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Retrospective analysis of the 13-year trend in acute and elective surgery for patients aged 60 years and over at Auckland City Hospital, New Zealand

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ABSTRACT

Background As the worldwide population has aged, the number of surgical procedures performed on older patients has increased. It is not known whether this increase has been proportional to growth in the elderly population. The aim of this study was to assess the population-adjusted incidence of acute and elective general and orthopaedic surgery in older patients at a tertiary hospital in New Zealand.

Methods This was a retrospective study using routinely collected electronic data from Auckland District Health Board (DHB) and New Zealand Ministry of Health databases. Population estimates and numbers of general surgical and orthopaedic procedures from 2004 to 2016 were obtained. Annual age-specific incidence rates of surgical procedures were calculated and trends analysed using negative binomial regression.

Results The incidence of elective surgery increased by 5.35% annually from 2004 to 2016. The rate of increase is lower in the Māori population (2.14%) compared with other ethnic groups (4.22%–5.62%). The incidence of acute surgery in those aged 70 years and above decreased from 2004 to 2016. The European and other ethnic group had the highest rate of acute surgery, and higher rates of elective surgery than Pacific and Asian peoples.

Conclusion The increasing number of elective general surgical and orthopaedic procedures performed on older patients in Auckland DHB is beyond what is expected for population growth alone. This has significant implication for clinicians, healthcare providers and governmental institutions. Ethnic differences are evident and warrants further attention as these may reflect disparities in access to surgery.

INTRODUCTION

Population ageing is a worldwide phenomenon. Driven by falling fertility rates and dramatic improvements in life expectancy, the number of individuals aged 65 or older is projected to grow from an estimated 524 million in 2010 to nearly 1.5 billion in 2050.[1] In New Zealand (NZ), the number of individuals aged 65 or older is expected to double from 2013 to 2038, reaching over 1.2 million and representing almost 25% of the total population.[2] This powerful demographic shift will challenge national infrastructure, especially health systems. Appropriate policies and programme are necessary to support the health and independence into old age.[1]

The health field debate regarding management of older people includes discussion of appropriate levels of preventative care, surgical and cancer treatment.[3–8] Surgical procedures have a crucial role in prolonging or improving quality of life. Immediate perioperative risk has dropped substantially in the past 50 years,[9] and surgical interventions have shifted towards less invasive techniques.[10] Age no longer precludes surgery and surgical procedures are often performed on older patients with complex comorbidities. The geriatric surgical population poses unique challenges for the perioperative clinician. Age is an independent predictor of morbidity and mortality after surgery,[11 12] standards of surgical care for older patients are lacking, and older patients are more likely to receive inappropriately invasive procedures or, paradoxically, to be denied life-saving treatment.[13]

Anecdotally, it seems that an increasing number of surgical procedures are performed on older patients, but there is surprisingly little formal evaluation of relevant evidence. In particular, it is unknown whether this simply reflects population growth in the older age groups or whether the rate of surgery is increasing in older people. Studies of geriatric surgical epidemiology are scarce. Published studies have examined trends in specific surgical procedures or specialties in the older population but these reflect changing management strategies within surgical disciplines rather than changing surgical needs of the older population.[14 15] One Californian study[16] examining the incidence rates of six surgical procedures from 1990 to 2000 in patients aged 80 and older concluded that the older population is a large and growing part of the surgical workload and that surgeons must embrace research, training and education to match future demand.

Ethnic disparities in health outcomes are evident internationally, with indigenous, immigrant and minority populations suffering poor health outcomes.[17 18] Ethnic disparities among older people are influenced by the processes of ageing, migration, acculturation and socioeconomic inequality.[18] Older minority populations are vulnerable to the effects of both institutional ageism and racism. In NZ, Māori, the indigenous people and Pacific peoples suffer worse health outcomes and a shorter life expectancy than their European and Asian counterparts.[19] Māori patients with colorectal cancer have higher mortality rates than non-Māori patients after adjusting for stage of disease.[20] Māori patients with ischaemic heart disease are less likely

to receive percutaneous or surgical intervention despite a higher mortality than non-Māori patients.[21] Greater patient comorbidity, poorer access to intervention and differences in treatment decisions contribute to this disparity.[20 21]

The objective of this study was to examine the population-adjusted incidence rate of elective and acute surgery in people over the age of 60 years at a tertiary hospital in NZ between 2004 and 2016. Ethnic disparities in incidence rates were also examined.

METHODS

Study design

This was a retrospective analysis of routinely collected clinical data for the period 2004–2016 held at the Auckland District Health Board (DHB), 1 of 20 DHBs in NZ responsible for the provision of publicly funded health services. In 2016/2017, Auckland DHB serviced a population of an estimated half a million people.[22] Data from the National Censuses suggested that the population aged 60 and older in Auckland increased by 42% between the years of 2004 and 2016, from 54 590 to 77 530 people (Statistics NZ, 2016). No patient identifying information was extracted for this study.

Data sources

The number of surgical procedures performed at Auckland DHB in the population aged 60 years and above was extracted from the Patient Information Management System (PIMS). PIMS was introduced in 2003 and all surgical procedures performed at Auckland DHB are routinely recorded in this database. It contains information including patient demographics such as age, sex and ethnicity, as well as surgical specialty and procedure codes allocated during each procedure. Each surgical procedure is coded with a unique International Statistical Classification of Diseases and Related Health Problems, revision 10 code (online supplementary file). We chose to analyse general surgical and orthopaedic procedures because these are common in the elderly,[23] and limiting our cohort to these specialties minimised numerator-denominator mismatch which could have arisen from referrals from peripheral regions if more specialised surgical procedures had been included. Both elective (planned) and acute (emergency) surgical procedures for general and orthopaedic surgery were extracted.

Estimates of the Auckland DHB population broken down by age were obtained from the Ministry of Health (MOH) based on the 2001, 2006 and 2013 National Censuses. For non-census years, projections of population numbers were produced by Statistics NZ by calculating the effects of fertility, mortality, migration and interethnic mobility within each age–sex group according to assumptions based on historical demographic trends and characteristics of each DHB (MOH, 2016).

Variables

Key variables were age group, sex, ethnic group and year. Surgical cases were categorised into three age groups—60–69 years, 70–79 years and 80 and over years. Sex was categorised as male or female. Self-identified patient ethnicity was categorised into the mutually exclusive Māori, Pacific, Asian or Other/European ethnic groups using the prioritisation classification recommended for the health and disability sector in NZ.[24] The differential effects of the year on surgical incidence rates by age and ethnic group were tested using age group by year and ethnic group by year interaction terms. Age group by ethnicity interaction term was used to test whether the ethnicity-specific surgical incidences varied in the different age groups.

Statistical analysis

The annual incidence rates of surgical procedures were calculated and repeated for each age and ethnic group for both elective and acute general and orthopaedic surgery. For each calculation, the numerator was the number of surgical procedures and the denominator was the Auckland DHB population estimate corresponding to the age or ethnic group of interest. Incidence rates were reported as the number of surgical procedures per 10 000 person-years.

Poisson regression was used to assess the annual change in incidence rate of total elective and acute surgery and within each specialty and age group using year as a continuous variable. Additional explanatory variables such as ethnic group, sex, age group and interaction terms were included when appropriate. The regression was repeated to obtain a parsimonious model with exclusion of statistically insignificant interaction terms ($p<0.05$). The fit and predictive power of the models were assessed using postregression goodness-of-fit tests. These indicated overdispersion, therefore, analyses were repeated using negative binomial regression. Reported results were taken from the final parsimonious regression model. Results are presented as annual change in incidence rates with 95% CIs and effect size presented as incidence rate ratios (IRRs). P values<0.05 were considered statistically significant. All statistical analyses were performed using Stata/IC 15.1 2017 (StataCorp).

RESULTS

Elective surgery

From 1 January 2004 to 31 December 2016, 13 998 elective general surgical cases and 6839 elective orthopaedic cases were performed on patients aged 60 and over. Excision of skin and subcutaneous lesions, hernia repair, major open abdominal surgery, anorectal procedures, mastectomy, laparoscopic procedures and closure of ileostomy accounted for over 67% of all elective general surgery in older patients at Auckland DHB. Hip and knee joint replacements, carpal tunnel release, spinal surgery, arthroscopic procedures and shoulder replacements accounted for over 65% of all elective orthopaedic surgery in older patients at Auckland DHB.

The population-adjusted incidence rate of elective general surgical and orthopaedic procedures in the older Auckland DHB population increased by 5.35% annually (95% CIs 4.12%

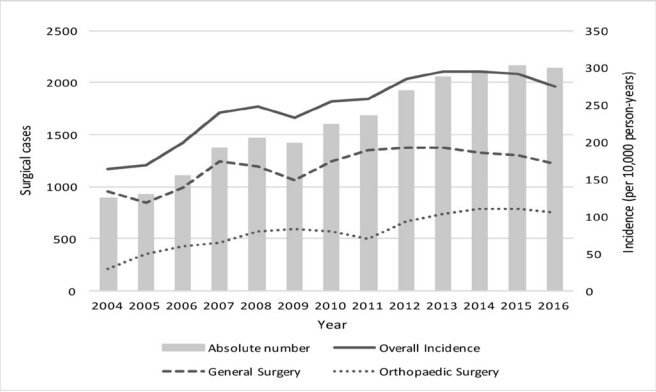

Figure 1 Absolute numbers and unadjusted incidence of elective general and orthopaedic surgery in patients aged 60 and older at Auckland District Health Board from 2004 to 2016.

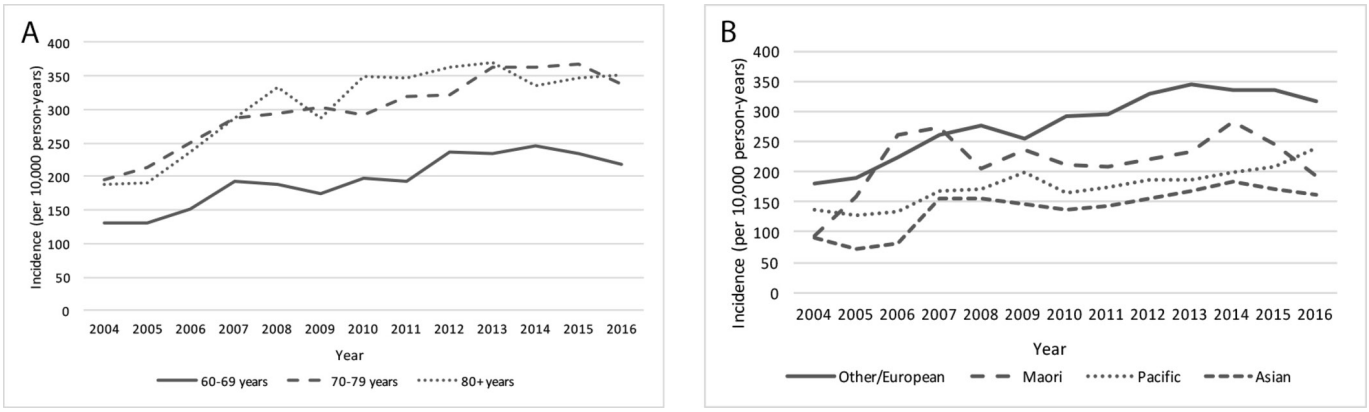

Figure 2 Unadjusted incidence of elective surgery in patients aged 60 years and older at Auckland District Health Board from 2004 to 2016, by age group (A) and ethnic group (B).

to 6.60%), representing an increase in annual surgical cases by a factor of 2.4 from 2004 to 2016. The annual increase in incidence rate of elective general and orthopaedic surgery was 3.89% (95% CIs 2.56% to 5.25%) and 8.55% (95% CIs 7.01% to 10.11%), respectively (figure 1).

The incidence rate of elective surgery was significantly higher in patients aged 70 years and over compared with those aged between 60 and 69 years (figure 2, table 1). The population-adjusted incidence rate of elective surgery increased significantly in all age groups; 5.63% (95% CIs 4.31% to 6.96%) annually in the 60–69 years, 5.05% (95% CIs 4.09% to 6.02%) annually in the 70 and 79 years, and 5.57% (95% CIs 4.10% to 7.06%) annually in the 80 years and over age groups.

The incidence rate of elective surgery was highest for other/European and Māori peoples, followed by Pacific and Asian peoples (figure 2, table 1). The annual incidence rate of elective surgery increased significantly in all ethnic groups except the Māori population; and the year by ethnic group interaction term indicated that the change in incidence was significantly lower for the Māori population when compared with the other/European population (figure 2, table 1).

Acute surgery

From 1 January 2004 to 31 December 2016, 5789 acute general surgical cases and 10 265 acute orthopaedic cases were

Table 1 Incidence rates and incidence rate ratios of elective and acute surgery by age and ethnic group

	Annual rate of change (%)	95% CI	P value	Incidence rate ratio	95% CI	P value
Elective Surgery						
Overall	5.35	4.12 to 6.60	0.000	–	–	–
By age group (years)						
60–69	5.63	4.31 to 6.96	0.000	1	–	–
70–79	5.05	4.09 to 6.02	0.000	1.32	1.23 to 1.42	0.000
80 and over	5.57	4.10 to 7.06	0.000	1.21	1.11 to 1.32	0.000
By ethnic group						
Māori	2.14	−0.94 to 5.32	0.018*	0.92	0.76 to 1.13	0.430
Pacific	4.22	1.29 to 7.24	0.363*	0.65	0.54 to 0.77	0.000
Asian	5.62	2.80 to 8.51	0.818*	0.48	0.41 to 0.57	0.000
Other/European	5.35 (ref)	4.12 to 6.60	–	1	–	–
Acute surgery						
Overall	0.11	−1.12 to 1.36	0.857	–	–	–
By age group						
60–69	0.09	−1.01 to 1.01	0.8	1	–	–
70–79	−1.16	0.06 to 2.26	0.040	1.40	1.22 to 1.60	0.000
80 and over	−1.29	0.55 to 2.02	0.001	2.67	2.34 to 3.08	0.000
By ethnic group						
Māori	−1.34	−4.56 to 1.20	0.235*	0.77	0.70 to 0.86	0.000
Pacific	0.43	−2.37 to 3.31	0.908*	0.89	0.83 to 0.97	0.006
Asian	0.25	−2.50 to 3.08	0.961*	0.52	0.48 to 0.56	0.000
Other/European	0.11 (ref)	−1.12 to 1.36	–	1	–	–

*Indicates whether change in incidence rate is significantly different to other/European (reference) population.

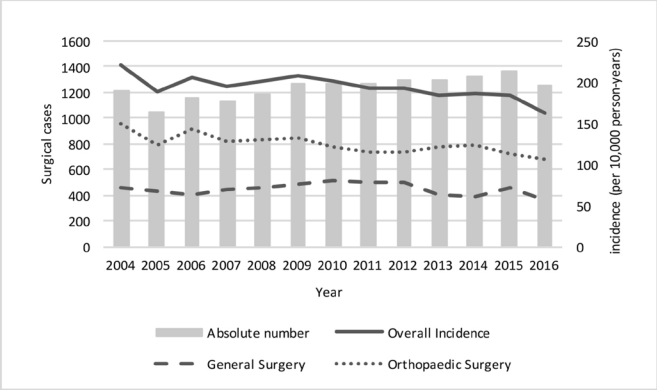

Figure 3 Absolute numbers and unadjusted incidence of acute general and orthopaedic surgery in patients aged 60 and older at Auckland District Health Board from 2004 to 2016.

performed on patients aged 60 and over. Open abdominal surgery, laparoscopic surgery, soft-tissue, anorectal procedures and hernia repairs accounted for 60% of acute general surgery in older patients. Fracture fixation, soft-tissue procedures and manipulation of hip joint dislocation accounted for 60% of acute orthopaedic surgery in older patients. The majority of fracture fixations were hip and femoral fractures.

The population-adjusted incidence rate of acute general surgical and orthopaedic procedures in the older Auckland DHB population appear have decreased from 2004 to 2016 although this was not statistically significant (0.11%, 95% CIs −1.12% to 1.36%) (figure 3).

The IRR of acute surgery for the 70 to 79 years and 80 years and above age groups were 1.40 and 2.67 times that of the 60–69 years age group, respectively (figure 4, table 1). The annual incidence rate of acute surgery decreased significantly in those aged 70–79 years (−1.16%, 95% CIs to −0.06% to −2.26%) and 80 years and above (−1.29%, 95% CIs −0.55% to −2.02%).

The incidence of acute surgery was significantly higher for Other/European people, followed by Pacific, Māori and Asian peoples (figure 4, table 1). There was no significant change in the incidence of acute surgery in any ethnic group from 2004 to 2016 (table 1).

DISCUSSION

The incidence of elective general and orthopaedic surgery in the older Auckland DHB population increased to a greater extent from 2004 to 2016 than population growth. In comparison, the incidence of acute surgery decreased in the age groups above 70 years. The incidence of elective and acute general and orthopaedic surgery was higher in the older age groups compared with the 60–69 years age group. Ethnic differences are evident; the incidence rate of elective surgery was highest in other/European and Māori peoples, and lowest in Asian people. The incidence of elective surgery has increased significantly in all but the Māori ethnic group. The incidence rate of acute surgery was highest in the other/European population.

The results of this study have implications for clinicians, service providers and governmental institutions. For the clinician, this study suggests that the demand for elective general and orthopaedic surgery in the older population is increasing, and a significant proportion of these surgical procedures are intermediate to high risk.[25] Clinicians must equip themselves to serve the needs of the geriatric surgical population by engaging in continued medical education and discussions around value-based care. Specialised teams and pathways to optimise perioperative care for the geriatric surgical population should be developed. Health fund allocation, service planning and purchasing decisions should be supported by epidemiological evidence.

The NZ government's Elective Health Strategy was implemented in 2011 with an aim to reduce waiting times for elective health services.[26] In addition, the MOH identified elective operations as a priority health target in 2011, aiming to increase the number of elective surgical discharges by 4000 per year.[27] The increasing incidence of publicly funded elective surgery in Auckland DHB may reflect the efforts of this initiative, as well as a reduction in health insurance coverage in the older NZ population over the past two decades.[28] It is also possible that clinicians' perspectives on surgery for older patients are changing; surgical intervention may be increasingly perceived as a safe and successful treatment option for many older patients.

Reassuringly, the incidence rate of acute general and orthopaedic surgery has not changed significantly and appears have decreased in those aged 70 years and over at Auckland DHB. The incidence rate of acute orthopaedic surgery was 1.73 times that of acute general surgery. The falling worldwide burden of hip fractures may explain this observation as hip fracture fixation accounted for 43% of acute orthopaedic surgery in older Auckland DHB patients.[29–34]

The provision of safe and equitable surgery is a central part of the NZ health system.[35] Ethnic differences in surgical incidence rates. therefore, deserve further attention. The disparity

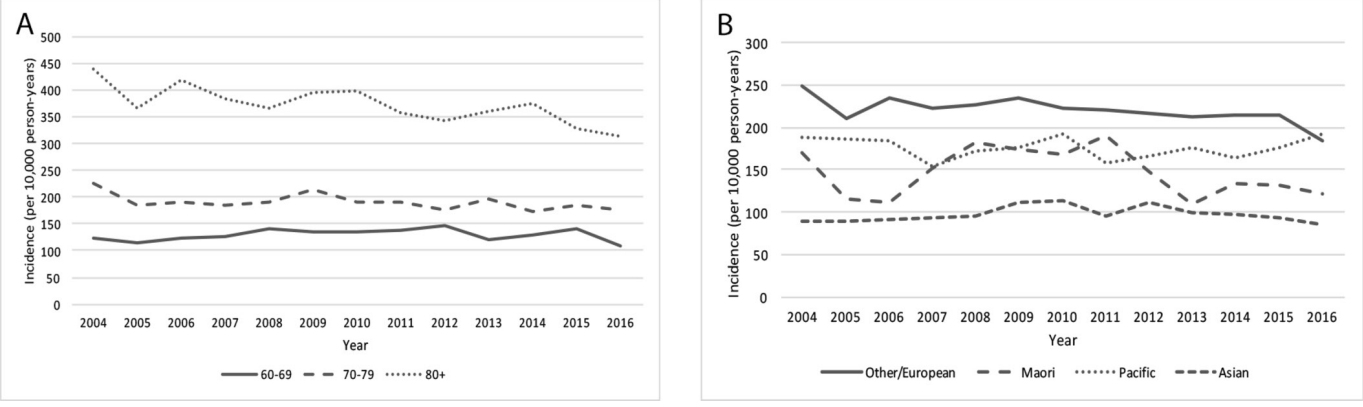

Figure 4 Unadjusted incidence of acute surgery in patients aged 60 years and older at Auckland District Health Board from 2004 to 2016, by age group (A) and ethnic group (B).

in outcomes between Māori and non-Māori is the most consistent, profound and comprehensively documented disparity in the health of New Zealanders. Burden of disease, differential access to healthcare and differences in the quality of healthcare contribute to ethnic disparities in health. The results of this study show that the incidence of acute surgery is significantly lower for the Māori population when compared with the other/European population. The incidence of elective surgery in the Māori population has not changed from 2004 to 2016 despite significant increases seen in the other ethnic groups. The lower burden of skin cancer and osteoporotic hip fractures may partly explain the lower surgical incidence rates in Māori and Pacific peoples but the burden of other surgical conditions such as arthritis, spinal disorders or other forms of cancer in Māori and Pacific peoples is comparable to that of NZ European people.[36–39] This study suggests the persistence of disparities into the oldest age groups. Further studies are required to examine where disparities occur along the surgical pathway and how health systems can be more responsive to disadvantaged peoples, including ways of improving the cultural safety of surgical health services.

WHO 2011 report on Global Health and Ageing emphasised the importance of developing appropriate data systems and research capacity to understand the relationships between health and ageing.[1] This is the first study to give a broad overview of geriatric surgical epidemiology. A further strength of the study is the use of high-quality, routinely collected electronic data which reduced the potential of measurement bias and error. Sampling error and selection bias were minimised as all surgical procedures were captured. The population-based sampling frame using data from the National Censuses for the denominator is also a strength. Although the results cannot be confidently extrapolated beyond the Auckland DHB region due to differences in regional and national demographic structures, health systems and needs, this study illustrates the importance of longitudinal research in informing clinicians and policy-makers of the changing health needs of the older population. Examining ethnic disparities in the older population can provide insight into how socioeconomic, cultural and institutional factors play out over an individual's lifetime.

We used high-quality sources of data for this study but there are limitations, which must be considered when interpreting our results. The study does not include privately funded surgical procedures in Auckland which would provide a more complete picture of the surgical needs of the older Auckland population. The MOH population estimates are obtained from census counts which relies on individual participation. The NZ Census has been shown to undercount the Pacific population due to concerns regarding deportation for illegal immigrants and overstayers.[40] Sample sizes in certain population groups were small, limiting our ability to detect statistically significant results. Coding errors may occur during the process of data entry into the PIMS database. There is also potential for a single patient to bias incidence rates if they received numerous surgical procedures in a year, especially in age or ethnic groups with small population numbers. The general surgical and orthopaedic services in Auckland DHB occasionally accept referrals of patients domiciled in another DHB, and this could lead to inaccuracy in the incidence rates. However, these are infrequent and unlikely to cause differential bias across different years, age or ethnic groups. Trends in incidence rates and IRRs between subgroups remain valid.

Large-scale big-data research has a significant role to play in our understanding of the health needs of the ageing population. This study could be replicated to include a nationwide analysis of geriatric surgical epidemiology in NZ. All publicly funded and most privately funded surgery are routinely and electronically recorded in the MOH National Minimum Dataset. This would provide a detailed overview of surgical provision in the older NZ population. Ethnic differences should be examined to establish if these reflect inequitable access to surgery and at which points in the surgical pathway the inequities occur. This research could be linked to outcome studies to ensure that value-based surgery is delivered to the individual as well as the NZ population.

Funding for surgical, anaesthetic, geriatric and rehabilitation services should be matched to growing need. Long-term service planning to manage the increase in demand for surgical services as a result not only of rapid population growth, but also the increase in the population-adjusted rate of elective surgery should commence with urgency.

What is already known on this subject

- The worldwide population is ageing and more surgical procedures are performed on older patients with complex comorbidities.
- It is unknown whether this increase is proportional to population growth in the older population.
- Ethnic disparities in access to healthcare are evident worldwide and it is unknown whether this extends to the older surgical population.

What this study adds

- This is the first epidemiological study to provide a broad overview of surgical incidence in older patients. This study highlights the feasibility of conducting longitudinal research using routinely collected data to inform clinicians, health managers and policy-makers of the changing health needs of the older population.
- The incidence of elective general and orthopaedic surgery in a tertiary hospital in New Zealand is increasing beyond population growth in the older population, while the incidence of acute surgery has decreased in those aged 70 and above from 2004 to 2016. Ethnic differences in surgical incidence rates are evident and suggest the persistence of disparities into the oldest age groups.

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