

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original research

Assessing the impact of an ageing population on complication rates and in-patient length of stay[☆]

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ARTICLE INFO

Article history:

Received 9 April 2013

Received in revised form

3 July 2013

Accepted 26 July 2013

Available online 2 August 2013

Keywords:

Surgical complications

Morbidity and mortality

Surgical outcomes

Elderly

Geriatric

ABSTRACT

Background: Ireland has an ageing population; with the proportion of people aged over 80 years estimated to increase over the next 20 years from 1.1% to 2.1%.

Aims: The aim of this study was to examine the demographics of the population served by the surgical department in a tertiary referral centre in the west of Ireland and to examine whether increasing age had an influence on morbidity, mortality and length of stay.

Methods: Data pertaining to all surgical admissions over a 6-month period between was collected prospectively using an ACS-NSQIP based proforma. Data collected included patient age, gender, operative intervention, in-patient length of stay, mode of admission and complications related to their admission.

Results: A total of 2209 patients were admitted under the care of the general, vascular and breast services in our centre over a 6-month period between August and January. Two thousand and nineteen patients had complete data collected. The average age was 50.37 years (± 23.62), with 24.12% ($n = 533$) older than 70 years. Only 12.31% of patients aged younger than 70 years experienced morbidity, compared to 25.10% of older patients. It was shown that there was a stepwise increase with complication rates and hospital in-patient stay across each decade of increasing age.

Multivariate analysis showed those factors most predictive of a complication to include emergency admission, major or complex major surgical intervention, female gender and age. Length of stay was also found to have a positive correlation with increasing age (Spearman's Rho, $p < 0.001$).

Conclusion: Increasing age is associated with increased complication rates and increased hospital length of stay.

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1. Background

Ireland has an ageing population. It is estimated that currently, 11% of our population is older than 65 years of age, a proportion that is expected to increase exponentially over the next two decades. The greatest increase is predicted to be amongst the “oldest old”, with the proportion of people aged over 80 years estimated to increase from 1.1% to 2.1%.¹

It has been previously well established that older patients are more likely to have a complicated in-hospital stay.^{2–6} With regards to surgical in-patients in particular, it has been documented that

20%–50% of those patients older than 80 years of age will have some form of morbidity in the post-operative period.^{7,8} It has also been shown that these complications are not always related to surgical factors, but more so to pre-existing patient co-morbidities, with previous studies showing the incidence of surgery-related morbidities to be equivalent between younger and older age groups, while “medical” complications to be much more prevalent in the older age group.^{9,10} As Ireland continues to age, the health service must acknowledge and address the impact that this will have on hospital work burden, resource allocation and in-patient length of stay.

2. Aims

The aim of this study was to examine the demographics of the population served by the general surgical department in a tertiary referral centre in the west of Ireland. Furthermore, we aimed to examine whether increasing age had an influence on morbidity, mortality and length of stay.

[☆] **Presentations:** (1) Registrar's Prize Meeting, Royal Academy of Medicine of Ireland Meeting, Surgical Section, Royal College of Surgeons in Ireland, Dublin, 20th April 2012. (2) 36th Sir Peter Freyer Memorial Lecture and Surgical Symposium, Arts Millennium Building, National University of Ireland Galway, 2–3rd September 2011.

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3. Methods

For this study, we examined a cohort of all patients admitted under the care of general (including colorectal and upper gastro-intestinal services), vascular and breast surgical services over a six-month period between August and January. Data pertaining to mode of referral, age, gender, length of stay was recorded prospectively using a proforma adapted from a computerised model¹¹ based on the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP).¹² More detailed data with regard to operative intervention and re-intervention was sourced retrospectively from theatre log books.

3.1. Proforma

Previous studies have well-illustrated a paucity in the recording of all patient mortality and adverse events in hospital and in the post-operative period.¹¹ Hutter et al. developed a computer-based morbidity and mortality reporting system in Massachusetts general hospital, based largely on the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP)¹² platform, and they showed significantly improved results utilising this system prospectively as opposed to retrospective collection of data. In our own centre, introducing a computer-based system to the hospital intranet was less feasible. We combatted this difficulty by introducing a paper-based proforma based on that of Massachusetts General and the ACS-NSQIP, which was included in each patient chart and completed prospectively during the course of the patient's in-hospital stay. This overcame the issue of inadequate resources in our information technology department and avoided the need for clinician training. A prospective audit completed in our surgical department showed that prospective collection of morbidity and mortality data by means of the paper-based proforma has made significant improvements in the accuracy of reporting of adverse events.¹³

3.2. Statistical analysis

Univariate and multivariate analyses were performed on the data utilising PASW (version 18) software. Data was assessed for normality of distribution using Shapiro–Wilk¹⁴ test. Analysis of normally distributed data was undertaken by means of parametric tests, while data with variation from normal distribution analysed using non-parametric tests. Multivariate analysis was performed using binary logistic regression. Variables included in this model included patient demographics (age and gender), admission variables (route of admission and admitting consultant specialty) and complexity of surgical intervention performed.

4. Results

A total of 2209 patients were admitted under the care of the general (upper and lower gastro-intestinal), vascular and breast services in our centre over the six-month period.

The demographics as well as mode of referral for this cohort are outlined in Table 1. Of this group, data regarding morbidity and mortality was prospectively accurately collected in 2094 (95%).

4.1. Demographics

Of 2209 patients, 1184 (54%) were female and 1025 (46%) male.

The mean age was 50.37 years (± 23.62). For comparative purposes, we analysed our cohort by dividing them into decades of age over 50 years. Those patients older than 70 years of age accounted for 24% of admissions ($n = 533$). Those patients aged younger than 25 years of age were admitted almost entirely via the Emergency Department ($n = 413$ (94%)). The majority of admissions at all ages was on an Emergency basis.

Patients younger than 16 years were excluded from statistical analysis, given the low rate of complications (2%, all wound related) in this cohort. A total of 1987 patients were therefore included in the study cohort. Data regarding complications was collected on 1822 patients (92%).

4.2. Surgical intervention

Of the 1822 patients included in our study group, 287 experienced at least one adverse event. 981 patients underwent at least one surgical intervention (49%), 204 of whom experienced a complication. 83 patients however, experienced an in-hospital

Table 1

Demographics of total cohort ($n = 2209$).

Demographics		N (%)			
Total (n)		2209			
Gender	Male	1013 (46%)			
	Female	1196 (54%)			
Age/Years	Mean	50.37			
	Std. Dev	23.62			
	Range	1–100			
	Ranges:				
	0–15	222 (10)			
16–25	213 (10)				
26–50	581 (26)				
51–75	814 (37)				
76–100	379 (17)				
Mode of referral n (%)					
Age/years	Elective	Emergency	OPD	Transfer	Total
0–15	5 (2)	216 (97)	0 (0)	1 (0.5)	222
16–24	16 (8)	180 (1)	3 (3)	0 (0)	199
25–50	176 (30)	404 (68)	13 (2)	2 (0.3)	595
51–60	145 (43)	168 (50)	18 (5)	4 (1)	335
61–70	138 (43)	157 (48)	25 (8)	5 (2)	325
71–80	116 (37)	160 (51)	23 (7)	17 (5)	316
81–90	46 (24)	126 (65)	15 (8)	7 (4)	194
91–100	1 (4)	20 (87)	2 (9)	0 (0)	23
Total	643 (29)	1431 (65)	99 (5)	36 (2)	2209

complication unrelated to any surgical procedure. This represents a substantial percentage (29%) of case morbidities.

4.3. Morbidities

The number of individual adverse events totalled 585, ranging from simple surgical site infections to multi-organ failure or death. Several patients experienced more than one complication, with an average of two morbidities occurring in those patients achieving suboptimal outcomes. The most common adverse events to occur among our patients included acute renal failure ($n = 43$); lower respiratory tract infections ($n = 61$), surgical site infections ($n = 74$) and unplanned return to theatre. Death occurred in 41 patients, of whom 19 (46%) had undergone a surgical intervention.

4.4. Relationship between age and adverse in-hospital events

A striking difference can be seen in the incidence of complications with increasing age. With each increasing decade over 50 years of age, there is a stepwise increase in the proportion of patients experiencing some form of morbidity during their in-patient course (Table 2). Only 12% of all patients younger than 70 years experienced an adverse event, compared to 25% of those patients aged 70 years or over.

Patients that succumbed to disease in hospital tended to be significantly older than those patients leaving hospital alive ($p < 0.001$, Table 2).

4.5. Length of stay (Fig. 1)

As expected, those patients experiencing a complication had a much more protracted in-patient stay than in those patients not experiencing morbidity. The median length of stay for patients without complications for all-cause admissions was 3 days, while the median length of stay in patients experiencing a complication was 15 days ($p < 0.001$, Mann–Whitney U test). Similarly Post-operative length of stay in patients undergoing a surgical intervention was also unsurprisingly greatly prolonged in the setting of a complication ($p < 0.001$, Mann–Whitney U test). Length of stay

Table 2
Complications and age.

Complications per decade of age (excluding patients <16 years old)			
Age range/years	Complication % (n)	Death (n)	
16–24 (199)	3.52 (7)	0 (0)	
25–50 (595)	6.55 (39)	0.34 (2)	
51–60 (335)	14.93 (50)	0.59 (2)	
61–70 (325)	20.92 (68)	0.92 (3)	
71–80 (316)	22.78 (72)	4.43 (14)	
81–90 (194)	23.2 (45)	7.73 (15)	
91–100 (23)	26.09 (6)	21.74 (5)	

Complicated –v–uncomplicated cases			
	Mean age	Median age	Significance
No complication	53 ± 20	54	<0.001
Complication	65 ± 16	68	
No death	55 ± 20	56	<0.001
Death	78 ± 11	80	

Independent samples median test^a

Multivariate analysis: factors affecting the incidence of a complication ^a			
Variable	Regression coefficient	Significance (p)	Odds ratio
Age	0.04	<0.001	1.04
Female gender ^c	0.32	0.03	1.38
Surgical intervention ^b		<0.001	0.24
Minor intervention ^d	0.34	0.32	1.41
Intermediate ^d	0.44	0.06	1.55
Major ^d	1.66	<0.001	5.25
Complex major ^d	2.22	<0.001	9.22
Emergency admission ^e	0.73	<0.001	2.07
Speciality		0.47	–

^a Binary logistic regression.

^b BUPA Schedule of Procedures 17 June 2013, 2013.

^c Compared to males.

^d Compared to no intervention.

^e Compared to elective admissions.

was also found to have a positive correlation with increasing age (Spearman's Rho, $p < 0.001$). There was a stepwise increase in both mean and median lengths of stay with each increasing age group.

4.6. Readmissions

Of 2209 patients admitted to the surgical department over the six-month period, 1962 were admitted only once. A further 247 were admitted on more than one occasion. Of these, 220 were admitted for further treatment or interventions, but 27 required readmission as a direct result of a complication occurring during their primary in-hospital stay. 15 of these patients were admitted as an emergency case, the remaining 16 on a semi-elective basis.

The median age of those 27 patients requiring readmission for their complication was 66 years (37–86). The median length of stay for a readmission as result of a complication was 11.63 days (median 8). Of all readmissions, 17 underwent a secondary surgical intervention.

In the case of readmissions, there was no statistically significant correlation between age and length of stay ($p = 0.574$, Spearman's Rho).

4.7. Multivariate analysis

Multivariate analysis was carried out by means of binary logistic regression to identify those factors contributing to the occurrence of a complication (Table 2). Factors found to be associated with an increased risk included increasing complexity of surgical intervention, emergency admission, female gender and increasing age. Compared to conservative management, the risk of a complication occurring was amplified with each increasing level of complexity of intervention,¹⁵ with minor interventions carrying an odds ratio of 1.41 ($p = 0.318$) compared to no intervention, and complex major interventions, an odds ratio of 9.22 ($p < 0.001$). Patients admitted to hospital on an emergent basis were twice as likely to experience at least one in-hospital adverse event. Females were at a moderately

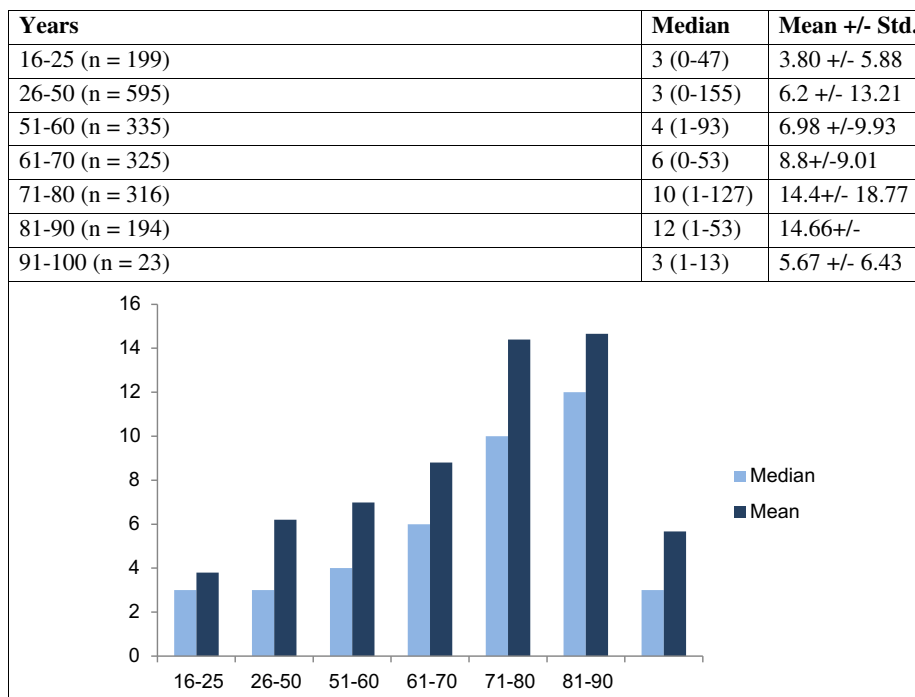


Fig. 1. Length of stay and age.

increased risk of a complication (OR = 1.38) compared to male counterparts. Accounting for these factors, age was found to be an independent risk factor in the development of a complication. Considering age as a contributing factor in the incidence of complication, there was found to be an increased risk of 0.41% for each yearly increase in age (OR 1.041). The speciality under which the patient was admitted did not statistically impact on the incidence of an adverse event.

5. Discussion

Despite the fact that only 11% of the country's current population is older than 65 years of age, over 31% ($n = 700$) of the patients admitted to our Surgical unit over the course of 6 months were 66 years or older. Older patients represent a significant proportion of our workload, and the complications to which older people are predisposed by virtue of their increasing age may mean they have an even disproportionately higher burden as regards delivery of care.

Elderly patients are a vulnerable group, especially in the post-operative period because of the inherent physiological changes of ageing, and limited physiological reserve with to tolerate the stress of a surgical intervention, be it elective or otherwise.¹⁰ This can be clearly exemplified in our cohort. Older patients more commonly experienced adverse events, as well as protracted stays in hospital. Those patients dying in hospital were also significantly older than those patients that did not experience in-hospital mortality.

Similar findings have been replicated in other units worldwide, across other specialities.

The Colorectal Cancer Collaborative Group⁵ carried out a systematic review regarding surgery in elderly patients for colorectal cancer, including a total 34,194 patients over the age of 65 years. This study concluded that the incidence of postoperative morbidity and mortality had a positive correlation with increasing age. Evidence in this study showed that, while older patients did experience significantly more post-operative complications, these events tended not to be directly related to the surgical intervention – there were significantly more medical adverse events in the older population but no significant difference in the rate of anastomotic leak. Similar results have been replicated in other large high-quality reviews.^{2–5,7}

Unlike other published work, this study investigates the impact of increasing age across a heterogeneous group of surgical specialities, including both elective and emergency patients, and also, including those patients managed by non-operative means. We have included in our study group, patients managed by conservative methods. It is noteworthy that, while surgical intervention was a significant risk factor for the development of a complication, conservative management did not preclude the development of in-hospital morbidity.

6. Conclusion

This study identifies a positive correlation between increasing age and the incidence of morbidity and mortality rates in patients

admitted with a surgical complaint. Age may be considered as a surrogate marker of increased comorbidities and older patients must therefore be considered more high-risk than younger counterparts.

Ethical approval

No ethical considerations.

Funding

Nil.

Author contribution

Study Design: TP McVeigh, D Al Azawi, GT O Donoghue, MJ Kerin.

Data Collection: TP McVeigh, D Al Azawi, GT O Donoghue.

Data Analysis: TP McVeigh, D Al Azawi, GT O Donoghue.

Writing: TP McVeigh, MJ Kerin.

Conflict of interest

Nil.

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