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Effective universal health coverage and improved 1-year survival after acute myocardial infarction: the Chilean experience

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Abstract

In 2005, Chile implemented a universal system of health guarantees (AUGE) aimed at improving equitable access to quality medical care for priority health conditions, including acute myocardial infarction (MI).

Objective To evaluate 1-year survival in MI patients before and after AUGE.

Methods Retrospective cohorts of patients with MI (with and without ST segment elevation) discharged alive from six public hospitals between January 2001–June 2005 (pre-AUGE) and July 2008–March 2009 (post-AUGE). Chilean national mortality and MI Registry (hospital-based) databases were linked using a unique identification number (ICD-10 codes I00-I99 were used to identify cardiovascular deaths). One-year survival was assessed using Weibull multivariate regression.

Results About 1867 patients were discharged alive pre-AUGE and 534 post-AUGE; 25% were women in both periods. When comparing pre-AUGE and post-AUGE, there was an increase in the use of primary and elective angioplasty (1.7 vs 23.6% and 7.3 vs 20.0%), beta-blockers (62 vs 71%) and statins (40 vs 90%); $P < 0.001$ all. One-year survival was 92% pre-AUGE (95% CI: 91–93%) and 96% post-AUGE (95% CI: 94–97%) (HR = 0.50, 95% CI: 0.31–0.82; $P = 0.003$). The post-AUGE improvement persisted after adjusting for variables associated with long-term case-fatality (HR = 0.44, 95% CI: 0.26–0.75). Percutaneous coronary intervention (HR = 0.31, 95% CI: 0.09–0.99) and statins use at discharge (HR = 0.45, 95% CI: 0.31–0.66) had the highest effects associated with lower case-fatality and both treatments increased in the post-AUGE period.

Conclusions The implementation of AUGE in Chile appears to have contributed to improved treatment of MI in public hospitals and increased 1-year survival, which is consistent with its aim to improve access to quality medical care and to reduce health inequities.

Key words: Acute myocardial infarction, Chile, equity, health care guarantees, health reform, survival, secondary prevention, universal health coverage

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Key Messages:

- A system of enforceable, rights-based guarantees to effective universal health coverage for priority conditions, including myocardial infarction, called AUGE was implemented in Chile's 2005 health reform. This study compares 1-year survival before and after AUGE in patients discharged alive after acute myocardial infarction from public hospitals in Chile.
- The survival analysis linked 2001 to 2009 data from the hospital-based Registry of myocardial infarction (GEMI Registry) and National Mortality Registry of the Ministry of Health. There was a significant improvement in 1-year survival in the post-AUGE period, accompanied with increased use of pharmacotherapy recommended in AUGE's clinical guidelines and of revascularization procedures, as well as better adherence to secondary prevention medication treatment.
- These findings are consistent with AUGÉs objectives to improve health and health equity through universal guarantees of timely access to quality and affordable medical care.

Introduction

Coronary heart disease (CHD) is the leading cause of death in the world, accounting for 12.8% of all deaths (World Health Organization). In Chile, CHD is the second cause of death in men and women (Ministerior de Salud Departamento de Estadísticas e Información en Salud 2011), 75% of CHD deaths are due to acute myocardial infarction (MI) (Alonso *et al.* 2010). Mortality rates from CHD decreased from 63.3 per 100 000 inhabitants in 1998 to 41.7 per 100 000 inhabitants in 2011, even though incidence remained constant (Ministerio de Salud de Chile, Departamento de Estadísticas e Información en Salud 2011; Ministerio de Salud de Chile, Departamento de Estadísticas e Información en Salud 2012). The observed increase in survival has been attributed to better access, improved medical care and adherence to clinical guidelines for acute coronary syndromes (Ford *et al.* 2007; Fox *et al.* 2007).

Before 2005, mandated care in Chile's dual, public–private health system was purportedly universal. However, effective coverage often depended on the capacity to pay for private care with long waiting times in the public sector.

The Chilean Health Reform aimed to reduce inequities in health care by guaranteeing appropriate medical care for priority health conditions, including MI, for the entire population, regardless of place of residence or health insurance system, under the Universal Health Guarantees Plan, known as AUGE (for the Spanish acronym). AUGE, came into force in July 2005, establishing legally enforceable guarantees of universal access to appropriate, quality health care for covered conditions, with maximum waiting times, and financial protection, including gratuity in the public system for low-income groups (República de Chile Ministerio de Salud de Chile 2005). Based on clinical evidence, a practice guideline for the management of MI was designed to optimize diagnosis, treatment and rehabilitation. Among the recommendations included in the guideline, secondary preventive drug treatment should be initiated within the first month after hospital discharge. All patients, except those with contraindications, should receive aspirin, beta-blockers and statins. Patients with ventricular dysfunction, diabetes or hypertension, should also receive angiotensin converting enzyme inhibitors or angiotensin receptor blockers (ACE inhibitors or ARBs) (República de Chile Ministerio de Salud 2009).

Some studies have found early evidence of increased coverage of treatment for chronic disease with improved outcomes after AUGE and a reduction in inequities in unmet health needs (Bitran *et al.* 2010; Frenz *et al.* 2014). Previous research suggests that AUGE guarantees have contributed to reduce in-hospital case-fatality from MI (Nazzal *et al.* 2008). However, the possible effect on 1-year survival has not been evaluated. This study aims to compare 1-year survival before and after AUGE in patients discharged alive after acute MI from public hospitals in Chile. Guaranteed universal access may have had a greater effect in public hospitals because of major deficiencies of resources in this sector. We hypothesized that improvement in the quality and opportunity of medical care for MI patients included in the universal health coverage plan will diminish the occurrence of cardiovascular deaths.

Materials and methods

Population and study design

We used a before-and-after observational design, using a hospital-based MI registry (GEMI Registry). The Chilean MI Registry began in 1993 as part of a multicentre study carried out by the Chilean Society of Cardiology. The GEMI registry that includes tertiary public and private hospitals enrolls approximately 20% of all the MI cases occurring annually in Chile and is representative in terms of age, sex and insurance status. For this study, we included patients discharged alive after a first or recurrent acute ST-segment elevation myocardial infarction (STEMI) or acute non-STEMI event from six public hospitals. These hospitals were selected for the analysis because they were the referral hospitals in their respective regions and had continuously participated in the registry during the study period. The study hospitals are located in five regions of Chile with a total catchment population of approximately 4 000 000 inhabitants, 24% of the national population approximately (*Hospital Regional La Serena*, IV Region; *Hospital San Juan de Dios* and*Hospital Barros Luco*, Metropolitan Region; *Hospital Regional de Talca*, VII Region; *Hospital Regional de Temuco*, IX Region; *Hospital Base de Valdivia*, XIV Region). The inclusion criteria for patient enrolment in the GEMI registry are: elevated cardiac markers (Creatine kinase or troponin), and at least one of the following: angina lasting [mt]30 min or electrocardiographic changes suggestive of myocardial ischemia or necrosis.

The study compared 1-year survival of MI patients enrolled during two periods: pre-AUGE period (January 2001–June 2005) and post-AUGE period (July 2008–March 2009). The pre-AUGE period included 5 years in order to analyze 1-year survival trends prior to the implementation of the new model of care. The data from the post-AUGE period was part of a follow-up study funded by the National Research and Development Fund for Health (FONIS SA08I20035), designed to evaluate the effect of the AUGE-guaranteed secondary prevention program for MI. The ethics committees of each hospital approved the study and all participants signed an informed consent form.

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Data sources and collection

For the pre-AUGE and post-AUGE phases, in each hospital cardiologists or trained nurses completed prospectively a standardized case report form for each patient with information on sociodemographic characteristics, prior cardiovascular history, coronary risk factors (hypertension, diabetes, hypercholesterolemia and smoking), clinical presentation, electrocardiography, previous and in-hospital treatments, reperfusion therapies, percutaneous coronary intervention, coronary artery bypass grafting and discharge medications. Standardized procedures for data collection and entry are used in the GEMI registry. All information is audited (including data management) at the Chilean Society of Cardiology. The GEMI methodology has been published previously (GRUPO GEMI 1993).

Occurrence of death within 1-year post-infarction and the cause of death were collected from the National Mortality Database of the Department of Statistics and Health Information of the Ministry of Health. This database includes 100% of deaths in Chile and has been established as a complete and accurate data set (Nunez and Icaza 2006). It allowed us to follow all the patients enrolled in the study, using a unique national identity number. Codes I00-I99 (ICD-10) were used to identify deaths from cardiovascular causes to ascertain the possible effect of the improvement in MI medical treatment on the probability of a fatal cardiovascular events. As the post-AUGE period was part of a second study that considered a clinical examination after 1-year of follow-up, only for this period information about pharmacological therapy, risk factors control and incidence of cardiovascular non fatal events in the long term were available. This follow-up examination included also anthropometric measures, cardiac frequency and blood pressure and biochemical analysis. Patients were controlled at the same hospital by the same cardiologist and nurses.

Statistical analysis

A descriptive analysis examined the distribution of demographic and clinical characteristics, in-hospital and discharge medication use, reperfusion strategies and revascularization procedures, comparing patients admitted before and after AUGE (for this analysis the use of ACE inhibitors and ARBs were grouped together). Mann–Whitney and Chi-square test were used to compare continuous and categorical variables, respectively. Survival curves were computed by year of admission within the pre-AUGE period (2001–2005) and log-rank test was used to evaluate differences within the 5 years included in this period. We also fitted a Prais–Winsten regression to study the temporal trend in the pre-AUGE period. This model is similar to a linear regression model, but it does not assume independence of the errors, and corrects the autocorrelation of the time series, considering first order correlation of the error terms (Durbin Watson statistics was used to assess the time autocorrelation correction) (Prais SJ). Unadjusted 1-year survival rates were plotted using the Kaplan–Meier method and the log-rank test was used to test differences between the pre and post-AUGE groups. Since survival time followed a Weibull distribution, these regression models were used for the analysis. Weibull regression is a parametrical survival model, which does not assume a constant hazard, allowing for modeling of constant, decreasing, or increasing risk and more precise estimations (Kleinbaum 2005). A binary variable for the period at hospital admission, related to AUGE implementation was included in the first multivariate model: pre-AUGE and post-AUGE (with pre-AUGE as the reference). This model also included clinical and demographic characteristics, which were associated with an increased risk of 1 year case-fatality (P value less than 0.05) in the univariate analysis: age, sex, hypertension, diabetes, previous MI and Killip III–IV at admission. In a second model, we evaluated the association of in-hospital and post discharge medications and interventional treatments (reperfusion therapies and elective coronary revascularization during hospitalization) with improved survival, selected by evidence based therapy, adjusting for all variables included in the first model. In order to avoid over adjustment, the Post-AUGE variable was excluded from this second model. Hazard ratios (HRs) and 95% confidence intervals (95 CIs) were reported. Analyses were performed using STATA 11.2 software (StataCorp, TX) (StataCorp. 2011).

Table 1. Baseline demographics and clinical characteristics by study period

Characteristic	Pre-AUGE (n = 1863)	Post-AUGE (n = 534)	P value
Demographic			
Age (median, 25–75), years	62 (52–71)	62 (53–71)	0.271
Gender (female),%	24.7	24.7	0.989
Past medical history, %			
Previous MI	9.7	8.8	0.502
Prior coronary angioplasty	2.0	4.5	<0.01
Coronary risk factors, %			
Diabetes	26.0	22.3	0.078
History of hypertension	57.0	62.0	0.037
History of hypercholesterolemia	23.6	31.1	<0.001
Presentation, %			
STEMI	70.9	72.3	0.631
Anterior infarct location	52.4	54.5	0.448
Killip classes III–IV at admission	6.4	6.1	0.808

CABG, coronary artery bypass graft surgery; MI, myocardial infarction; STEMI, ST- segment elevation myocardial infarction.

Results

During the full study period, 4010 MI patients were discharged alive from the participating hospitals, 3367 before AUGE and 643 after AUGE. Of these, 1867 patients were enrolled in the GEMI registry pre-AUGE and 534 post-AUGE, representing 55.4 and 83.1% of total MI cases, respectively. Four patients from the first period were excluded due to missing information for the majority of the study variables. 1863 patients in the pre-AUGE group and 534 patients in the post-AUGE group were included in the final sample.

Table 1 shows similar demographic and clinical characteristics for both groups (pre-AUGE and post-AUGE), except for a higher prevalence of hypertension and dyslipidemia in the post-AUGE group. In-hospital pharmacological treatment and revascularization procedures are presented in Table 2. There was a significant increase after AUGE in the use of primary angioplasty (2.0–23.6%, $P < 0.0001$) and a decrease in thrombolysis (55.8 to 44.0%, $P < 0.0001$). In-hospital and discharge medication also increased significantly, especially for statin (40.0–89.9%) and beta-blocker (62.0–71.1%) prescription at discharge ($P < 0.001$ for both). Coronary angiography was performed in more than half of patients after AUGE (24.6–58.4%; $P < 0.0001$), increasing the proportion of patients treated with revascularization procedures. In the post-AUGE period, the rates of medication at hospital discharge and after 1 year of follow-up were similar: 90 and 95% for aspirin; 71 and 70% for beta-blockers; 89 and 87% for statins and 72 and 71% for ACE inhibitors & ARBs, respectively.

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Table 2. Medical treatments and revascularization procedures by period (pre and post-AUGE)

Characteristic (percent)	Pre-AUGE ($n = 1863$)	Post-AUGE ($n = 534$)	*P* value
Thrombolytic[a]	55.9	44.0	<0.0001
Primary angioplasty[a]	1.7	23.6	<0.0001
In-hospital medications			
Aspirin	96.4	95.3	0.249
Beta-blockers	69.2	81.6	< 0.0001
ACE inhibitors and ARBs	77.8	82.2	0.002
Statins	40.4	96.0	<0.0001
Medications at discharge			
Aspirin	85.7	90.4	<0.01
Beta-blockers	62.0	71.1	<0.0001
ACE inhibitors and ARBs	71.0	73.2	0.862
Statins	40.0	89.9	<0.0001
Procedures during hospitalization			
Coronary angiography	24.6	58.4	< 0.0001
Percutaneous coronary intervention	7.3	20.0	< 0.0001
CABG	1.1	4.7	< 0.0001

ACE inhibitors, angiotensin-converting enzyme (ACE) inhibitors; ARBs, angiotensin-II receptor antagonists; CABG, coronary arteries bypass graft surgery.

[a]Only in STEMI patients ($N = 1.286$ patients pre-AUGE and $N = 386$ patients post-AUGE).

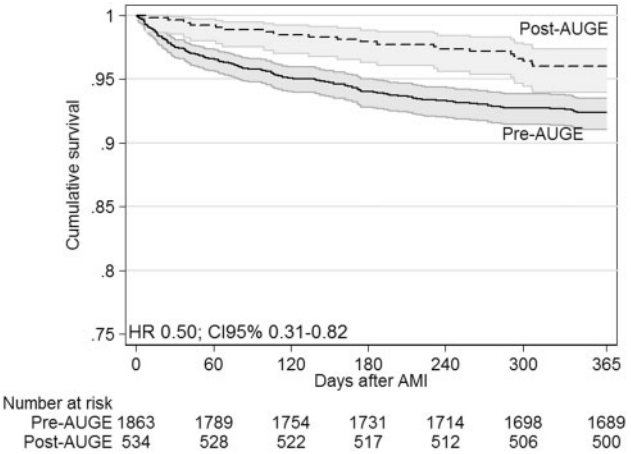

Figure 1. Unadjusted Kaplan–Meier survival curves by period (pre and post-AUGE).

One-year survival

Overall 1-year case-fatality was 9.3% ($N = 174$) before AUGE and 6.4% ($N = 34$) after AUGE ($P = 0.03$); when considering only cardiovascular causes the difference in 1 year case-fatality was even more considerable: 7.6% ($N = 141$) and 3.9% ($N = 21$) ($P = 0.003$), respectively. Unadjusted survival curves pre and post AUGE are shown in Figure 1. The comparison of the survival plots in the 2001–2005 period showed no differences ($P =$ for log rank test) and no trend in case-fatality by year (Prais–Winsten coefficient: −0.56 (95% CI = −1.81 to 0.68), $P = 0.024$)

In the post-AUGE period, the risk of case-fatality decreased by 50% (HR = 0.50, 95% CI: 0.31–0.82). The association of AUGE with better survival remained after adjusting for clinical characteristics associated with case-fatality in the multivariate regression (HR = 0.44, 95% CI: 0.26–0.75). The association of therapeutic interventions (medication at discharge and revascularization procedures during hospitalization) with survival is presented in Table 3. Percutaneous coronary intervention (HR 0.31, 95% CI: 0.09–0.99) and statin drug use at discharge (HR 0.45, 95% CI: 0.31–0.66) showed the greatest association with a lower case-fatality risk. For 154 patients (6.4%) the Killip class variable at admission was missing (but these patients were not excluded from the final study sample). We carried out a sensitivity analysis and no differences were found. Results did not differ when using Cox regression for the multivariate analysis.

Discussion

This is the first study in Chile to evaluate the effect of post-infarction treatment on 1-year survival in the context of AUGE. The results show that after the inclusion of MI in Chile's universal health guarantees plan to insure effective coverage of quality healthcare (AUGE), there was an improvement in 1-year survival for patients treated in public hospitals, accompanied with increased use of pharmacotherapy recommended in the clinical guidelines and revascularization procedures.

The creation of coronary care units in the 1980s has been associated with decreased fatality rates due to MI in Chile, with a long-term trend in mortality reduction (Corbalan *et al.* 2002; Nazzal and Alonso 2011). However, we found no such trend in the 2000–2005 period in the study hospitals. This may be explained by the severe resource constraints faced by public hospitals at the time, which resulted in treatment delays, quality problems and insufficient implementation of secondary prevention strategies, a situation that triggered the health reform.

In this context, the objective of AUGE was to extend effective medical coverage to all MI patients, regardless of their capacity to pay, minimizing wait times for urgent care consultation, diagnostic tests and access to early and effective treatment in the acute phase, as well as ensuring appropriate secondary prevention and follow-up care (República de Chile Ministerio de Salud 2009). Data from European and Unites States Registries provide evidence that adherence to clinical guidelines improves survival by up to 50% in post MI patients (Danchin *et al.* 2005; Masoudi *et al.* 2006; Stommel *et al.* 2006; Salomaa *et al.* 2007; DeWilde *et al.* 2008; Bramlage *et al.* 2010; Smolina *et al.* 2012), similar to our findings. This result may be attributable to the increased use of in-hospital and discharge pharmacotherapy after AUGE in our population, which is even higher than that reported by the PURE study in countries with similar levels of development as Chile, where statins use was 21%, antiplatelet drugs 27% and beta-blockers nearly 30% (Yusuf *et al.* 2011). The efficacy of secondary prevention drugs has been widely documented (Freemantle *et al.* 1999;Baigent *et al.* 2005; 2009), and treatment with these drugs is now the standard of care according to international guidelines (Perk *et al.* 2012; O'Gara *et al.* 2013). In Chile, we found that the rates of prescribed medication at hospital discharge and after 1-year of follow-up were practically identical, suggesting that early initiation of cardioprotective drugs and adequate access to medication guaranteed by health services benefits adherence. The impact of medication therapy discontinuation in mortality is known (Ho et al. 2006; Jernberg et al. 2011; Amann *et al.* 2014; Jernberg et al. 2011), showing the need to improve follow-up care. In Chile, since 2002 it was implemented a Cardiovascular Program in primary care aimed to improved risk factors control and medical adherence in those patients, which may have contributed to increase survival after AUGE.

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Table 3. Multivariate analysis for survival after AMI adjusted for clinical characteristics and treatments

Variable	HR	95%CI Model 1	*P* value	HR	95%CI Model 2	*P* value
Post-AUGE period	0.44	0.26–0.74	0.002	–	–	
Age	1.04	1.03–1.06	0.001	1.04	1.02–1.06	0.001
Female gender	1.31	0.93–1.84	0.125	1.29	0.92–1.82	0.143
Previous MI	1.23	0.77–1.95	0.377	1.33	0.84–2.18	0.228
Diabetes	1.12	0.79–1.58	0.528	1.12	0.80–1.59	0.501
History of hypertension	1.73	1.16–2.59	0.007	1.71	1.14–2.56	0.009
Killip class III–IV at admission	2.43	1.59–2.59	0.001	2.03	1.31–3.13	0.002
Reperfusion procedures during hospitalization				1.13	0.79–1.59	0.492
Aspirin at discharge				0.84	0.53–1.34	0.476
Beta-blockers at discharge				0.74	0.53–1.05	0.096
ACE inhibitors & ARBs at discharge				1.22	0.83–1.80	0.292
Statins at discharge				0.45	0.31–0.66	0.001
Percutaneous coronary intervention during hospitalization				0.31	0.09–0.99	0.050
CABG during hospitalization				0.54	0.07–3.89	0.539

Data for 2235 patients; 153 events/768392 person-days. Model 1: post -AUGE period and clinical characteristics were included; Model 2: model 1 plus treatment during hospitalizations. Post Auge- period was removed from the model to avoid over adjustment.

ACE, angiotensin-converting enzyme inhibitors; ARBs, angiotensin-II receptor antagonists; CABG, coronary arteries bypass graft surgery; MI, myocardial infarction.

This observational study has several limitations. This is a not randomized study design using an appropriate control group as reference for comparison with a new active intervention; therefore factors other than those assessed may have had an effect in the reduction in 1 year case-fatality. The use of a before and after observational design, comparing the frequency of events in population cohorts in two time periods, cannot discriminate whether a natural temporal trend or other concurrent interventions are related to the findings, such as changes in international and national AMI guidelines, which might have improved the use of beta blockers and statins in all patients without contraindications or ACE inhibitors in patients with ventricular dysfunction, beside the effect on drugs availability and percutaneous coronary interventions for selected patients inherent to the implementation of AUGE. Yet, we did not find a significant downward trend in case-fatality reduction in the pre-AUGE period. In addition, since the pre-AUGE and post-AUGE patients were from the same hospitals, which are regional referral centers, it is likely that the population remained fairly stable during the study period in terms of socioeconomic and demographic characteristics. Furthermore, we adjusted for demographic and clinical characteristics likely to be related to case-fatality in the model.

A second limitation is the selection of public hospitals with a higher level of complexity, which limits generalizability of our conclusions to other types of centers and patients. However, given the universal nature of AUGE, it is plausible that findings would be similar for other hospitals of similar levels of complexity, in the public and private sector. In addition, 80% of the Chilean population is enrolled in the public insurance system, and in regions many people with private insurance use public hospitals. Another constraint is the potential for selection bias since not all patients admitted to the study hospitals were enrolled in the GEMI Registry. We were able to quantify the percentage of patients included in the GEMI registry, but we did not have access to clinical information to fully address this potential bias. However, in terms of age and sex, we did not find differences between patients included and not included in the registry.

In relation to compliance with drug treatment at 1 year, information was available only for the post-AUGE period and was based on self-report. However, some studies have supported the self-report method as acceptable in the context of epidemiological studies (Grymonpre *et al.* 1998; Codina *et al.* 2002). Finally, because information regarding behavioural risk factors and socioeconomic status (as education level or income) in the pre-AUGE period was incomplete or not available, the comparative analysis was restricted to in hospital management, so the effect of other risk factors on case-fatality could not be evaluated. Socioeconomic position has been identified as a strong risk factor for mortality after MI both in Chile and internationally (Wang *et al.* 2014; Nazzal *et al.* 2015).

The strengths of this study include the use of Chile's centralized vital statistics mortality registry, which covers nearly 100% of the deaths. Over 98% of deaths are certified by physicians and fewer than 3% are attributed to unknown causes (Nunez and Icaza 2006). Moreover, in order to control for any case-fatality trend starting in the pre-AUGE period, we analyzed yearly rates in the 5 years prior to the implementation of the health guarantees, by which time the country had already begun to use coronary angioplasty and reperfusion techniques as well as statins for secondary prevention.

In conclusion, our findings associate the implementation of AUGE's universal health guarantees in Chile with improvements in effective coverage of in-hospital and at-discharge treatments for MI patients in public hospitals. These improvements in effective coverage, coupled with sustained adherence to secondary prevention medicines, may explain the increase in 1-year survival after discharge that we observed. These findings are consistent with AUGE's objective to improve health and health equity through universal, timely access to quality and affordable medical care, backed by rights-based guarantees. To be able to deliver these guarantees entailed a series of financing, investment and clinical management transformations to strengthen public hospital capacities to deliver opportune, quality care. Nevertheless, we are cautious in attributing our findings to any specific policy, particularly in light of the limitations of the study design for determining causality.

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Conflict of interest statement. None declared.

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