Trends in length of stay following acute coronary syndrome hospitalisation in New Zealand 2006–2016: ANZACS-QI 32 study

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ABSTRACT

AIMS: Length of hospital stay (LOS) for acute coronary syndrome (ACS) has important clinical and cost implications. We report recent trends and predictors of ACS hospitalisation LOS in New Zealand.

METHODS: Using routine national hospitalisation datasets, we calculated mean LOS for ACS admissions annually from 2006 to 2016, by demographics, ACS subtype and ACS procedures (coronary angiography, percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG)). We also identified predictors of longer LOS.

RESULTS: Among 185,962 ACS hospitalisations, mean LOS decreased from 7.8 to 6.7 days between 2006 and 2016 (adjusted decrease = -0.18 days/year). Decline in LOS was observed for all demographic subgroups by age, sex, ethnicity and deprivation quintile. While coronary angiography and PCI rates increased during this time, LOS declined for all management strategies. However, the adjusted rate of decline was greater for patients receiving coronary angiography without revascularisation (-0.24 days/year), PCI (-0.22 days/year) and CABG (0.33 days/year)—than those not receiving angiography (-0.14 days/year), P<0.001. A greater decline occurred for NSTEMI and STEMI (9.4 to 7.5 days and 7.8 to 6.2 days, respectively) than UA (5.4 to 4.9 days). Predictors of longer LOS in 2016 were older age, female, Māori or Pacific ethnicity, not receiving coronary angiography, initial presentation to a non-interventional hospital and CABG.

CONCLUSIONS: Mean LOS for ACS hospitalisations declined between 2006 and 2016. The decline was greatest in the increasing proportion of patients who received a coronary angiogram. Further reductions in LOS may be achieved by implementation of nationally agreed pathways for adequate and timely access to coronary angiography.

Length of hospital stay (LOS) following an acute coronary syndrome (ACS) hospitalisation has significant clinical, prognostic and cost implications for the patients and healthcare systems.[1–3] Gradual decline in ACS hospitalisation LOS has been observed in many countries[3–5] and a range of factors can prolong LOS, resulting in wide heterogeneity in LOS.[2,6] Several studies have also shown that early discharge is safe and feasible after revascularisation and not associated with adverse prognosis.[5,8–12] This is reflected in guidelines which now recommend early discharge for low risk and uncomplicated patients, particularly for ST-elevation myocardial infarction (STEMI).[2,7] In New Zealand, all ACS hospital admissions are captured in routinely collected national hospitalisation datasets using ICD-10 AM codes and available to the All New Zealand

ACS Quality Improvement (ANZACS-QI) investigators. We have previously validated the accuracy of these codes for identifying ACS. We have also developed and validated a method for 'bundling' hospital admission associated with a single ACS episode to allow LOS to be accurately determined.[13–15] The aim of this study is to report the trends and predictors of LOS following ACS hospitalisations in New Zealand from 2006 to 2016.

Methods

The methodology of the ANZACS-QI Programme, which serves as the platform for this study, has been previously reported.[13] All ACS admissions to New Zealand public hospitals between 2006 and 2016 were identified from the national hospitalisations dataset using standard ICD-10 codes I20.0, I21-I22. These codes include STEMI, non-ST elevation MI (NSTEMI), unstable angina (UA) and a small sub-group as MI unspecified. ACS admissions were 'bundled' to take into account transfers to other hospitals within the same hospitalisation. This bundling process identified discrete episodes of care, associated hospital admission and discharge dates. LOS was defined as the time in days from first hospital admission to final hospital discharge for each discrete episode of care.[13] A small number of patients with LOS >8 weeks (1.2% of total admissions) were excluded from this analysis because the prolonged LOS is likely due to other non-ACS comorbidity and their inclusion would carry undue weight in the analysis.

Mean LOS for the combined cohort and subgroups each year were calculated. The subgroups of interest included demographic variables: age groups (20–44, 45–59, 60–69, 70–79 and 80–89 years old), sex (male and female), ethnicity (Māori, Pacific, Indian, Other Asian and European/other) and New Zealand Deprivation Index (NZDep2013) quintiles (Q1-Q5);[16] whether the initial admission was to a hospital with or without a coronary intervention-capable catheterisation laboratory; ACS subtypes (STEMI, NSTEMI and UA); investigation/management strategy (no angiography, angiography without revascularisation, percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG)).

SAS version 9.4 (SAS Institute Inc. Cary NC) was used for statistical analysis. Data were presented as mean+/-standard deviation or frequency (percentage) for continuous and categorical variables respectively. P-value less than 0.05 was deemed statistically significant. Multivariable linear regression was performed for the whole cohort to calculate the overall rate of change of LOS per year adjusting for covariates, including all the aforementioned demographic, catheterisation laboratory, ACS subtype and management strategy variables. This was repeated for the different invasive strategies subgroup to see if their LOS decreased adjusting for covariates. Finally, this was also performed for the 2016 ACS hospitalisations cohort only to identify independent predictors of longer LOS. Model estimates represented the number of days the LOS is increased or decreased by.

Ethics approval was obtained from the Northern Region Ethics Committee (AKY/03/12/314) and Multi-Region Ethics Committee (MEC/01/19/EXP and MEC/11/EXP/078) as part of the VIEW research programme.

Results

There were 185,962 ACS hospitalisations during 2006–2016. Baseline characteristics from 2006 and 2016 are shown in Table 1. Mean LOS by year of all ACS hospitalisations are shown in Figure 1. From 2006–2008 LOS remained stable (7.8–8.1 days), followed by a steady decline to 6.7 days in 2016. The overall adjusted rate of decrease was 0.18 (95% confidence interval 0.17–0.20) days per year. LOS by regions and by centres with and without interventional catheterisation lab is illustrated in Figure 1B.

A relatively similar decline in LOS occurred across all demographic groups—age, sex, ethnicity and deprivation quintile. The mean LOS increased with age, but the age group-related declined steepest for those over 80 years. Females had slightly longer mean LOS than males, although the gap reduced with time. While LOS declined overall for all ethnic groups, there was variability within each group. The decline in LOS was similar in all NZDep quintiles over the period.

Table 1: Baseline characteristics.

Characteristic	2006	2016
N	**20,166**	**14,464**
Age (years)		
20–44	670 (3.3%)	428 (3.0%)
45–59	3,454 (17.1%)	2,622 (18.1%)
60–69	3,370 (16.7%)	3,367 (23.2%)
70–79	5,426 (26.9%)	3,726 (25.8%)
80–89	6,886 (34.1%)	4,321 (30.0%)
Sex		
Male	11,580 (57.4%)	8,832 (61.1%)
Female	8,586 (42.6%)	5,632 (38.9%)
Ethnicity		
Māori	1,844 (9.1%)	1,572 (10.9%)
Pacific	643 (3.2%)	677 (4.7%)
Indian	405 (2.0%)	517 (3.6%)
Asian	273 (1.4%)	326 (2.3%)
European/Other	17,001 (84.3%)	11,372 (78.6%)
Presented to interventional hospital		
Yes	11,559 (57.3%)	10,094 (69.8%)
No	8,607 (42.7%)	4,370 (30.2%)
NZDep 2013 Quintiles		
Q1	2,421 (12.0%)	2,160 (14.9%)
Q2	3,031 (15.0%)	2,305 (15.9%)
Q3	3,972 (19.7%)	2,902 (20.1%)
Q4	5,324 (26.4%)	3,416 (23.6%)
Q5	5,347 (26.5%)	3,651 (25.2%)
ACS subtype		
STEMI	2,852 (14.1%)	2,678 (18.2%)
NSTEMI	10,413 (51.6%)	7,817 (54.0%)
UA	5,978 (29.6%)	3,291(22.8%)
MI unspecified	923 (4.6%)	678 (4.7%)
Investigation/management		
No angiography	13,375 (66.3%)	6,394 (44.2%)
Angiography	6,791 (33.7%)	8,070 (55.8%)
Coronary revascularisation	4,173 (20.7%)	5,402 (37.3%)
PCI	3,251 (16.1%)	4,482 (31.0%)
CABG	922 (4.6%)	920 (6.4%)

Figure 1: Length of stay of ACS admission 2006–2016 overall.

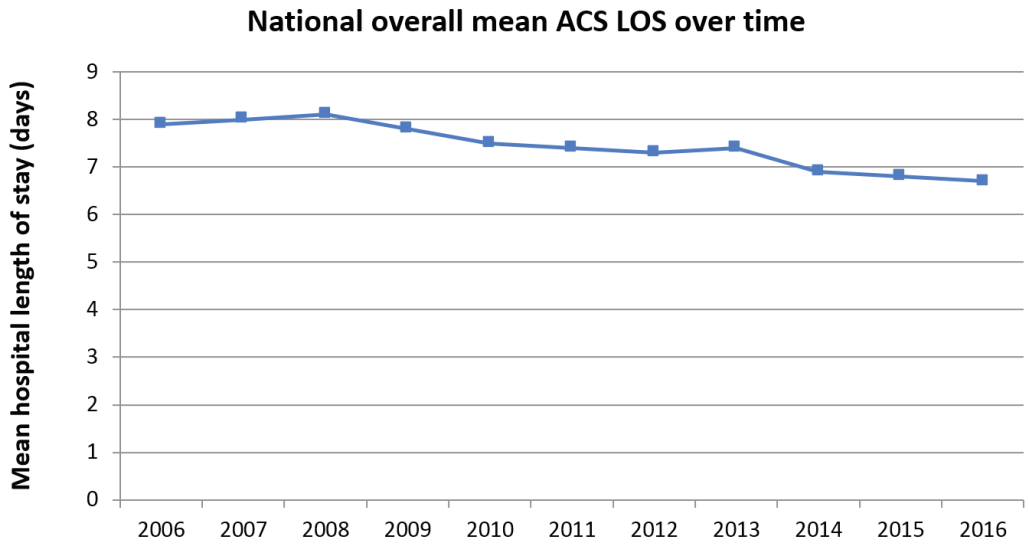


Figure 2: Length of stay of ACS admission 2006–2016 by (a) age group, (b) sex and (c) ethnicity (d) New Zealand Deprivation Index 2013.

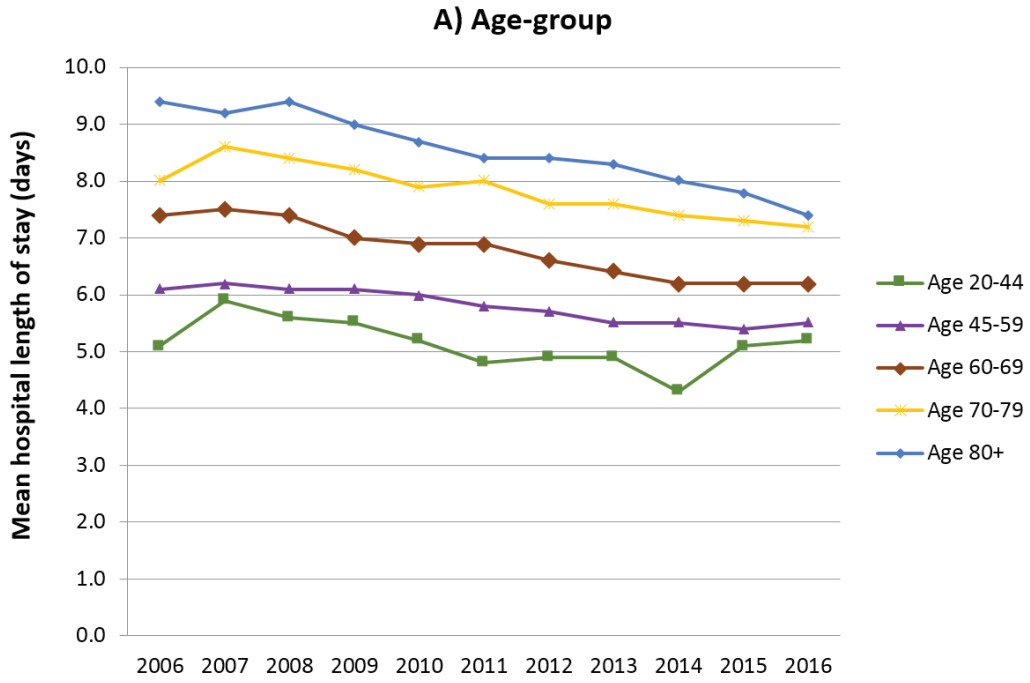
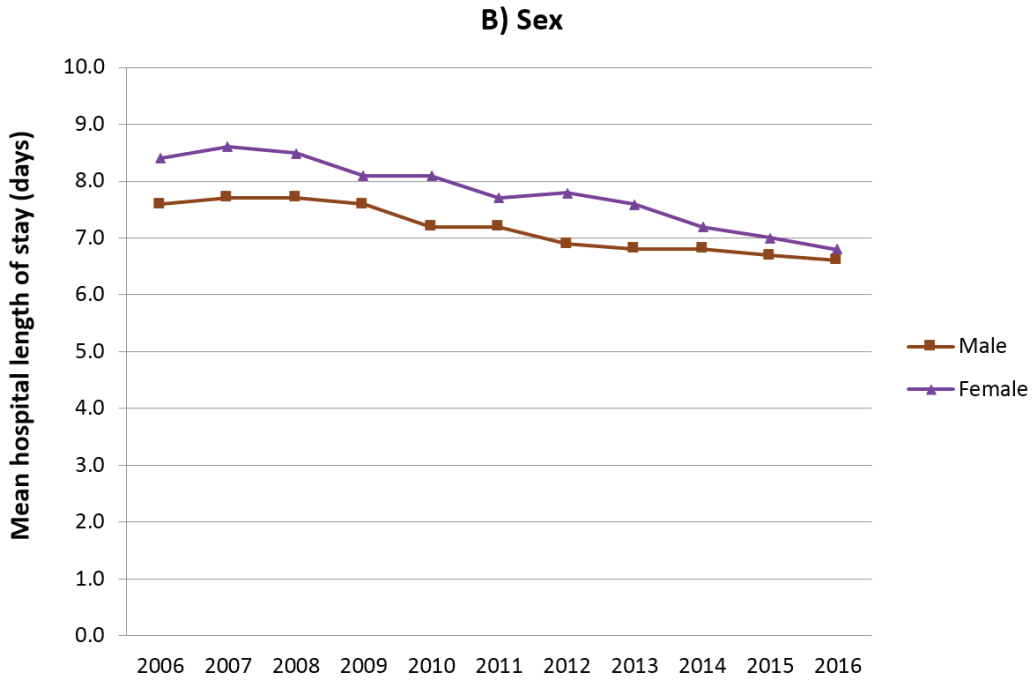
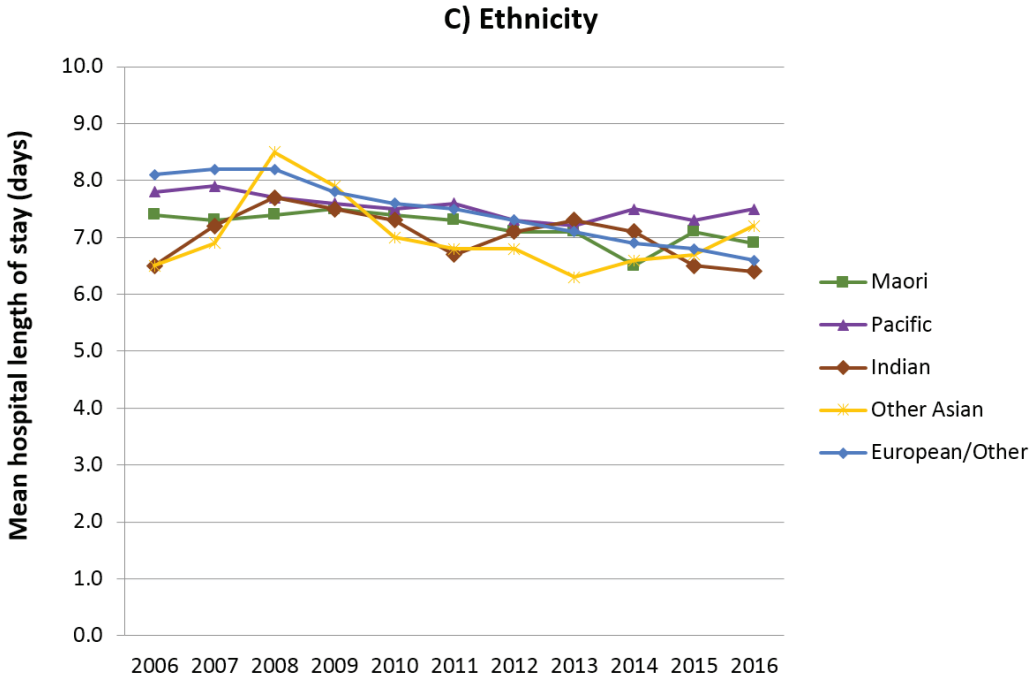


Figure 2: Length of stay of ACS admission 2006–2016 by (a) age group, (b) sex and (c) ethnicity (d) New Zealand Deprivation Index 2013 (continued).





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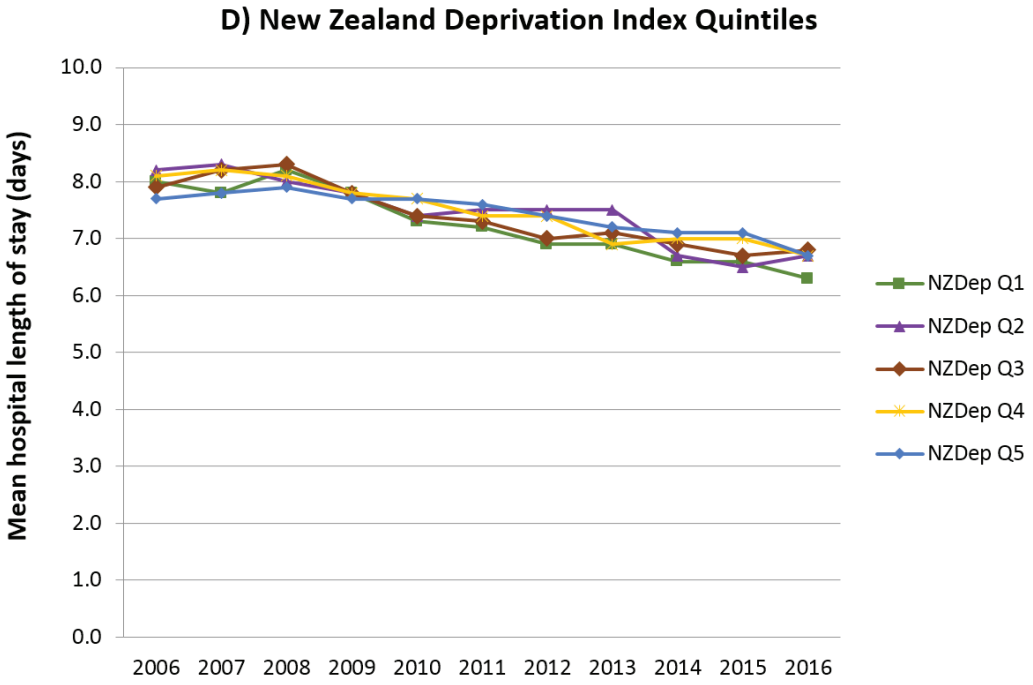

Between 2006 and 2016 the percentage of ACS patients having coronary angiography increased from 34 to 56% and PCI increased from 16 to 31%, while CABG rates were largely unchanged. Those receiving CABG had a much longer mean LOS then non-CABG admissions across the time period (Figure 3). There was reduction in LOS for all management strategies from 2006 to 2016. The adjusted rate of decline was greater for patients receiving coronary angiography—angiography without revascularisation (-0.24 days/year), PCI (-0.22 days/year) and CABG (0.33 days/year)—than for those not receiving angiography (-0.14 days/year), P<0.001.

A greater decline between 2006 and 2016 occurred for NSTEMI and STEMI patients (9.4 to 7.5 days and 7.8 to 6.2 days, respectively) than for UA patients (5.4 to 4.9 days) (Figure 4). In the small group of MI unspecified patients, there was no clear change in LOS. NSTEMI had the longest mean LOS, followed by STEMI and UA.

Centres with interventional catheterisation lab had longer mean LOS by 0.8 days in 2005 but declined faster than centres without interventional catheterisation lab and in recent years have had similar LOS (Figure 5).

Results of the multivariable linear regression analysis are shown in Table 2. In 2016, older age, female sex, Māori or Pacific ethnicity and initial presentation to a non-interventional hospital were associated with longer LOS. ACS subtypes had similar LOS, except for UA, which was associated with shorter LOS. Among management strategies, PCI had the shortest LOS and CABG had the longest.

Figure 3: Length of stay of ACS admission 2006–2016 by ACS management strategy A) all strategies, B) all strategies excluding CABG.

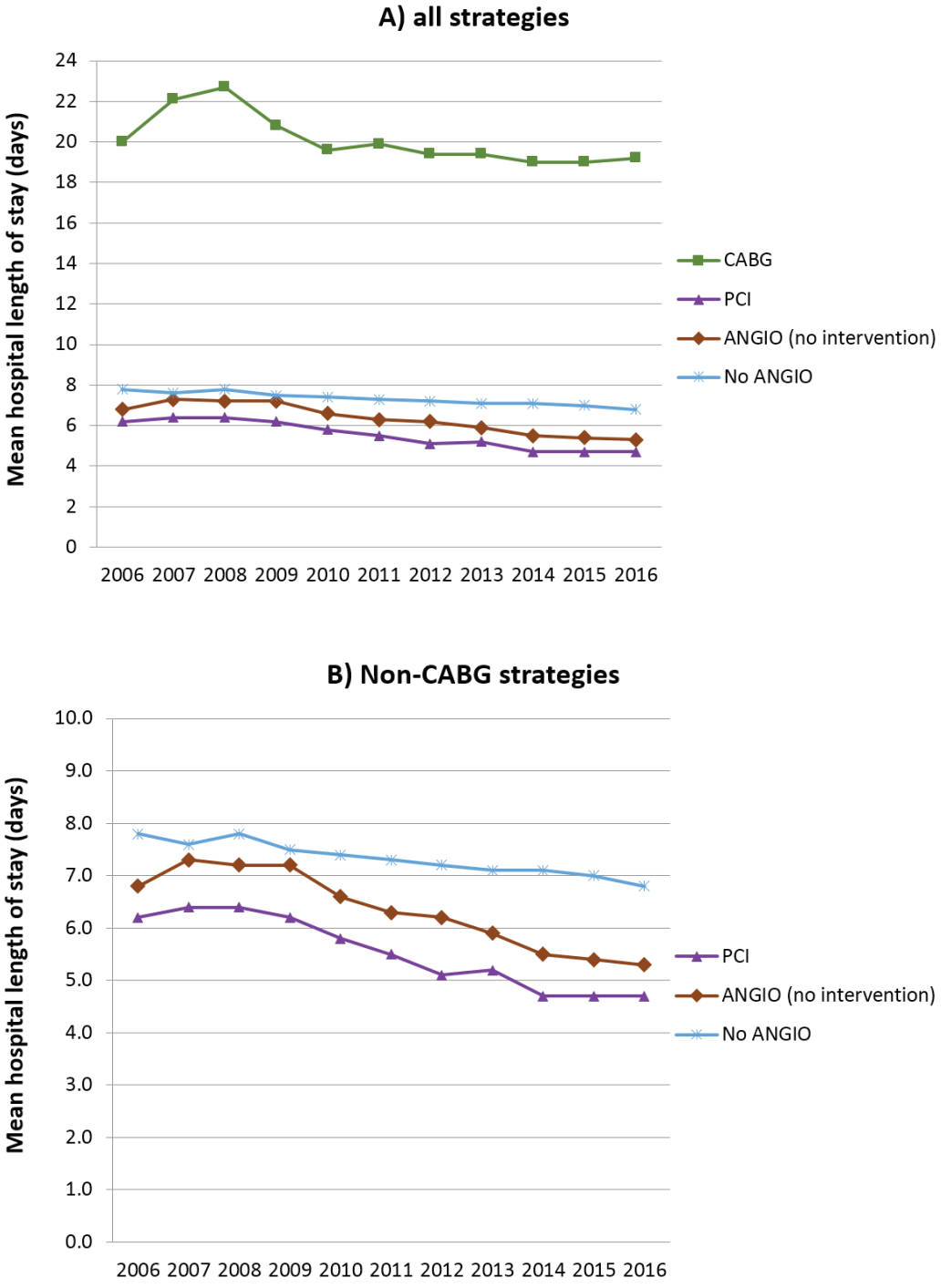

Figure 4: Length of stay of ACS admission 2006–2016 by ACS subtypes.

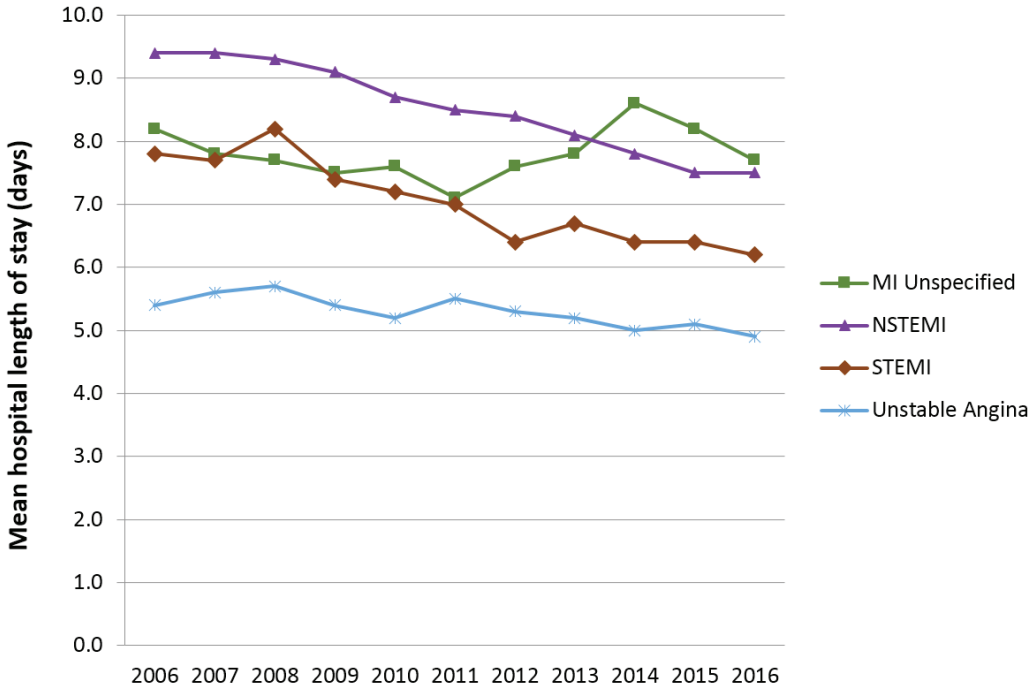

Figure 5: Length of stay of ACS admission 2006–2016 by presence of interventional laboratory at initial admitting hospital.

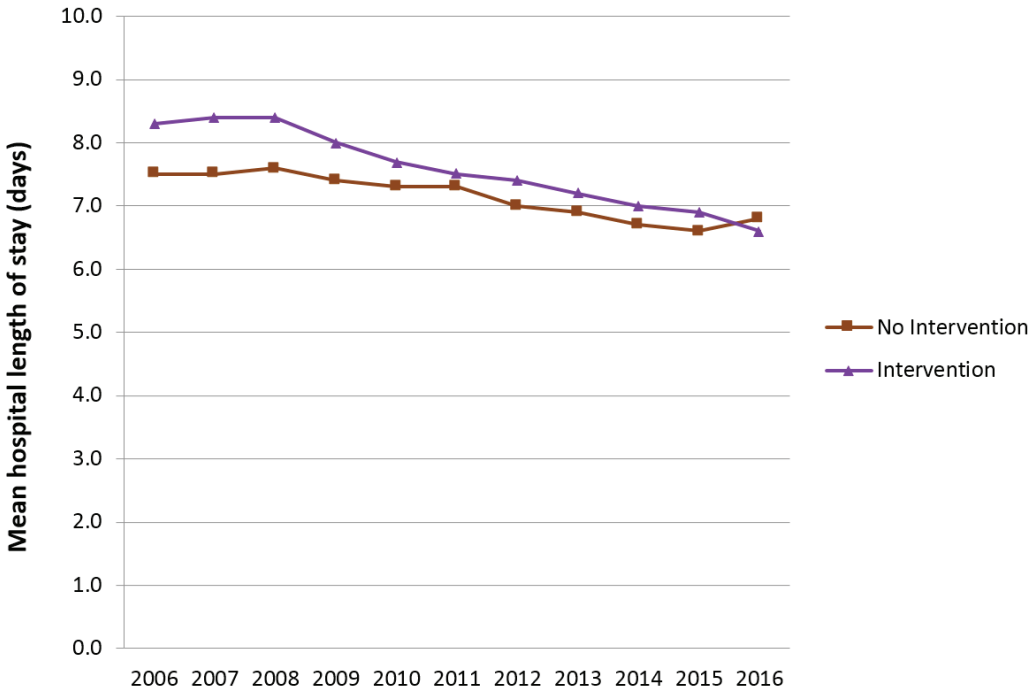

Table 2: Adjusted differences in LOS (days) by demographics, ACS subtype and management, after ACS hospitalisations in 2016.

Parameter	Difference in LOS (days)	95% confidence interval	P value
Age (years)			
20–44 (reference)	0.00		
45–59	0.23	-0.5. 1.0	0.543
60–69	0.63	-0.1, 1.4	0.090
70–79	1.9	1.1, 2.6	<0.001
80–89	2.5	1.7, 3.2	<0.001
Sex			
Male	0.0		
Female	0.4	0.1, 0.6	0.006
Ethnicity			
European/Other	0.0		
Māori	0.9	0.5, 1.3	<0.001
Pacific	0.7	0.1, 1.3	0.020
Indian	-0.1	-0.8, 0.5	0.700
Asian	0.4	-0.4, 1.2	0.362
NZDep 2013 Quintiles			
Q1	0.0		
Q2	0.2	-0.2, 0.7	0.220
Q3	0.4	0.0, 0.8	0.057
Q4	0.5	0.1, 0.9	0.011
Q5	0.4	0.0, 0.8	0.073
Catheterisation laboratory available acutely			
Yes	0.0		
No	0.4	0.1, 0.6	0.012
ACS subtype			
NSTEMI	0.0		
STEMI	-0.3	-0.6, 0.0	0.171
MI unspecified	0.1	-0.5, 0.7	0.296
UA	-2.8	-3.1, -2.4	<0.001
Management strategy			
PCI	0.0		
No angiography	1.5	1.2, 1.9	<0.001
Angiography without revascularisation	0.7	0.3, 1.0	<0.001
CABG	14.9	14.4, 15.5	<0.001

Model estimates for each parameter correspond to the mean difference in LOS in days compared to the reference level after adjustment for covariates. Reference groups appear first for each parameter. For example, after adjustment, 80–85-year-olds have a mean LOS 2.5 days longer than 20–44-year-olds.

Discussion

The mean LOS after hospitalisation in New Zealand for an ACS event has declined over 10 years by more than a day. This decline occurred for almost all demographic subgroups, and also for those receiving different management strategies. Furthermore, while only a third of ACS patients received angiography in 2006, this had increased to over half by 2016. The decline in LOS was greater in these patients than in those not receiving coronary angiography. The decline in LOS was also greater for NSTEMI and STEMI compared to UA. In the most recent year of this study (2016), the independent predictors of longer LOS were older age, female sex, Māori or Pacific ethnicity and receipt of CABG, while initial admission to a hospital with catheterisation laboratory access, UA and receipt of angiography with or without PCI was associated with shorter LOS.

Trends in LOS

An overall decline in mean LOS has also been reported in other countries.[3–5] This decline is a consequence of several factors, including more frequent and earlier use of coronary procedures and other evidence-based treatments, reduced in-hospital complications for ACS patients, as well as recent guidelines recommending earlier discharge from hospital with appropriate therapy and follow-up.[2,7] In our study the most striking decline in LOS was in NSTEMI and STEMI patients. In this analysis we cannot determine the reasons for this reduction. However, reductions in time to angiography and PCI are likely to be an important factor, as other New Zealand studies have reported both a strong correlation between time from admission to angiography and overall LOS,[17] and 1–2 day reductions in this door to angiography time, and percutaneous revascularisation during the same procedure.[18,19] As angiography rates have increased more in patients with MI than for those with UA, this would explain the observed LOS decline trends by ACS subtype.

Other changes in interventional management that may be important include a greater use of primary PCI for STEMI over this period and increasing utilisation of same-visit angiography and PCI, rather than these procedures occurring as two separate visits to the catheterisation laboratory.[19] Alongside these changes in coronary interventional management, there is increasing confidence from other studies suggesting that uncomplicated patients who have been successfully revascularised can be safely discharged earlier.[5,8–12] This was reflected in our cohort with greater adjusted rates of decline for those undergoing angiography or revascularisation than those who did not have angiography. While it is reassuring that in the same cohort of patients, other ANZACS-QI analyses have reported a decrease in both one-year mortality and non-fatal reinfarction, further analyses are planned to assess the impact of earlier discharge on outcomes.

Predictors of LOS

Age and sex: This study found a strong association between LOS and age. This is likely to be largely due to age-related comorbidity, which puts older patients at higher risk of ACS and non-ACS related complications.[20–22] Length of stay was particularly prolonged in those aged over 80 years, who may take longer to become fit enough for discharge due to the burden of cardiovascular disease, deconditioning and frailty. The reasons for the observation that females, even after adjustment, have 0.4 day longer LOS than males, requires further study. A recent ANZACS-QI study reported that rates of angiography after ACS in women were lower than for men, but that similar rates of angiography were observed after taking into account relative contraindications to having angiography, suggesting that differences in comorbidity burden and type of disease may be important factors.[23]

Ethnicity

Māori patients were more frequently admitted to hospitals without a catheterisation laboratory, which will have contributed to their longer LOS.[24] However, even after adjustment for this, Māori and Pacific patients had 0.9 and 0.7 days longer LOS than European/Other patients. Prior studies have shown that Māori and Pacific patients with coronary heart disease, although on average younger, have a greater prevalence of cardiovascular risk factors, and more complex clinical presentations including more heart failure and comorbidities. These factors may result in clinically appropriate delays in angiography and

reduce overall angiography rates relative to other ethnic groups.[17,24–25] One study also reported higher rates of adverse outcomes for Māori after CABG, although LOS was not longer than for Europeans.[26]

ACS sub-types: The main reason why patients with NSTEMI have longer LOS than those with STEMI is because they typically wait until the next available day time list for coronary angiography and revascularisation, whereas in New Zealand the standard of care for STEMI is urgent revascularisation, by primary PCI or fibrinolysis, and increasingly, transfer for early coronary angiography for those receiving fibrinolysis.[2,7] Another contributing factor is that CABG, with the associated implications for LOS, is more frequent after NSTEMI than STEMI. UA has a better prognosis than either MI subtypes due to the absence of myocardial necrosis and damage, and these patients can often be safely discharged earlier. There was no decline for the 5% of patients classified as MI unspecified.

Management strategy: Length of stay was shortest among those who had PCI. These patients receive a definitive treatment and the cause of ACS is clear, so clinicians have more confidence in discharging them early. The slightly longer LOS for those having angiography without revascularisation may be due to a need for further investigations to identify the cause, as well as keeping patients in hospital until their cardiac biomarkers fall. In contrast, the persisting greater LOS in patients who do not undergo coronary angiography is often due to critical clinical presentations and multiple comorbidities, which can lead to worse prognosis and prolonged recovery time. Patients requiring CABG continue to have the longest mean LOS by almost two weeks, compared to other treatment modalities, and indeed all subgroups. The Society of Thoracic Surgeon's Database reports that half of the patients after isolated CABG are discharged less than six days after operation and only 6% more than 14 days after operation.[27] Although comparable data are not currently available for ACS patients in New Zealand, it is likely that the largest component of modifiable LOS in CABG patients is in reducing the waiting time for surgery. Over the 10-year period of this study there has been a lot of work in New Zealand put in to improving out-patient waiting times for cardiac surgery but less emphasis on in-patient waiting times.[28] Mean LOS after CABG, which is necessary for post-operative care, was approximately 8–9 days in one New Zealand study.[29]

Interventional facility: It was reassuring that for patients residing in regions without catheterisation, who therefore needed transfer for coronary procedures, LOS was on average less than half a day longer only, reflecting efficiency of the cardiac transfer and collaborative services throughout the country.

Study implications

Extrapolating the observed reduction in mean LOS of 1.4 days from its peak in 2008 to the nadir in 2016 to the 14,464 ACS admissions in 2016, indicates that approximately 20,000 bed days were saved in New Zealand in 2016. This represents a major financial benefit in an increasingly costly health funding environment. There are also benefits for patients who are receiving appropriate treatment more rapidly and are spending less time in hospital.

However, there is still room for further reductions in LOS. Much of the improvement in LOS over the study decade has likely been related to more rapid and frequent use of angiography. Recent data suggests that the current rate of angiography in metropolitan centres is probably clinically appropriate,[23] although increases may still be needed particularly in centres without on-site interventional access.[18] ANZACS-QI registry data also shows persisting modifiable delays in those who do receive angiography, particularly for patients presenting to regional hospitals without catheterisation laboratories. Earlier in-hospital CABG should be possible. There is some regional variability in how long patients stay in hospital after PCI and angiography and by identifying and propagating best practice using national guidelines/pathways it may be possible to safely reduce LOS further.

Limitations

There are some limitations to this study. ACS diagnosis, subtypes, characteristics, procedures and LOS rely on ICD-coding, which may be imprecise. Local validation studies have however demonstrated very good accuracy relative to an independent clinical registry.[14] Other variables that

may influence LOS that were not available included co-morbidities, cardiac investigation results and frailty measures. We were unable to collect data on specific clinical reasons that could have influenced LOS. Patients who die during hospitalisation may have very short or long hospital stays depending on their clinical course, so a short LOS does not always imply an uncomplicated hospitalisation. Overall resource utilisation and cost-effectiveness (both in-hospital and ambulatory) were not able to be assessed in this study.

Conclusion

In summary, there was an overall decline in mean LOS for ACS hospitalisation between 2006 and 2016 in New Zealand. The fall in LOS has been greatest in the increasing proportion of patients who receive a coronary angiogram. Further improvements to ensure adequate and timely access to coronary angiography, and the implementation of nationally agreed pathways can reduce LOS further.

Competing interests:
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