Title

Myocardial Infarction Care Among The Elderly: Declining Treatment With Increasing Age In Two Countries.

Journal

Health Affairs, 40(9)

Authors

Hsu, John

Iversen, Tor

Price, Mary

et al.

Publication Date

2021-09-01

DOI

10.1377/hlthaff.2021.00108

Peer reviewed

HHS Public Access
Author manuscript
Health Aff (Millwood). Author manuscript; available in PMC 2024 March 03.

Published in final edited form as:
Health Aff (Millwood). 2021 September ; 40(9): 1483–1490. doi:10.1377/hlthaff.2021.00108.

Myocardial Infarction Care Among The Elderly: Declining Treatment With Increasing Age In Two Countries

John Hsu [director, associate professor],
Clinical Economics and Policy Analysis Program at the Mongan Institute Health Policy Center, Massachusetts General Hospital; Department of Medicine and the Department of Health Care Policy, Harvard Medical School, both in Boston, Massachusetts.

Tor Iversen [professor],
Department of Health Management and Health Economics, Institute of Health and Society, University of Oslo, in Oslo, Norway.

Mary Price [senior consulting data analyst],
Mongan Institute Health Policy Center, Massachusetts General Hospital.

Tron Anders Moger [professor],
Department of Health Management and Health Economics, Institute of Health and Society, University of Oslo.

Delaney Tevis [research assistant],
Mongan Institute Health Policy Research Center, Massachusetts General Hospital.

Terje P. Hagen [professor, head],
Institute of Health and Society, University of Oslo.

William H. Dow [professor]
Division of Health Policy and Management, School of Public Health, University of California Berkeley, in Berkeley, California.

Abstract

The elderly account for the majority of medical spending in many countries, raising concerns about potentially unnecessary spending, especially during the final months of life. Using a well-defined starting point (hospitalization for an initial acute myocardial infarction) with evidence-based postevent treatments, we examined age trends in treatments in the US and Norway, two countries with high levels of per capita medical spending. After accounting for comorbidities, we found marked decreases within both countries in the use of invasive treatments with age (for example, less use of percutaneous coronary interventions and surgery) and the use of relatively inexpensive medications (for example, less use of anticholesterol [statin] drugs for which generic versions are widely available). The treatment decreases with age were larger in Norway compared with those in the US. The less frequent treatment of the oldest of the old, without even use of basic medications, suggests potential age-related bias and a disconnect with the evidence on treatment

john.hsu@mgh.harvard.edu .

value. Hospital organization and payment in both countries should incentivize greater equity in treatment use across ages.

Allocating resources thoughtfully across the population represents a fundamental societal challenge in health care. Allocation across ages is particularly challenging, given the differing levels of need, potential benefits, and complications between the elderly and the young within each country, not to mention the associated definitional and measurement challenges.[1-3] Prior studies in the US have suggested the presence of excessive spending on the elderly during their final months of life—that is, the expenditure of resources that could be used for younger patients or other societal needs.[4-6] Other data indicate that many medical treatments are both safe and efficacious for the elderly and might contribute to the relatively favorable life expectancies among the elderly in the US and other countries.[7-12] We examined treatment use and choice by age for a well-defined patient population and starting time: people ages sixty-five and older with a new hospitalization for an acute myocardial infarction.

We document these age patterns in the US health care system, and we also present comparative data from another highly resourced but more tightly regulated health care system that has a notable emphasis on equity in care: the Norwegian system. This international comparison allowed us to explore whether US patterns of care for older adults may be idiosyncratic to the US system or whether there may be empirical regularities in these patterns across health care systems that merit deeper exploration more generally.

Norway, with a population of 5.4 million people,[13] has tax-financed health care with access for all citizens. There is patient cost sharing for outpatient consultations but not for inpatient stays. A national health service provides health care in a mixed centralized-decentralized system. Primary care physicians are mostly private practitioners, and hospitals are state owned, with salaried physicians. Hospitals are organized under four regional health authorities. These regional health authorities are responsible for the hospitals in their region, and compared with the US system, they more tightly oversee hospital quality and equitable access to care based on need. Hospital revenue is a mix of risk-adjusted capitation based on the population in the catchment area and diagnosis-related group (DRG)–based activity-based financing.

In comparison, the US Medicare program, with enrollment of sixty-one million people in 2020,[14] is a publicly funded program providing coverage for hospital and physician care, as well as prescription drugs for nearly all citizens ages sixty-five and older, plus those meeting other eligibility criteria—for example, people with end-stage renal disease. The program includes both a government-administered, traditional fee-for-service system (traditional Medicare) and a smaller component administered by private health plans (Medicare Advantage, which is not included in our analysis). The majority of physicians and hospitals providing care under the Medicare program are privately owned. Within the traditional fee-for-service Medicare program that we studied, hospital revenue is primarily based on DRGs.

Despite some marked differences, there are also key similarities between the US and Norwegian systems that facilitate international comparisons. First, the study population ages sixty-five and older is well insured in both countries. Second, in both systems the government is the primary payer of coverage for the vast majority of the population in this age group, thus minimizing selection concerns. Third, hospital financing has elements of activity-based funding in both countries, although physician payment is more activity based in the US than in Norway, which may incentivize maintaining more intensive treatment with age in the US than in Norway. To assist us in examining these similar contexts, we had access to high-quality data from both countries that we were able to harmonize.

The US and Norway have two of the highest per capita medical spending levels in the world, with the elderly accounting for much of the spending. The two countries also have high levels of life expectancy, although their relative life expectancies flip with age.[15-18] Specifically, Norway has one of the highest life expectancy levels (or lowest mortality levels) in the world for people ages 65–69, but lower life expectancy than the US for people who reach age 80 or older. According to the Human Mortality Database, the mortality rates in the period 2010–14 (covering our study period) were 1.5 percent and 1.2 percent for people ages 65–69 in the US and Norway, respectively; by ages 85–89 the corresponding mortality rates were 10.3 percent and 11.3 percent.[19]

Using detailed individual-level data from the two settings, we examined the within-country age patterns of treatment after a new acute myocardial infarction. We focused on common procedures and medications that have a strong evidence base underlying treatment, including treatment of the elderly.[7-12,20] Specifically, we hypothesized that treatment use overall would be comparable across ages after comorbidities were controlled for—for example, after an initial acute myocardial infarction, the percentage of patients age seventy-five receiving evidence-based post–acute myocardial infarction treatment would be comparable with the percentage of similarly healthy patients age sixty-six receiving treatment in the same country.

Because concerns about the ability of older patients to tolerate invasive treatments such as surgery might affect treatment choices, we also hypothesized that overall, the percentage of subjects receiving invasive treatments might decrease with increasing age—that is, the type of treatment could shift with age, although the use of any treatment would remain stable. This hypothesized shift would occur despite the fact that prior studies have found that both percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) are safe and represent high-value care for the oldest of the old.[7,21]

Noninvasive medication-based treatments—such as statins—continue to be recommended at older ages, and given the low risk of these medications, we hypothesized that the percentage of new patients with acute myocardial infarction using these treatments would not differ with age; that is, there could be a greater reliance only on medical management of an acute myocardial infarction among the oldest of the old.

Study And Methods

DATA AND SAMPLE

We included all patients in Norway who were hospitalized with acute myocardial infarction during 2010–15 (N = 39,566). To restrict the sample to incident cases, we excluded patients with an admission for acute myocardial infarction as a primary or secondary diagnosis the year before the start of follow-up. Further, we included data from 2016 to assess 365 days of follow-up of outcomes for all cases. Norway has a national hospital discharge register, from which we identified patients with acute myocardial infarction, using *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision, codes (ICD-10:I21–22). We linked these data to data from Norway's national outpatient utilization, pharmacy, and mortality databases. Because of data privacy restrictions in the national pharmacy prescription register, data had to be aggregated in five-year age groups from ages 65–69 up to ages 90–94.

For the US, we used a national 20 percent random sample of all fee-for-service Medicare beneficiaries and *International Classification of Diseases*, Ninth Revision, codes (ICD-9:410;2009–15 data from Medicare Parts A, B, and D and the Master Beneficiary Summary File) to create a comparable cohort by age and year (N = 110,145). Medicare is the predominant insurer for older Americans. Patients who reside outside the US were excluded from the study sample. Given the restrictions imposed by the Norwegian pharmacy data, we also aggregated the US data into the five-year age groups mentioned above (and evaluated the impact of the age groups versus no aggregation in sensitivity analyses). The Mass General Brigham Institutional Review Board, Norwegian Regional Committee for Medical and Health Research Ethics South East, and Norwegian Data Protection Authority approved the project. The data providers have no responsibility for our interpretation of the data.

OUTCOMES

We defined two categories of treatments, all converted to binary outcomes. First, we examined invasive procedures: one-day PCI and thirty-day PCI or CABG. Second, we examined four classes of medications: 3-hydroxy-3-methylglutaryl coenzyme A (AHMG-CoA) reductase inhibitors (statins), beta-blockers, angiotensin agents (for example, angiotensin-converting enzyme inhibitors or angiotensin receptor blockers), and antiplatelet agents (excluding aspirin).

Patients presenting with a new acute myocardial infarction are candidates for one of the invasive interventions, although the indication for treatment will vary with the clinical features of the infarction and the potential for complications associated with intervention. Nearly all patients presenting with a new acute myocardial infarction also should receive medications from the above drug classes. These medications have been widely used in the elderly for years, with several available generic versions—for example, inexpensive generic versions of statins and beta-blockers were available during the study period. In supplemental analyses presented in online appendix exhibit A1, we also examined 30-day and 365-day post–acute myocardial infarction all-cause mortality.[22] We also examined the percentage of initial acute myocardial infarctions that were ST elevation infarctions by age (see appendix exhibit A2).[22]

STATISTICAL METHODS

Because of limits imposed by our data use agreements, we assessed age trends separately within each country, linearly regressing each outcome variable on age and age squared in the patient-level data; we also controlled for comorbidity using the Charlson score.[23] Sensitivity analyses without adjusting for the Charlson score yielded similar results. We displayed the adjusted age trends graphically, showing the observed data points along with the fitted models, and included 95% confidence intervals for the fitted models, estimated using the margins command in Stata 16. The large sample sizes produced narrow confidence intervals, as can be seen graphically, so we did not further report formal tests comparing major age trend differences that are easily inferred visually.

In the appendix we also report linear regressions of 30-day and 365-day post–acute myocardial infarction mortality, similarly graphing observed data points along with fitted models as a function of age, age squared, and Charlson score (see appendix exhibit A1).[22] We also present a model that further controls for the above acute myocardial infarction treatment and medications.

LIMITATIONS

This study had several limitations. We used administrative data sets from the two countries that relied heavily on ICD diagnosis codes. These data are not equivalent to richer clinical data sets from trials—for example, they do not contain information about the location of coronary artery blockages or the magnitude of damage from the infarction. The data also lack information about individual-level cognitive and physical functionality or measures of quality of life.

Medication data from Norway did not include patients who were transferred from the hospital to a nursing home. In a supplementary analysis we found that the proportion of patients older than age eighty who live in a nursing home is rather similar before and after the acute myocardial infarction admission, thus mitigating the concern about potential bias.

The analysis of post–acute myocardial infarction mortality did not attempt to demonstrate a causal relationship between the acute myocardial infarction care and survival, as several clinical trials have demonstrated the efficacy of these treatments (see appendix exhibit A1).[22]

Study Results

Exhibits 1 and 2 illustrate the age trends in post–acute myocardial infarction procedure use among patients ages sixty-five and older in the US and Norway (controlling for the Charlson comorbidity score). At ages 65–69 just over 40 percent of patients in each country received PCI within one day of admission (exhibit 1). Those rates dropped steadily with age in both countries, reaching only 10 percent in the US and 4 percent in Norway for patients ages ninety and older. The age trends in thirty-day PCI or CABG rates were similar, again with steep drops as age increased: In Norway rates of thirty-day PCI or CABG decreased from 70 percent in the 65–69 age group to 6 percent in the 90 and older group, and across the same age groups, the rates went from 63 percent to 14 percent in the US (exhibit 2).

Exhibits 3 and 4 display similar decreases in medication use with increasing age. For example, in Norway 91 percent of patients ages 65–69 received a statin within 365 days after an acute myocardial infarction, but only 30 percent of patients ages ninety and older received one; the US decline was from 81 percent to 49 percent (exhibit 3). The drops in antiplatelet drug use were similarly steep (exhibit 4), and the drops in angiotensin-converting enzyme inhibitors or angiotensin receptor blockers and beta-blockers were only moderately less steep with age (see appendix exhibits A3 and A4, respectively).[22] In subgroup analyses (data not shown), we found that the age trends in procedures and medications were similar among men and women.

Not surprisingly, comorbidity-adjusted post–acute myocardial infarction mortality increased more steeply with age in Norway than it did in the US at both 30 days and 365 days (see appendix exhibit A1).[22] Inclusion of the treatment information resulted in a substantial reduction in the magnitude of the post–acute myocardial infarction mortality age trend.

Discussion

Decisions about how to allocate resources within any society are difficult at best, and they ideally should be informed with accurate causal information about the impact of use on patient outcomes, along with real-world estimates of use patterns. For acute myocardial infarction treatment, existing clinical trial data provide the best information supporting the causal impact of treatment on survival among the elderly. In this article we address the last point: that is, an examination of the use of treatments supported by trial evidence among elderly patients of varying ages. To our surprise, we found that post–acute myocardial infarction treatments dropped substantially with increasing age, including both more invasive procedural treatments and inexpensive medications. Moreover, this age-related reduction in treatment occurred in two countries with some of the world's highest per capita spending levels.

Although the size of the decrease was modestly smaller in the US than in Norway, the overall trend of declining treatment with age was consistent across both countries and across all of the treatments studied. Although we could not exclude other relevant contributors, such as unobserved frailty or patient or family preference, this result is consistent with the concern of age-based treatment bias.

Despite evidence of the high value of intensive care for the elderly, prior studies have documented widespread reluctance to administer such care in the US and elsewhere, possibly reflecting professional norms that are not evidence based.[7,19] It is possible that elderly acute myocardial infarction patients in both countries could benefit from additional treatment.

Although our objective was to describe real-world treatment patterns and not to demonstrate the impact of treatment use on post–acute myocardial infarction mortality, these results are consistent with the hypothesis that the smaller drop in treatment intensity with age in the US may be protective against post–acute myocardial infarction mortality among the older elderly.

Detailed individual-level examinations of treatment patterns in multiple settings have been relatively rare to date, partly because of the difficulty in harmonizing data sets across settings in a way that allows for ruling out alternative explanations related to measurement differences or the heterogeneity of underlying risk.[24] Our approach of focusing on within-setting comparisons and use of detailed data sets mitigate these concerns.

These issues are of pressing concern as the numbers of elderly people, including the older group of elderly people, increase over time with both demographic shifts and improvements in medical technological capabilities. Overall, we found that treatment intensity after an acute myocardial infarction might drop off too quickly for older patients in the US and Norway.

Policy Implications

Policy makers and insurance plan executives should consider incentivizing treatment equity across ages in an effort to shift practice closer to that suggested by the trial evidence for the elderly. At the simplest level, the addition of several post–acute myocardial infarction generic medications would require relatively inexpensive regimens per patient. Moreover, if some patients might not benefit from additional treatment because of frailty, cognitive or physical impairments, or individual preferences, health systems also should incentivize the explicit documentation of such decisions not to treat.

Conclusion

Greater age-related equity in care is needed as the numbers of elderly people—including the older group of elderly people—increase over time with both demographic shifts and improvements in medical technological capabilities. The current discrepancy between practice and trial evidence indicates a need and an opportunity to improve this equity at potentially little additional cost per person. In sum, the current treatment intensity in both the US and Norway might wane too quickly into that good night, even in these two countries with otherwise admirable mortality rates.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

John Hsu received grant funding from the National Institute on Aging (Grant No. P01AG032952). Hsu also has consulted for Cambridge Health Alliance, Columbia University, University of Southern California, the Delta Health Alliance, Robert Wood Johnson Foundation, and Community Servings. Tor Iversen and William Dow received grant funding from the Peder Sather Center for Advanced Study.

NOTES

1. Norwegian Ministry of Health and Care Services. Principles for priority setting in health care: summary of a white paper on priority setting in the Norwegian health care sector [Internet]. Oslo: Norwegian Government Security and Service Organization; 2017 [cited 2021 Jul 6]. Available from: https://www.regjeringen.no/contentassets/439a420e01914a18b21f351143ccc6af/en-gb/pdfs/stm201520160034000engpdfs.pdf
2. Emanuel EJ, Emanuel LL. The economics of dying. The illusion of cost savings at the end of life. N Engl J Med. 1994;330(8):540–4. [PubMed: 8302321]
3. Medicare Payment Advisory Commission. Report to the Congress: selected Medicare issues [Internet]. Washington (DC): MedPAC; 1999 Jun [cited 2021 Jul 6]. Available from: http://www.medpac.gov/docs/default-source/reports/Jun99Entirereport.pdf?sfvrsn=0
4. Riley GF, Lubitz JD. Long-term trends in Medicare payments in the last year of life. Health Serv Res. 2010;45(2):565–76. [PubMed: 20148984]
5. Einav L, Finkelstein A, Mullainathan S, Obermeyer Z. Predictive modeling of U.S. health care spending in late life. Science. 2018;360(6396):1462–5. [PubMed: 29954980]
6. Baicker K, Chandra A. Medicare spending, the physician workforce, and beneficiaries' quality of care. Health Aff (Millwood). 2004;(Suppl Web Exclusives):W4–184–97.
7. Tegn N, Abdelnoor M, Aaberge L, Endresen K, Smith P, Aakhus S, et al. Invasive versus conservative strategy in patients aged 80 years or older with non-ST-elevation myocardial infarction or unstable angina pectoris (After Eighty study): an open-label randomised controlled trial. Lancet. 2016;387(10023):1057–65. [PubMed: 26794722]
8. Mortensen MB, Falk E. Primary prevention with statins in the elderly. J Am Coll Cardiol. 2018;71(1):85–94. [PubMed: 29301631]
9. Grundy SM, Stone NJ, Bailey AL, Beam C, Birtcher KK, Blumenthal RS, et al. 2018 AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS/APhA/ASPC/NLA/PCNA Guideline on the management of blood cholesterol: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation. 2019;139(25):e1082–143. [PubMed: 30586774]
10. Catapano AL, Graham I, De Backer G, Wiklund O, Chapman MJ, Drexel H, et al. 2016 ESC/EAS guidelines for the management of dyslipidaemias. Eur Heart J. 2016;37(39):2999–3058. [PubMed: 27567407]
11. Armitage J, Baigent C, Barnes E, Betteridge DJ, Blackwell L, Blazing M, et al. Efficacy and safety of statin therapy in older people: a meta-analysis of individual participant data from 28 randomised controlled trials. Lancet. 2019;393(10170):407–15. [PubMed: 30712900]
12. van der Ploeg MA, Floriani C, Achterberg WP, Bogaerts JMK, Gussekloo J, Mooijaart SP, et al. Recommendations for (discontinuation of) statin treatment in older adults: review of guidelines. J Am Geriatr Soc. 2020;68(2):417–25. [PubMed: 31663610]
13. Statistics Norway [home page on the Internet]. Oslo: Statistics Norway; [cited 2021 Jul 21]. Available from: https://www.ssb.no/en
14. Henry J. Kaiser Family Foundation. State Health Facts: total number of Medicare beneficiaries, 2020 [Internet]. San Francisco (CA): KFF; [cited 2021 Jul 21]. Available from: https://www.kff.org/medicare/state-indicator/total-medicarebeneficiaries/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D
15. Manton KG, Vaupel JW. Survival after the age of 80 in the United States, Sweden, France, England, and Japan. N Engl J Med. 1995;333(18):1232–5. [PubMed: 7565998]
16. Crimmins EM, Preston SH, Cohen B editors. Explaining divergent levels of longevity in high-income countries. Washington (DC): National Academies Press; 2011.
17. Palloni A, Yonker JA. Is the US old-age mortality advantage vanishing? Popul Dev Rev. 2016;42(3):465–89. [PubMed: 31530961]
18. Ho JY, Preston SH. US mortality in an international context: age variations. Popul Dev Rev. 2010;36(4):749–73. [PubMed: 21174869]

19. Human Mortality Database [home page on the Internet]. Berkeley (CA): HMD; [cited 2021 Jul 6]. Available from: https://www.mortality.org/
20. Orkaby AR, Driver JA, Ho YL, Lu B, Costa L, Honerlaw J, et al. Association of statin use with all-cause and cardiovascular mortality in US veterans 75 years and older. JAMA. 2020;324(1):68–78. [PubMed: 32633800]
21. Olenski AR, Zimerman A, Coussens S, Jena AB. Behavioral heuristics in coronary-artery bypass graft surgery. N Engl J Med. 2020;382(8):778–9. [PubMed: 32074429]
22. To access the appendix, click on the Details tab of the article online.
23. Charlson score was estimated using the Stata module Charlson, which calculates the score from data containing *International Classification of Diseases*, Ninth Revision, Clinical Modification, or *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision, comorbidity diagnoses codes. They were identified from the relevant codes in primary or secondary diagnoses for hospital admissions in the year before the acute myocardial infarction admission. Comorbidities included were acute myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular dementia, chronic obstructive pulmonary disorder, rheumatoid disease, peptic ulcer, mild liver disease, diabetes, hemiplegia or paraplegia, renal disease, cancer, severe liver disease, metastatic cancer, and AIDS.
24. Frølich A, Schiøtz ML, Strandberg-Larsen M, Hsu J, Krasnik A, Diderichsen F, et al. A retrospective analysis of health systems in Denmark and Kaiser Permanente. BMC Health Serv Res. 2008;8:252. [PubMed: 19077229]

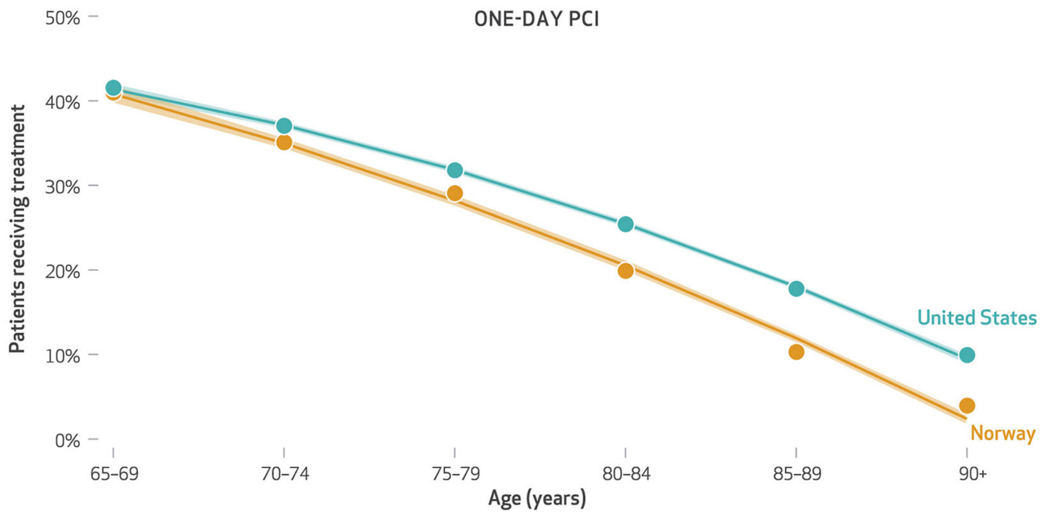

EXHIBIT 1. Trends for one-day percutaneous coronary intervention (PCI) among the elderly in Norway and the US, by age group

SOURCE Authors' analysis of data from Norway (national hospital discharge, outpatient utilization, pharmacy, and mortality data, 2010–16) and the US (20 percent random sample of fee-for-service Medicare claims, 2009–15). NOTES Points indicate unadjusted estimates. The data for the solid lines were estimated using a linear regression model adjusted for age, age squared, and Charlson score and the margins command in Stata. The shaded areas represent 95% confidence intervals for the adjusted margins.

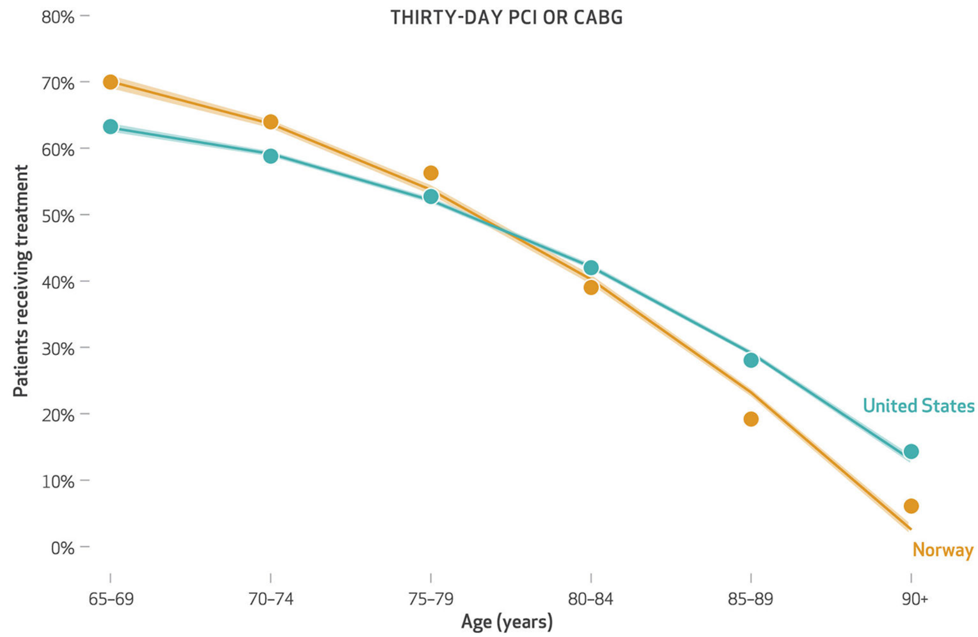

EXHIBIT 2. Trends for thirty-day percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG) among the elderly in Norway and the US, by age group

SOURCE Authors' analysis of data from Norway (national hospital discharge, outpatient utilization, pharmacy, and mortality data, 2010–16) and the US (20 percent random sample of fee-for-service Medicare claims, 2009–15). NOTES Points indicate unadjusted estimates. The data for the solid lines were estimated using a linear regression model adjusted for age, age squared, and Charlson score and the margins command in Stata. The shaded areas represent 95% confidence intervals for the adjusted margins.

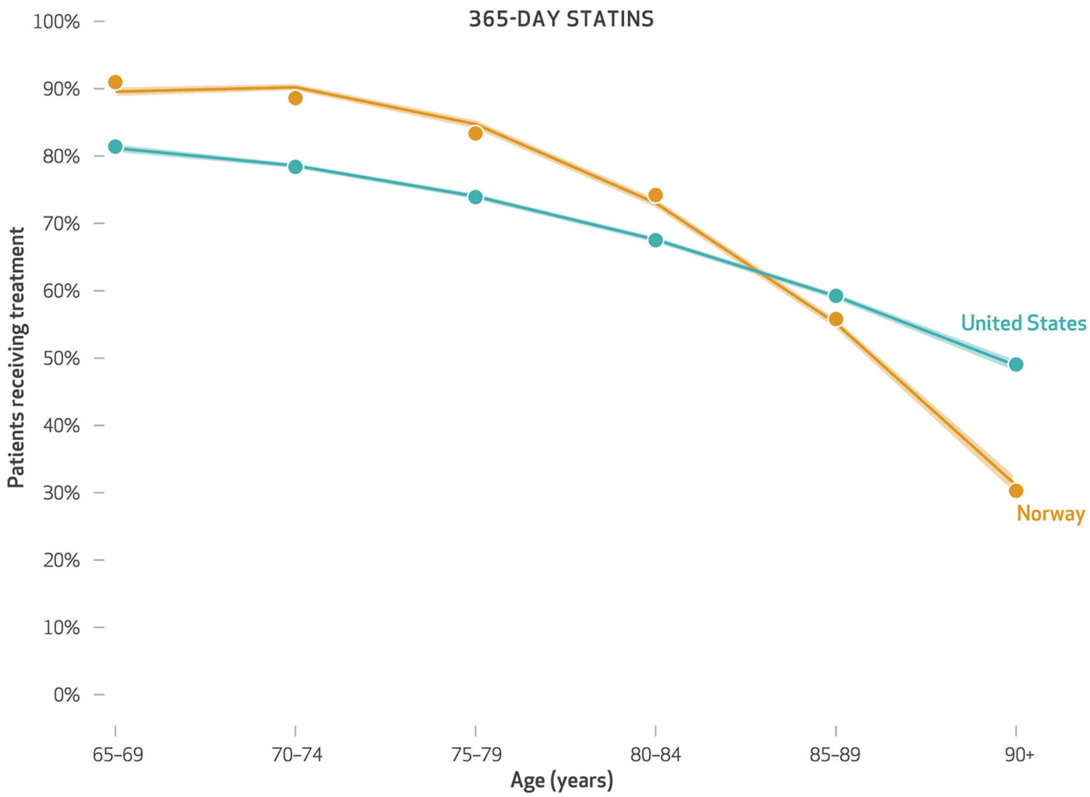

EXHIBIT 3. Trends for 365-day statins among the elderly in Norway and the US, by age group

SOURCE analysis of data from Norway (national hospital discharge, outpatient utilization, pharmacy, and mortality data, 2010–16) and the US (20 percent random sample of fee-for-service Medicare claims, 2009–15). NOTES Points indicate unadjusted estimates. The data for the solid lines were estimated using a linear regression model adjusted for age, age squared, and Charlson score and the margins command in Stata. The shaded areas represent 95% confidence intervals for the adjusted margins.

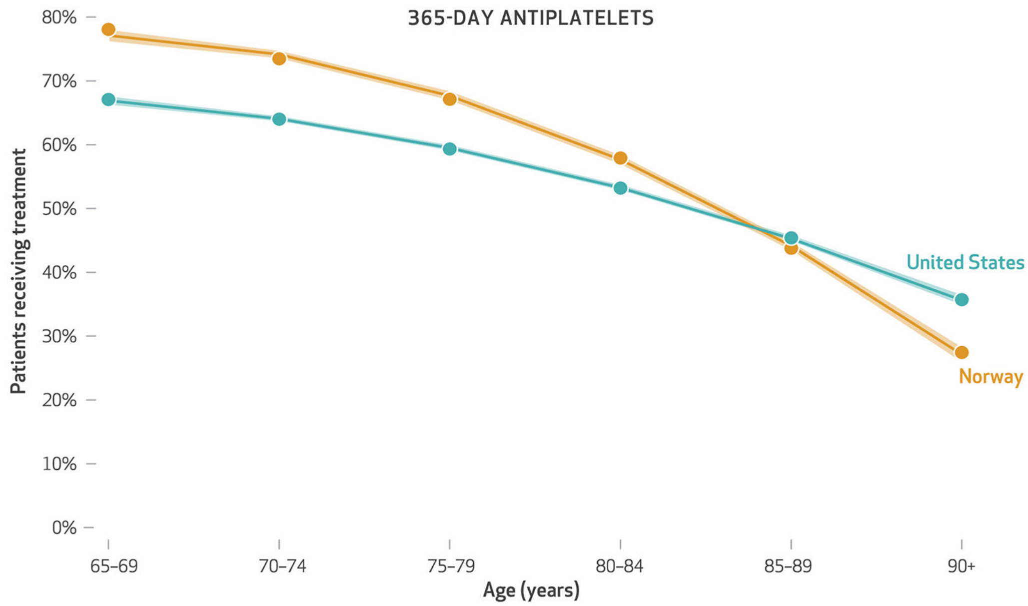

EXHIBIT 4. Trends for 365-day antiplatelets among the elderly in Norway and the US, by age

SOURCE Authors' analysis of data from Norway (national hospital discharge, outpatient utilization, pharmacy, and mortality data, 2010–16) and the US (20 percent random sample of fee-for-service Medicare claims, 2009–15). NOTES Points indicate unadjusted estimates. Data for the solid lines were estimated using a linear regression model adjusted for age, age squared, and Charlson score and the margins command in Stata. The shaded areas represent the 95% confidence intervals for the adjusted margins.