procedure totalled 397475 cases (26.9% of all admissions); 55368 (14.0%) were in SIMD decile 1 and 26043 (6.6%) in SIMD decile 10 (table 2). A total of 299344 (75.3%) had no comorbidity, 82146 (20.7%) had mild comorbidity, 9673 (2.4%) had moderate comorbidity and 6312 (1.6%) had severe comorbidity (table 2). Detailed breakdowns of admissions by diagnoses have been published in our previous works, including trends over the past 20 years.[9 18]

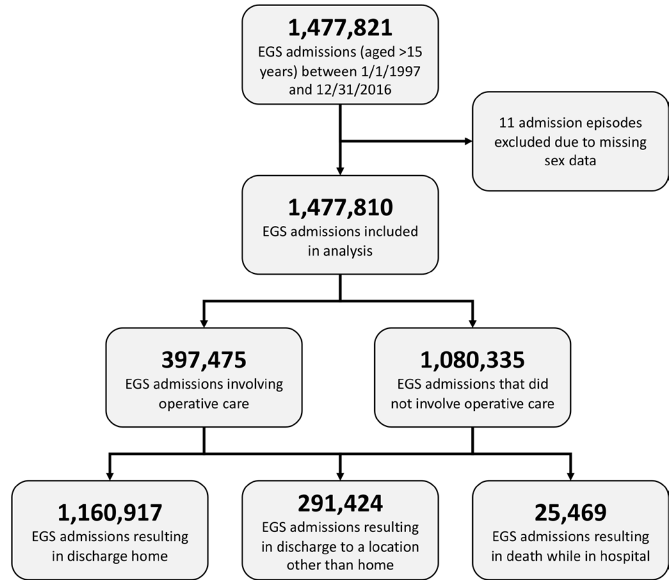

Figure 1 Flow diagram of included and excluded cases. EGS, emergency general surgery.

Outcomes

A total of 1452341 (98.3%) patients were discharged from hospital and 25469 (1.7%) died in hospital (table 1); 1160917 patients (78.6%) were discharged home, while 291424 (19.7%) were discharged from the acute care setting to a non-home environment (table 1). The overall 30-day, 90-day and 1-year crude mortality rates were 3.7%, 7.2% and 12.4%, respectively (table 1). These figures remained unchanged depending on SIMD decile, but were greatly affected by comorbidity.

Among the operative subgroup, 319970 (80.5%) of patients were discharged directly home and 77505 (19.5%) were not (table 2). A total of 392366 (98.7%) were discharged from hospital and 5109 (1.29%) died in hospital (table 2). Overall 30-day, 90-day and 1-year crude mortality rates were 3.2%, 6.7% and 11.4%, respectively (table 2). As with the overall cohort of admissions, the outcomes of operative patients were largely affected by CCI but not by SIMD (table 2).

Combined analysis

This finding is corroborated by online supplementary table 1, which shows that crude mortality and mortality risk ratios are not affected by deprivation, but are greatly affected as comorbidity increases. When the referent is set to no comorbidity (CCI 0) and the least deprivation level (SIMD 10), admissions with CCI >4 had an inpatient mortality risk 16 to 23 times and 1-year mortality risk 90 to 96 times that of the comparison group (online supplementary table 1). Similarly, for the subgroup of admissions which included a surgical operation, admissions with CCI >4 had an inpatient mortality risk 24 to 41 times (online supplementary table 2) and 1-year mortality risk 156 to 173 times that of the referent group (online supplementary table 2).

Statistical analysis

Logistic regression analyses showed that, compared with those with CCI 0, admissions with CCI >4 were less likely to be discharged home (OR 0.376, 95% CI 0.367 to 0.387) and had higher inpatient mortality (OR 13.741, 95% CI 13.094 to 14.42), 30-day mortality (OR 14.085, 95% CI 13.594 to 14.594),

Table 1 Demographics of all patients admitted for EGS in Scotland 1997 to 2016

All patient demographics			All	SIMD 1	SIMD 2	SIMD 3	SIMD 4	SIMD 5	SIMD 6	SIMD 7	SIMD 8	SIMD 9	SIMD 10	CCI 5-Year 0	CCI 5-Year 1 to 2	CCI 5-Year 3 to 4	CCI 5-Year >4
Age	All adults (>15)	All	1 468 238	237 824	195 889	176 224	162 909	149 591	136 094	123 954	108 515	95 408	81 830	1 116 808	299 657	37 558	23 787
		Male	700 479	116 647	92 473	82 535	76 969	71 196	65 167	59 775	51 870	45 249	38 598	521 238	151 804	21 938	11 334
		Female	767 759	121 177	103 416	93 689	85 940	78 395	70 927	64 179	56 645	50 159	43 232	595 570	147 853	15 620	12 453
	16–30	All	276 349	51 865	40 337	33 603	29 994	26 530	23 065	21 129	18 756	16 032	15 038	266 649	10 571	767	667
		Male	123 758	23 945	17 938	14 648	13 353	11 859	10 212	9573	8479	6973	6778	119 274	5214	347	314
		Female	152 591	27 920	22 399	18 955	16 641	14 671	12 853	11 556	10 277	9059	8260	147 375	5357	420	353
	31–45	All	308 175	59 724	45 061	37 280	32 749	29 232	25 604	23 477	21 735	18 593	14 720	277 158	28 330	3048	2219
		Male	146 279	30 514	21 622	17 586	15 353	13 717	11 995	10 765	9852	8200	6675	131 640	13 604	1749	1038
		Female	161 896	29 210	23 439	19 694	17 396	15 515	13 609	12 712	11 883	10 393	8045	145 518	14 726	1299	1181
	46–60	All	312 074	51 976	41 866	37 046	33 846	30 910	28 541	26 708	23 566	20 682	16 933	238 620	61 717	7887	6034
		Male	155 601	26 959	20 768	18 428	17 004	15 284	14 186	13 387	11 521	9961	8103	117 984	31 623	4657	2730
		Female	156 473	25 017	21 098	18 618	16 842	15 626	14 355	13 321	12 045	10 721	8830	120 636	30 094	3230	3304
	60–75	All	316 745	44 921	39 783	37 942	37 085	33 780	31 735	28 182	23 879	21 463	17 975	187 603	106 537	14 384	9853
		Male	165 470	23 329	20 272	19 278	19 107	17 781	16 857	15 165	12 821	11 471	9389	93 903	58 654	8819	5021
		Female	151 275	21 592	19 511	18 664	17 978	15 999	14 878	13 017	11 058	9992	8586	93 700	47 883	5565	4832
	>75	All	254 895	29 338	28 842	30 353	29 235	29 139	27 149	24 458	20 579	18 638	17 164	146 778	92 502	11 472	5014
		Male	109 371	11 900	11 873	12 595	12 152	12 555	11 917	10 885	9197	8644	7653	58 437	42 709	6366	2231
		Female	109 371	17 438	16 969	17 758	17 083	16 584	15 232	13 573	11 382	9994	9511	88 341	49 793	5106	2783
LOS	Total	Median	2	2	2	2	2	2	2	2	2	2	2	2	3	3	4
		25 Quartile	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		75 Quartile	4	4	4	4	5	5	5	4	4	4	4	4	6	8	9
D/C		%	79%	80%	79%	78%	78%	78%	78%	78%	78%	78%	79%	83%	66%	59%	58%
Mortality	Inpatient	%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	1%	5%	6%	11%
	30-day	%	4%	3%	4%	4%	4%	4%	4%	4%	4%	4%	4%	2%	9%	13%	23%
	90-day	%	7%	7%	7%	8%	8%	8%	8%	8%	7%	7%	7%	3%	17%	23%	41%
	1-year	%	12%	12%	12%	13%	13%	13%	13%	13%	13%	13%	12%	8%	25%	32%	52%

CCI, Charlson Comorbidity Index; D/C, discharged home; LOS, length of hospital stay; n, number of admissions; SIMD, Scottish Index of Multiple Deprivation.

Table 2 Demographics of patients admitted for EGS in Scotland who underwent an operative procedure 1997 to 2016

Operative patient demographics			All	SIMD 1	SIMD 2	SIMD 3	SIMD 4	SIMD 5	SIMD 6	SIMD 7	SIMD 8	SIMD 9	SIMD 10	CCI 5-Year 0	CCI 5-Year 1 to 2	CCI 5-Year 3 to 4	CCI 5-Year >4
Age	All adults (>15)	All	395 234	55 368	49 924	47 274	44 052	40 949	37 547	34 271	31 420	28 386	26 043	299 344	82 146	9673	6312
		Male	196 185	27 893	24 373	23 167	21 496	20 283	18 499	17 374	15 718	14 229	13 153	146 621	42 312	5666	2931
		Female	199 049	27 475	25 551	24 107	22 556	20 666	19 048	16 897	15 702	14 157	12 890	152 723	39 834	4007	3381
	16–30	All	78 751	12 898	10 884	9410	8473	7614	6807	6308	5900	5279	5178	75 732	3298	194	135
		Male	39 697	6698	5426	4610	4262	3780	3350	3181	3025	2683	2682	38 167	1759	91	65
		Female	39 054	6200	5458	4800	4211	3834	3457	3127	2875	2596	2496	37 565	1539	103	70
	31–45	All	82 907	13 715	11 476	10 079	8964	8036	7204	6543	6306	5734	4850	74 677	7533	780	486
		Male	41 612	7087	5658	4954	4454	4146	3597	3294	3123	2818	2481	37 457	3857	458	221
		Female	41 295	6628	5818	5125	4510	3890	3607	3249	3183	2916	2369	37 220	3676	322	265
	46–60	All	82 405	11 641	10 281	9791	8847	8265	7879	7398	6747	6069	5487	62 268	16 913	2090	1622
		Male	42 352	6095	5194	5119	4522	4181	3959	3913	3445	3091	2833	31 483	9145	1273	746
		Female	40 053	5546	5087	4672	4325	4084	3920	3485	3302	2978	2654	30 785	7768	817	876
	60–75	All	86 349	10 616	10 286	10 285	10 164	9529	8799	7939	6934	6274	5523	50 063	30 104	3776	2771
		Male	44 967	5424	5194	5226	5194	5013	4645	4251	3702	3378	2940	24 906	16 545	2346	1368
		Female	41 382	5192	5092	5059	4970	4516	4154	3688	3232	2896	2583	25 157	13 559	1430	1403
	>75	All	64 822	6498	6997	7709	7604	7505	6858	6083	5533	5030	5005	36 604	24 298	2833	1298
		Male	27 557	2589	2901	3258	3064	3163	2948	2735	2423	2259	2217	14 608	11 006	1498	531
		Female	37 265	3909	4096	4451	4540	4342	3910	3348	3110	2771	2788	21 996	13 292	1335	767
LOS	Total	Median	3	3	3	3	3	3	3	3	3	3	3	3	4	4	6
		25 Quartile	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
		75 Quartile	6	6	6	6	6	6	6	6	6	6	6	5	9	9	14
D/C		%	81%	82%	81%	80%	80%	80%	80%	80%	80%	80%	81%	86%	66%	58%	61%
Mortality	Inpatient	%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	3%	5%	10%
	30 day	%	3%	3%	3%	4%	3%	3%	3%	3%	3%	3%	3%	1%	8%	12%	20%
	90 day	%	7%	7%	7%	7%	7%	7%	7%	7%	6%	7%	6%	3%	16%	22%	41%
	1 year	%	13%	11%	11%	12%	12%	12%	12%	12%	11%	11%	11%	7%	23%	32%	52%

CCI, Charlson Comorbidity Index; D/C, discharged home; LOS, length of hospital stay; n, number of admissions; SIMD, Scottish Index of Multiple Deprivation.

Table 3 Logistic regression analyses for discharge home and inpatient, 30-day, 90-day and 1-year mortality

Logistic regression analysis	Parameter	Age	Male	SIMD 1	SIMD 2	SIMD 3	SIMD 4	SIMD 5	SIMD 6	SIMD 7	SIMD 8	SIMD 9	CCI 1 to 2	CCI 3 to 4	CCI >4
All patients															
Discharge home	OR	0.98	0.95	0.97	0.97	0.95	0.96	0.95	0.98	0.98	0.97	0.97	0.57	0.43	0.38
	Lower 95% CI	0.98	0.94	0.95	0.95	0.93	0.94	0.93	0.95	0.96	0.95	0.95	0.57	0.42	0.37
	Upper 95% CI	0.98	0.96	0.99	0.99	0.97	0.98	0.97	1.00	1.01	0.99	0.99	0.58	0.44	0.39
Inpatient mortality	OR	1.07	0.95	1.36	1.41	1.30	1.24	1.16	1.13	1.16	1.15	1.09	3.95	5.56	13.74
	Lower 95% CI	1.07	0.92	1.28	1.32	1.21	1.16	1.08	1.05	1.08	1.07	1.01	3.83	5.29	13.09
	Upper 95% CI	1.07	0.97	1.46	1.50	1.39	1.33	1.24	1.21	1.24	1.24	1.18	4.07	5.84	14.42
30-day mortality	OR	1.06	1.07	1.28	1.27	1.24	1.15	1.14	1.10	1.11	1.11	1.05	3.79	5.54	14.09
	Lower 95% CI	1.06	1.05	1.22	1.21	1.18	1.10	1.09	1.05	1.06	1.05	1.00	3.72	5.35	13.59
	Upper 95% CI	1.06	1.09	1.34	1.33	1.30	1.21	1.20	1.16	1.17	1.16	1.11	3.87	5.73	14.59
90-day mortality	OR	1.05	1.05	1.19	1.20	1.17	1.11	1.09	1.08	1.09	1.08	1.08	3.48	5.09	14.68
	Lower 95% CI	1.05	1.04	1.15	1.16	1.13	1.08	1.05	1.04	1.05	1.04	1.04	3.43	4.95	14.26
	Upper 95% CI	1.05	1.06	1.23	1.24	1.21	1.15	1.13	1.12	1.13	1.12	1.12	3.54	5.23	15.11
1-year mortality	OR	1.03	1.00	1.11	1.11	1.09	1.06	1.04	1.04	1.03	1.04	1.07	2.61	3.78	9.85
	Lower 95% CI	1.03	0.99	1.08	1.08	1.06	1.03	1.01	1.01	1.01	1.01	1.04	2.58	3.70	9.59
	Upper 95% CI	1.03	1.01	1.14	1.14	1.12	1.08	1.07	1.07	1.06	1.07	1.10	2.64	3.87	10.12
Operative patients															
Discharge home	OR	0.97	1.00	0.92	0.96	0.95	0.96	0.95	0.99	0.97	0.96	0.95	0.49	0.36	0.37
	Lower 95% CI	0.97	0.98	0.89	0.92	0.91	0.93	0.91	0.95	0.93	0.92	0.91	0.48	0.34	0.35
	Upper 95% CI	0.97	1.02	0.96	1.00	0.99	1.00	0.99	1.03	1.01	1.00	1.00	0.50	0.37	0.39
Inpatient mortality	OR	1.07	0.97	1.62	1.55	1.41	1.36	1.30	1.08	1.27	1.16	1.13	3.85	5.60	15.21
	Lower 95% CI	1.06	0.92	1.41	1.34	1.22	1.17	1.12	0.92	1.09	0.99	0.96	3.60	5.01	13.75
	Upper 95% CI	1.07	1.03	1.87	1.79	1.63	1.57	1.50	1.26	1.48	1.36	1.33	4.12	6.25	16.82
30-day mortality	OR	1.06	1.09	1.53	1.40	1.38	1.21	1.18	1.13	1.18	1.11	1.11	3.37	5.26	12.16
	Lower 95% CI	1.06	1.05	1.39	1.28	1.25	1.10	1.07	1.02	1.07	1.00	1.00	3.24	4.90	11.31
	Upper 95% CI	1.06	1.13	1.68	1.54	1.51	1.33	1.30	1.25	1.31	1.23	1.24	3.52	5.65	13.06
90-day mortality	OR	1.05	1.07	1.33	1.28	1.26	1.14	1.14	1.11	1.12	1.08	1.10	3.51	5.28	15.46
	Lower 95% CI	1.05	1.04	1.25	1.20	1.18	1.06	1.06	1.04	1.05	1.00	1.02	3.41	5.00	14.61
	Upper 95% CI	1.05	1.10	1.42	1.37	1.34	1.21	1.22	1.19	1.20	1.16	1.19	3.61	5.57	16.35
1-year mortality	OR	1.03	1.06	1.22	1.18	1.14	1.09	1.09	1.09	1.08	1.06	1.09	2.82	4.25	11.21
	Lower 95% CI	1.03	1.04	1.16	1.12	1.08	1.03	1.03	1.03	1.02	1.00	1.03	2.76	4.05	10.64
	Upper 95% CI	1.03	1.08	1.28	1.24	1.20	1.15	1.14	1.15	1.14	1.12	1.15	2.89	4.45	11.82

SIMD, Scottish Index of Multiple Deprivation; CCI, Charlson Comorbidity Index.

90-day mortality (OR 14.679, 95% CI 14.258 to 15.112) and 1-year mortality (OR 9.849, 95% CI 9.586 to 10.12) (table 3).

Compared with the most affluent population (SIMD 10), the most deprived population (SIMD 1) were less likely to be discharged home (OR 0.974, 95% CI 0.954 to 0.994) and had higher inpatient mortality (OR 1.363, 95% CI 1.276 to 1.456), 30-day mortality (OR 1.278, 95% CI 1.221 to 1.338), 90-day mortality (OR 1.192, 95% CI 1.152 to 1.233) and 1-year mortality (OR 1.113, 95% CI 1.084 to 1.142) (table 3). Similar results are seen among those who had an operation (table 3).

Poisson analysis showed that, compared with those with CCI 0, admissions with CCI >4 had longer LOS (OR 1.685, 95% CI 1.677 to 1.694), and compared with the most affluent population (SIMD 10), the most deprived population (SIMD 1) also

Table 4 Poisson regression analyses for length of hospital stay

Poisson analysis	Parameter	Male	SIMD 1	SIMD 2	SIMD 3	SIMD 4	SIMD 5	SIMD 6	SIMD 7	SIMD 8	SIMD 9	Age	CCI 1 to 2	CCI 3 to 4	CCI >4
All patients	OR	0.87	1.11	1.10	1.10	1.10	1.08	1.08	1.07	1.06	1.03	1.02	1.35	1.51	1.69
	Lower 95% CI	0.87	1.11	1.09	1.10	1.09	1.08	1.07	1.06	1.05	1.02	1.02	1.35	1.51	1.68
	Upper 95% CI	0.87	1.12	1.10	1.10	1.10	1.09	1.08	1.07	1.06	1.03	1.02	1.36	1.52	1.69
Operative patients	OR	0.85	1.13	1.08	1.08	1.06	1.06	1.07	1.06	1.03	1.03	1.02	1.32	1.35	1.71
	Lower 95% CI	0.85	1.12	1.08	1.07	1.05	1.05	1.06	1.06	1.02	1.02	1.02	1.31	1.34	1.70
	Upper 95% CI	0.86	1.14	1.09	1.09	1.07	1.06	1.07	1.07	1.03	1.04	1.02	1.32	1.36	1.73

Reference variables: Female; SIMD 10; CCI 0.
CCI, Charlson Comorbidity Index; SIMD, Scottish Index of Multiple Deprivation.

had a longer LOS (OR 1.11, 95% CI 1.11 to 1.12) (table 4). A similar effect occurred among admissions of patients who had an operation (table 4).

DISCUSSION

This study has demonstrated, using population-level data, that increased levels of comorbidity and, to a lesser extent, socioeconomic deprivation significantly affect outcomes of EGS admissions in a free at the point of care healthcare system. Not only is this a novel finding, it is methodologically unique from a public health perspective in that we examined the whole population of EGS admissions over 20 years instead of examining the impact on a specific diagnosis or operation over a shorter time period.

These findings have implications for public health policy and service delivery planning. Patients with multimorbidity are at increased risk of in-hospital, short-term and medium-term mortality.[19] They are also at higher risk of discharge to a non-home environment. Early identification of those individuals who are likely to require further care needs may need to be explored in order to ensure patient movement through the acute sectors of NHS care. Our data also show that the need for further support structures is greatest in the deprived regions.

There are also clinical applications from this work: clinicians need to better appreciate (and quantify) the impact that comorbidity and, to a lesser extent, socioeconomic deprivation have on LOS, discharge destination and both in-hospital and post-discharge mortality. This pertains to the very nature of patient–provider discussion in setting the expectations for length of hospital admissions, the likelihood of being discharged home directly or the likelihood of inpatient or post-discharge death, regardless of operative intervention. While it is not possible to suggest a 'comorbidity threshold' for involving services such as physiotherapy, occupational therapy, social work or geriatrics, clinicians should be aware that, compared with patients with no comorbidity, patients with minor comorbidity (CCI 1 to 2) are half as likely to be discharged home (all patients OR 0.57, operative patients OR 0.49), and patients with major comorbidity (CCI >4) are only one-third as likely to be discharged home (all patients OR 0.38, operative patients OR 0.37) (table 3). Interestingly, the number of patients who are discharged home is the same in both the operative and non-operative groups. This finding suggests that the barriers to discharge are not related to treatment.

Other studies have shown associations between socioeconomic deprivation and health outcomes. The Whitehall studies of British civil servants identified increased morbidity and cardiovascular risk among those working in lower employment grades, and this effect was observed to be sustained for over a decade.[1] Packard *et al* showed that socioeconomic adversity in children negatively affects their health and cognition in adult life.[2] Overall mortality was higher in the deprived population compared with the affluent population (HR 1.36, 95% CI 1.09 to 1.69) for patients who underwent resection for colorectal cancer in Scotland between 1991 and 1994.[3] Deprivation was associated with increased major and minor complications following ileostomy reversal in a Scottish population.[4] Socioeconomic deprivation was independently associated with higher mortality rates after kidney transplantation, with the least deprived having reduced 5-year mortality (HR 0.65, 95% CI 0.54 to 0.77).[5] Taylor *et al* showed that, in patients undergoing coronary artery bypass graft, deprivation was independently associated with increased risk of postoperative myocardial infarction, stroke, death and prolonged hospital stay.[6] Wrigley *et al* showed that socioeconomic deprivation was adversely associated with survival in patients with colorectal cancer,[7] with HR for mortality from colorectal cancer in the most deprived areas of 1.12 (95% CI 1.00 to 1.25) and all-cause mortality 1.18 (95% CI 1.07 to 1.30). Symons *et al* showed that high-risk EGS patients with Carstairs score 5 (most deprived) compared with Carstairs score 1 (least deprived) had a higher 30-day mortality risk with OR 1.22 (95% CI 1.18 to 1.27).[8]

The relatively small effect of deprivation on outcomes may be explained by Scotland's single-payer healthcare system. Healthcare is delivered free at the point of care, including primary care (general practitioners) and secondary/tertiary care (hospital specialists), both in the elective and emergency setting. This may reduce some financial barriers to receiving healthcare, thereby increasing access for those who in other healthcare systems may struggle to receive emergency medical care.

There is evidence in the literature that comorbidities affect the outcome of patients undergoing EGS, but most focus on patients who have had operative procedures. Patients undergoing EGS procedures who had a higher CCI had increased 30-day mortality postoperatively (adjusted OR 1.39, 95% CI 1.11 to 1.73).[10] Another study showed that this effect was even greater for patients undergoing high-risk EGS procedures, as those patients with CCI >2 had a higher 30-day mortality (OR 2.61, 95% CI 2.56 to 2.67).[8] Many studies have focused on elderly EGS patients, and concluded that frailty was a significant predictor of outcomes including perioperative complications, length of hospital stay,[11] mortality, institutional discharge and cost.[12] Frailty and comorbidity are related, in that frail patients have a higher CCI score,[12] but they are not synonymous. Recent efforts have focused on these factors; in particular, the National Emergency Laparotomy Audit (NELA) identified that nearly half of all emergency laparotomies are performed on patients over 70, that their mortality rate, LOS, comorbidity and frailty are much higher than younger patients, and that only 3% of hospitals provide regular proactive assessments from geriatricians.[20–22] Similarly, in Scotland, 49% of emergency laparotomies were performed in patients aged >65 years and 16% of these were frail, scoring >4 in the Rockwood Clinical Frailty Score,[23] and it has been suggested that we build 'clinical relationships with geriatricians to develop targeted frailty pathways'. The UK-wide Emergency Laporatomy and Frailty study reported that, of patients aged >65 years undergoing laparotomy, 20% are frail, which is associated with increased postoperative mortality, morbidity, length of critical care stay and LOS.[24]

The information collected at routine assessment at time of admission (the 'clerking in' of patients) could be better used to inform the likely hospital course. An area of future research could be to develop a prediction score at admission based on factors which predict likelihood of various outcomes, such as LOS, discharge destination and mortality. This has been done for perioperative mortality (P-POSSUM)[25] and could have clinical relevance—for example, to trigger patients' needs assessments (physiotherapy, occupational therapy, social care requirements), review by a geriatrician, or early discussions/decisions about ceilings of care with the patient and their families.

We defined EGS as those patients who were admitted to a Scottish hospital under the care of a consultant (attending) general surgeon.[9 18 19 26] There have been other methods of defining EGS,[27] however this is the most pragmatic definition in the context of the UK as it defines the actual service delivered instead of only including the patients whose coded diagnosis at discharge falls within the remit of the general surgical specialism ('ideal' definition). This is an important distinction for two reasons: (1) because the nature of EGS service is such that diagnoses are often dependent on laboratory and radiological services, which may take time, and thus many admissions result in diagnoses which would not normally be looked after by general surgeons; and (2) clinical resources should be allocated based on actual demand, not ideal situations.

This study has strengths and limitations. Its greatest strength is the large number of hospital episodes included. The population-wide data have great advantages in that there are very few missing data, but there is also a lack of granularity. This limited the variables which could be controlled for, and thus limited interpretations of findings. For example, there is no information on the specific comorbidities which contribute to make up the CCI, so for any individual admission we do not know whether the outcome was influenced by specific comorbidities (cardiac, respiratory, immunological, extremes of body mass index, frailty) or other factors including presenting physiology, case severity, or clinical and radiological findings. Therefore, although there is little bias introduced in the dataset and the confidence intervals are narrow given the very large sample size, detailed associations related to underlying conditions could not be determined. There is also a risk of confounding factors which could not be controlled for, given the limited breadth of the dataset. Another limitation is that SIMD describes deprivation within post code regions, therefore not all individuals within a particular data zone will have the same characteristics. Data providers quality assure data for all indicators before providing them to the Office of the Chief Statistician and Performance, which then performs further checks on indicators and domains.[14] Data are correlated with previous years, investigated and considered for amendment if they have changed dramatically.[14] Therefore, despite not being tailored for the individual, SIMD is likely the most reliable method of characterising deprivation in Scotland. As a multicenter study, it would have been pertinent to study clustering effects by facility, but we did not have a facility variable or field in the database so it could not be performed. Further work on a representative sample of these patients using more detailed data could provide prognostic information at the point of admission, augmenting the prognostic work resulting in the NELA score and P-POSSUM score for emergency laparotomy.[22 25]

The generalizability of these results may be wide. Although the data came from a single nation (Scotland), it was a population-wide sample over the course of 20 years, with very few missing data, and therefore may compare to similar populations (highly developed Western nations). Lastly, because we included data from the last 20 years, if there had been a change in the direction of any effect over time the conclusions generated may be misleading.

In conclusion, increased levels of comorbidity and, to a lesser extent, socioeconomic deprivation significantly adversely affects EGS outcomes including mortality, discharge destination and length of hospital stay. Further work is warranted to determine whether prognostic scoring at EGS admission could be developed, which can help guide treatment pathways for patients.

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