Benefits of fracture liaison services (FLS) in four Latin American countries: Brazil, Mexico, Colombia, and Argentina

Rima Aziziyeh, Javier Garcia Perlaza, Najma Saleem, Hannah Guiang, Kirk Szafinski and Rebecca K. McTavish

Aims: Fracture liaison services (FLS) use a multidisciplinary approach to treat patients who have experienced an osteoporotic fracture to reduce the risk of subsequent fractures. To date, there has been minimal FLS implementation in Latin America where fractures continue to be undertreated. This study aims to estimate the number of fractures averted, bed days avoided, and costs saved resulting from universal FLS implementation in Brazil, Mexico, Colombia, and Argentina.

Materials and methods: A calculator was developed to estimate the annual benefits of FLS programs in Brazil, Mexico, Colombia, and Argentina from a public hospital perspective. It was assumed all patients with a hip, vertebral, or wrist fracture were referred to an FLS program. Country-specific data were obtained from a previous systematic review and interviews with osteoporosis experts. Hospitalization and post-hospitalization costs were expressed in 2019 USD without discounting. Costs of FLS implementation were not considered.

Results: In 2019, the number of FLS patients prevented from having a subsequent hip, vertebral, or wrist fracture was estimated as 15,607 in Brazil, 8,168 in Mexico, 5,190 in Argentina, and 2,435 in Colombia with total bed days saved of 142,378 in Brazil, 75,877 in Mexico, 52,301 in Argentina, and 21,725 in Colombia. The annual cost savings in 2019 were highest in Argentina (28.1 million USD), followed by Mexico (19.6 million USD), Brazil (7.64 million USD) and Colombia (3.04 million USD). Over five years (2019–2023) the cumulative cost savings were 145 million USD in Argentina, 106 million USD in Mexico, 40.5 million USD in Brazil, and 16.1 million USD in Colombia.

Conclusion: Universal FLS implementation in Brazil, Mexico, Colombia, and Argentina was predicted to prevent 31,400 fractures, avoid 292,281 bed days, and save 58.4 million USD in 2019, though caution is warranted in the interpretation of these results due to high uncertainty. Increased implementation of FLS programs in Latin American countries may help to realize these benefits.

Introduction

Osteoporosis is a skeletal disease characterized by the gradual loss of bone mineral density, leading to bone fragility and higher susceptibility to fractures.1 Fragility fractures result from low-level trauma.2 For example, these fractures can occur from minimal impact, such as a fall from standing height or less, or from simple activities, such as reaching, bending, or twisting. They most commonly occur in the spine, hip, and wrist.3 Patients who have experienced fragility fractures are at an increased risk of subsequent fractures.2 This is detrimental because fractures are associated with increased rates of hospitalization or institutionalization, decreased quality of life, and increased economic burden to health care systems.2,4,5

In 2012, between 13–29% of the Latin American population were aged 50 years and older.6 By 2050, this age group is estimated to account for 28–49% of the Latin American population.5 The number of fragility fractures is expected to increase as a result of the aging population, as are the costs associated with these fractures. Annually, the cost of osteoporosis-related fractures for 2018 was reported as 411 million USD in Mexico, 360 million USD in Argentina, 310 million USD in Brazil, and 94 million USD in Colombia.7 Osteoporotic fractures are undertreated in Latin America.8 Upwards of 57% of patients who are at risk for osteoporotic fracture in Argentina, Brazil, Colombia, and Mexico do not receive treatment.9 Without a proper response to osteoporotic fractures, health care systems are failing to prevent subsequent fractures. Various management models have been created to address the post-fracture care gap.10 These range from patient education and awareness programs to intensive therapeutic programs that focus on prescribing pharmacologic treatment. The fracture liaison service (FLS) program is one of the most favored management models with proven
efficacy for the prevention of subsequent fractures. In FLS programs, patients with fragility fractures are identified, assessed for fracture risk, and given the appropriate treatment.

Countries in Latin America have started to develop FLS programs, but implementation is still in the early stages. As of 16 June 2020, there were two established FLS programs and one underway in Argentina, 10 established and 22 underway in Brazil, seven established and six underway in Colombia, and six established and 10 underway in Mexico. In all four countries, less than 10% of hospitals had an associated FLS program and correspondingly, access to fracture prevention was limited. More research is needed to establish the benefit of FLS programs and incentivize their continued development. Therefore, the objective of this study was to quantify the number of patients with a previous hip, vertebral, or wrist fracture who were prevented from having a subsequent hip, vertebral, or wrist fracture, the number of bed days saved, and the cost savings attributable to universal FLS implementation in four Latin American (LATAM) countries: Brazil, Mexico, Colombia, and Argentina. Universal implementation was assumed as the ideal scenario to maximize the incentive for developing FLS programs and move policymakers to action.

**Methods**

**Overview of the LATAM FLS benefits calculator**

The LATAM FLS benefits calculator was designed to follow a similar format as the Asia Care Group FLS benefits calculator, and also referenced the United Kingdom Royal Osteoporosis Society FLS benefits calculator. The LATAM calculator estimated the annual number of FLS patients prevented from having a subsequent hip, vertebral, or wrist fracture, the number of bed days saved, as well as the total hospitalization and post-hospitalizations costs saved from successful FLS implementation in each country. The analysis assumed all patients aged 50 years and over with a hip, vertebral, or wrist fracture in Brazil, Mexico, Colombia, and Argentina were referred to an FLS program. All calculations were conducted from a public hospital perspective over a five-year time horizon (2019–2023).

We previously completed a systematic review and interviews with clinical experts to understand the burden of osteoporosis in the four countries of interest. The results of the systematic review and interviews have since been published and were leveraged in this study to parameterize the LATAM FLS benefits calculator with country-specific data.

**Population**

The population of interest was men and women aged 50 years and over. The United Nations population projections were used to determine the starting populations for 2019 and the anticipated annual growth rate for the 50 and over age group in each country.

**Fracture incidence**

The LATAM FLS benefits calculator focused on three of the most common types of osteoporotic fractures: hip, vertebral, and wrist. Hip fracture incidence rates were identified for Brazil, Mexico, Colombia, and Argentina from the literature. However, as detailed previously, country-specific vertebral and wrist fracture incidence rates were not found in the literature. Instead, they were imputed using the LATAM hip fracture rates in conjunction with age- and sex-specific hip-to-vertebral and hip-to-wrist fracture ratios reported for Sweden. The use of Swedish fracture ratios is a common approach for models with incomplete epidemiological information and has been used in FRAX publications from Brazil and Colombia. In the calculator, the same fracture incidence rates were applied year over year to the total population aged 50 and over to calculate the number of incident hip, vertebral, and wrist fractures. These “incident” fractures were considered as “previous” fractures to distinguish them in time from the “subsequent” fractures that could be averted following FLS intervention. For simplicity, it was assumed that the number of previous fractures was equal to the number of patients eligible for inclusion in FLS programs.

**Fracture prevention**

The LATAM FLS benefits calculator used incidence rates to derive a population of patients with previous hip, vertebral, or wrist fractures eligible for FLS inclusion. It then calculated the number of subsequent fractures averted through FLS programs at the same three sites: hip, vertebral, and wrist. The risk of subsequent fracture at other sites was not considered within this analysis.

The prevention rate of a subsequent fracture at any of the three sites (hip, vertebral, or wrist) was modelled as 4.12% for patients with a previous hip fracture, 8.35% for patients with a previous vertebral fracture, and 7.71% for patients with a previous wrist fracture. These prevention rates were calculated from UK data and assumed 80% medication compliance and a relative risk reduction of 40% for FLS patients (See Supplementary Appendix B). The same prevention rates were applied to all four LATAM countries.

The Asia Care Group calculator assumed that if a patient had a subsequent fracture, it would be at the same site as the previous fracture. However, this assumption is not reflective of real events. Thus, in the LATAM FLS benefits calculator, 71% of subsequent fractures (i.e. fractures that FLS programs may prevent) were assumed to occur at the previous site, and other fractures were distributed according to their relative incidence.

**Costs**

The average per patient costs associated with subsequent hip, vertebral, and wrist fractures were calculated as the sum of hospitalization costs (hospital stay, testing, and surgery) plus post-hospitalization follow-up costs (outpatient visits).
All costs were presented in United States dollars (USD). Costs were inflated to 2019 values using estimates published by the Organization of Economic Co-operation and Development (OECD) for year over year inflation. Costs were inflated before conversion, in accordance with the Evidence for Policy and Practice Information and Coordinating Centre costing tool. 

### Hospitalization costs

The costs associated with hospitalization were modelled as average per patient costs and were specific to each fracture type (hip, vertebral, wrist) and country (see Supplementary Appendix A). The hospitalization unit costs included the costs of personnel, capital, and food throughout the patients’ hospital stay plus testing and surgery costs. Drug costs were excluded from the analysis.

Country-specific hospital cost per diems were obtained from a World Health Organization (WHO) source. More specifically, the primary hospital bed costs from WHO were used because they excluded the costs of drugs and diagnostic tests, but included costs related to personnel, capital, and food. The WHO primary hospital bed cost was intended to reflect a public hospital in an urban setting that operated in the 80th percentile within a group of institutions with comparable capacity and output. A Brazilian publication reported a range of hospital lengths of stay for patients with hip and vertebral fractures. The midpoint of each range was used as the length of stay in the calculator (15.5 days for hip, 13.5 days for vertebral). It was assumed that patients with wrist fractures would be discharged on the same day (one day). Due to a lack of country-specific data, these lengths of stay were applied to all four countries. All fracture patients were assumed to incur hospital costs (i.e. hospital cost per diem x length of stay), regardless of surgery status.

Testing costs were derived from country-specific literature sources. The testing costs included costs for bone densitometry scans, clinical laboratory tests, and radiological fracture assessments. All fracture patients were assumed to incur testing costs, regardless of surgery status.

Estimates for cost-per surgery were identified from the literature for Brazil, Mexico, and Colombia; the cost-per surgery for Argentina was informed by expert opinion. Published site-specific surgery rates were used to estimate the annual proportion of patients who incurred surgery costs (79.7% hip, 4% vertebral, 25% wrist). The same surgery rates were applied for all four LATAM countries.

### Post hospitalization follow-up costs

The costs associated with post-hospitalization follow-up were modelled as average per patient costs and were specific to each fracture type (hip, vertebral, wrist) and country (see Supplementary Appendix A). The costs were calculated by multiplying the cost per outpatient visit by the estimated number of outpatient visits. As with the hospital cost per diems, the costs per outpatient visit were country-specific and came from a WHO source that was representative of a public institution. For hip fractures, the number of outpatient visits was informed by the literature (Brazil: 6 visits, Colombia: 3 visits, Mexico: 3 visits, Argentina: 3 visits) in all four countries, vertebral fractures were assumed to have 50% fewer outpatient visits than hip fractures, and wrist fractures were assumed to have 75% fewer outpatient visits than hip fractures. All fracture patients were assumed to incur post-hospitalization follow-up costs.

### Cost savings

Annual cost savings were calculated by multiplying the number of FLS patients prevented from having a subsequent fracture each year by the associated per-patient fracture cost (hospitalization plus post-hospitalization follow-up).

### Bed days saved

Hospital beds are often a restricted commodity and freeing up these resources represents a benefit to public hospitals. The annual number of bed days saved was calculated by multiplying the number of FLS patients prevented from having a subsequent fracture at each given site by the respective hospital length of stay for that site, then summing all the days.

### Scenario analyses

Additional scenario analyses were conducted to address uncertainty in the LATAM FLS benefits calculator for each country. Several inputs were varied including the FLS-associated fracture prevention rates, fracture incidence rates, hospitalization costs, and post-hospitalization costs. Where possible, we informed the range of tested values from the literature. In the absence of data from the literature, we varied the inputs by ±20%. Details of these scenario analyses are provided in the Supplementary Appendix C.

### Results

In 2019, the number of patients aged 50 years and older with previous hip, vertebral, and wrist fractures who would be eligible for inclusion in an FLS program was 232,501 in Brazil, 122,781 in Mexico, 82,666 in Argentina, and 35,732 in Colombia. Among these eligible patients, the number of FLS patients prevented from having a subsequent hip, vertebral, or wrist fracture was predicted to be highest in Brazil (15,607), followed by Mexico (8,168), Argentina (5,190), and Colombia (2,435) (Figure 1). Over five years from 2019 to 2023, the cumulative number of FLS patients with fractures prevented was estimated as 82,670 in Brazil, 44,298 in Mexico, 26,828 in Argentina, and 12,935 in Colombia. Correspondingly, the total number of bed days saved from 2019 to 2023 was highest in Brazil (754,171 days) followed by Mexico (411,515 days), Argentina (270,344 days), and Colombia (115,430 days) (Table 1).
In contrast, the annual cost savings in 2019 resulting from successful FLS implementation and averted fractures was highest in Argentina (28.1 million USD), followed by Mexico (19.6 million USD), Brazil (7.64 million USD), and Colombia (3.04 million USD) (Figure 2). When assessing cost savings by fracture site, the prevention of subsequent hip fractures was associated with the largest cost-savings compared to vertebral and wrist fractures (Table 2). Over five years from 2019 to 2023, the cumulative cost savings climbed to 145 million USD in Argentina, 106 million USD in Mexico, 40.5 million USD in Brazil, and 16.1 million USD in Colombia.

In the scenario analyses, changes in fracture incidence rates had the greatest impact on annual costs saved. The calculator was also sensitive to changes in hospitalization costs and fracture prevention rates (i.e. predicted efficacy of FLS). Varying the post-hospitalization costs had minimal impact on the results (See Supplementary Appendix C).

### Discussion

The results of this study demonstrate that FLS programs have the potential to produce substantial resource and cost-savings for Argentina, Brazil, Colombia, and Mexico. Brazil had the greatest number of patients with fractures prevented and bed days saved because it is the most populous of the four countries. Despite having fewer patients with fractures prevented, Argentina showed the greatest cost savings due to the increased per patient costs of treatment, relative to Brazil, Mexico, and Colombia. The increased per patient cost of treatment in Argentina was largely driven by the high surgery unit cost which was estimated by local clinicians to be $11,466 USD (vs. $868 in Brazil, $3,088 in Mexico, and $1,441 in Colombia) across all four counties, hip fractures were the most expensive to treat. Therefore, the prevention of hip fractures provides the highest potential for cost-savings and should be prioritized.

Based on our findings, the implementation of FLS programs could help alleviate the economic burden faced by Brazil, Mexico, Colombia, and Argentina as a result of osteoporotic fractures. Efforts to curb costs are critical given that roughly four million fractures are anticipated to occur in these four countries between 2018 and 2022 with concomitant costs of 6.25 billion USD. However, according to clinical experts, osteoporosis is not regarded by the government as a health priority in Brazil, Mexico, Colombia, and Argentina. Consequently, current rates of post-fracture care are very poor. Although the infrastructure for a select few FLS programs has started to develop, widespread adoption is needed to maximize cost savings and achieve efficiencies in the delivery of care.

The results of this study indicate that FLS programs are a cost-saving approach to fracture prevention in Argentina, Brazil, Colombia, and Mexico. These findings align with previous studies which have demonstrated the cost savings associated with FLS in the US, UK, and Canada. In the US, an economic model was constructed to assess the benefits of FLS programs in men and women who had experienced a hip fracture from a health-care system perspective. The model estimated that for every 10,000 post hip fracture patients, an FLS would associate with 153 fewer fractures (109 hip, 21 vertebral, 5 wrist, 17 other) and cost savings of $66,879 (2010 USD) compared to usual care. Similarly in the UK, an economic model estimated that for every 1,000 fragility fracture patients, an FLS would associate with 18

### Table 1. Annual bed days saved for Argentina, Brazil, Colombia, and Mexico (2019–2023).

| Year | Argentina | Brazil | Colombia | Mexico |
|------|-----------|--------|----------|--------|
| 2019 | 52,301 days | 142,378 days | 21,725 days | 75,877 days |
| 2020 | 53,170 days | 146,486 days | 22,385 days | 78,962 days |
| 2021 | 54,054 days | 150,712 days | 23,065 days | 82,172 days |
| 2022 | 54,953 days | 155,060 days | 23,766 days | 85,513 days |
| 2023 | 55,866 days | 159,534 days | 24,488 days | 88,990 days |
| Total | 270,344 days | 754,171 days | 115,430 days | 411,515 days |

Figure 1. Annual number of patients with subsequent fractures averted in Argentina, Brazil, Colombia, and Mexico (2019–2023).
fewer fractures (including 11 hip) and cost savings of £21,000 (2009 GBP).

In Canada, national FLS coverage among 211,968 patients was predicted to result in 1,272 hip fractures averted, 29,252 fewer bed days, and cost savings of $27.3 million CAD during the first year (2015). Cumulatively over eight years, the number of hip fractures averted in Canada was predicted to rise to 19,283, with an additional 10,518 other fractures averted and cost savings over $413 million CAD.

This study has several strengths. To our knowledge, it is the first investigation to report on the benefits of FLS implementation in the LATAM region. Despite being early in the FLS development cycle, efforts were made to ensure the calculator was informed by a robust literature search and interviews with osteoporosis experts from Brazil, Mexico, Colombia, and Argentina. Non-adherence was also incorporated into the calculator to improve validity, as recommended by a previous economic modelling study. Wherever possible, consistent assumptions and uniform data sources were leveraged for use in the calculator to increase cross-country comparability. In addition, the calculator was also built to forecast changes in the number of FLS patients with subsequent fractures prevented, cost savings, and bed days saved out to five years. This is important because it demonstrates how benefits are likely to accrue over time in response to the increased number of incident fractures.

Despite these strengths, there are some limitations in this study. Namely, data had to be imputed or assumed for important inputs in the calculator where no LATAM-specific information was available. For example, fracture ratios from Sweden were used to impute the incidence rates of vertebral and wrist fractures, and UK data were used to inform the prevention rates and overall efficacy of FLS. Assuming the Swedish and UK primary data were representative of the LATAM context introduced significant uncertainty. Due to the high level of assumption driving the model, caution is warranted in the interpretation of results. The calculator also did not account for increased fracture risk in the period immediately following a previous fracture, instead the risk was assumed to be constant in each annual cycle. Further research is needed to understand how the number of fractures and costs saved change over time relative to changes in underlying risk. In addition, the LATAM FLS benefits calculator was limited to the hospital perspective and only considered hip, vertebral, and wrist fractures. The calculator did not include indirect costs resulting from caregiver and patient care.

Table 2. Annual cost savings for Argentina, Brazil, Colombia, and Mexico by fracture site (2019).

| Cost savings | Argentina | Brazil | Colombia | Mexico |
|--------------|-----------|--------|----------|--------|
| Hip fractures averted | $18,984,613 | $4,127,554 | $1,366,079 | $10,205,121 |
| Post-hospitalization costs saved | $95,086 | $78,744 | $42,273 | $149,232 |
| Subtotal | $19,079,699 | $4,206,298 | $1,408,353 | $10,354,353 |
| Vertebral fractures averted | $3,573,692 | $1,757,364 | $952,750 | $5,784,707 |
| Post-hospitalization costs saved | $47,965 | $52,897 | $30,917 | $96,453 |
| Subtotal | $3,621,657 | $1,810,261 | $983,667 | $5,881,160 |
| Wrist fractures averted | $5,356,686 | $1,590,749 | $627,517 | $3,325,842 |
| Post-hospitalization costs saved | $23,247 | $29,710 | $17,699 | $52,443 |
| Subtotal | $5,379,933 | $1,620,459 | $645,216 | $3,378,285 |
| Total annual costs savings for 2019 | $28,081,289 | $7,637,018 | $3,037,236 | $19,613,799 |

All costs are presented in 2019 United States Dollars (USD).
productivity losses or costs associated with other fractures (e.g., rib, pelvis, proximal humerus). The inclusion of these indirect costs and additional fracture sites would be expected to produce even greater cost savings. Similar to the Asia Care Group FLS benefits calculator, the LATAM FLS benefits calculator focused exclusively on hospitalization/post-hospitalization costs and did not consider cost of FLS implementation, including drug costs. Since the cost of implementing FLS programs was considered outside the scope of the current study, it is not clear to what extent the reported cost savings would help to offset the additional coordinator plus assessment and treatment costs associated with FLS implementation. Future studies that weigh the costs prevented against upfront investment costs are warranted to better understand the impact of FLS sites on the overall cost equation.

Conclusion

It is well known that the occurrence of a fracture increases the risk of a subsequent fracture.2 Despite this knowledge, a notable gap in care persists between detecting patients who have experienced a previous fracture and initiating treatment. FLS programs represent a specific model of care, whereby a coordinator proactively identifies patients with fracture, investigates their risk, and facilitates effective osteoporosis treatment in high-risk patients. Based on our findings, the universal implementation of FLS programs in Brazil, Mexico, Colombia, and Argentina would prevent subsequent fractures, ultimately resulting in cost savings and decreased occupation of hospital beds. Several assumptions were required to populate our calculator and generate these findings. As such, it is imperative that future work build on this endeavor to derive Latin American specific data and further validate our estimates. There is a pressing need for health care payers and decision makers to act on these findings given the significant economic and patient burden of osteoporosis in Latin America.2 The increased development of FLS programs in Brazil, Mexico, Colombia, and Argentina has the potential to close the post-fracture care gap and mitigate costs.

Transparency

Declaration of funding

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Declaration of financial/other relationships

RA, JGP, and NS are employees of Amgen. HG, KS, and RKM are employees of EVERSANA. EVERSANA consults for various pharmaceutical, medical device, and biotech companies.

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Author contributions

RA, JGP, KS, and RKM were involved in the conception and design of the study. All authors were involved in the analysis of data and all authors contributed to the interpretation of data. All authors participated in drafting the paper and critical revisions for intellectual content. All authors approved the final version. All authors agree to be accountable for all aspects of the work.

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