The Frequency of Osteoporosis and Optimal Cut-off Points for Screening Fracture Risk among Women in the North of Jordan; Experience at Prince Rashid Bin Al-Hassan Hospital

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ABSTRACT

Objectives: To estimate the frequency of osteoporosis as well as the optimal cut-off points of osteoporosis fracture risk based on bone mineral density T-score of lumbar spine and the total hip region for the women in North of Jordan.

Methods: This is a hospital-based study which was conducted among 394 women with frequent joints pain were seen in the out patient clinic of the physical and medical rehabilitation clinic at Prince Rashid Bin Al-Hassan Military Hospital, North of Jordan, between January and December 2009. Their age ranged from 32 to 80 years. Women with secondary osteoporosis were excluded and patients with orthopedic complaints were included in this study. The bone mineral density (gm/cm^2) and T-score were obtained by dual-energy X-ray absorptiometry for the lumbar spine and total hip region, performed in the Department of Nuclear Medicine at King Hussein Medical Center-Amman/Jordan. We used Statistical Package of Social Science to find the frequency based on WHO definition, the T-score of less than or equal to -2.5 is defined as osteoporosis, a T-score between -1 and -2.5 as osteopenia, and T-score of more than -1 was considered as normal. The Pearson Correlation statistical method was run between weight, height, Body Mass Index (weight divided by height meter square) and bone mineral density T-score. Receiver Operating Characteristic Curve analysis classified the 247 women without bone fractures and 147 with bone fractures in order to set the arbitrarily rapid best T-score cut-off values for prediction and screening of fracture risk regardless of the age and race.

Results: The lumbar spine bone mineral density T-score found 260 women (66.0%) to be classified as normal with T-score of -0.7 to -0.4, 12.9% as osteopenic with T score -2.0 to -1.7 and 21.1% as osteoporosis with T-score -3.6 to -3.3. The total hip bone mineral density T-score was analyzed, 71.8% were normal with T-score -0.6 to -0.3, 17.5% osteopenic with T-score -2.0 to -1.7, and 10.7% as osteoporotic with a T-score of -3.3 to -3.0. The frequency of osteoporosis increased with increasing age, low weight, and short height ($P < 0.05$) but did not correlate with Body Mass Index. The lumbar spine bone mineral T-score $\leq$ -2.5 was found to be the optimum cut-off value in the prediction of fracture risk (sensitivity 91.2% and specificity 89.9%). The total hip bone mineral T-score $\leq$ -2.4 was found to be the optimum cut-off value in the prediction of fracture risk (sensitivity 93.9% and specificity 90.3%).

Conclusions: Early diagnosis of the disease and initiate proper therapy for osteoporosis is available, but prevention is definitely more cost-efficient

Key words: Bone Mineral Density T-score, Cut-off Value, Fracture Risk Hip, Osteoporosis, Osteopenia, Lumbar.

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Introduction

Osteoporosis is the most common worldwide-generalized disease of the skeleton.[1] It is one of the most common metabolic bone diseases, which is characterized by progressive loss of bone density and thinning of bone tissue, enhanced bone fragility and an increase fracture risk.[2-4] Postmenopausal osteoporosis is a major public health problem and estrogen deficiency is a key factor in the pathogenesis of postmenopausal osteoporosis.[5-10]

The Bone mineral density (BMD) measurements obtained by dual energy X-ray absoptiometry (DEXA) for lumber spine and hip region is widely regarded as the most important non-invasive determinant of bone fragility, strength, and fracture risk.[1] According to the World Heath Organization (WHO) definition, the T-score of -1 to -2.5 is defined as osteopenia and that less than or equal to -2.5 is defined as Osteoporosis.[1,5,11,12]

Osteoporosis increases in prevalence with age and is very common in elderly women.[13] With aging, the process of coupled bone formation is affected by the reduction of osteoblast differentiation, activity, and life span, which is further, potentiated in the perimenopausal years with hormone deprivation and increased osteoclast activity.[14,15] Age-related bone loss is thus not only a consequence of hormone deprivation, but also the result of changes in bone formation and cell-cell interactions with a unique pathophysiology. In this review, we describe the cellular and metabolic changes associated with aging bone and present recent evidence regarding cell differentiation within the bone marrow. We also consider the mechanism of programmed cell death, apoptosis, as being an important determinant of aging in bone as well as describe possible future interventions to prolong the life span of osteoblasts.[14]

The high prevalence of osteoporosis observed in diabetic patients could be attributed to association of multiple variables on top of diabetes and menopause such as vitamin D deficiency, lack of sun exposure and lack of intake of milk and dairy products, lack of exercise and probably genetic.[15-20]

Parathyroid hormone is anabolic in bone, but when secreted in excess it is catabolic.[21] Its levels increase with age in both genders, paralleling the incidence of osteopenia and osteoporosis.[21,22] It is well established that hyperparathyroidism is responsible for changes in bone metabolism leading to a reduction in bone mineral density,[17,23] and the National Osteoporosis Foundation lists hyperparathyroidism as a risk factor for osteoporosis.[4,22]

The aim of this study is to estimate the frequency of osteoporosis as well as the optimal cut-off points of osteoporosis fracture risk based on DEXA bone mineral density T-score of lumbar spine and the total hip region for the women in North of Jordan.

Methods

This is a hospital-based study which was conducted among 394 women with frequent joints pain were seen in the out patient clinic of the physical and medical rehabilitation at Prince Rashid Bin Al-Hassan Military Hospital, North of Jordan, between January and December 2009. Their age ranged from 32 to 80 years (mean age +/- SD; 51.6 ± 14.1 years). The local ethical committee of the Royal Medical Services approved this study. Women with secondary osteoporosis were excluded from the study. Patients with orthopedic complaints were included in this study. The bone mineral density (gm/cm^2) and T-score measurements, that obtained by Dual-Energy X-ray Absorptiometry (DEXA) lumbar spine (L1-4) and total hip region, which was performed in the Department of Nuclear Medicine at King Hussein Medical Center-Amman/Jordan. Based on WHO definition, osteoporosis classified as a T-score of <-2.5, osteopenia as a T- score between -1 and -2.5 and T-score > -1 was considered as normal. The data of women's age, weight, height, body mass index (weight divided by height meter square) and DEXA results "bone mineral density T-score for lumbar spine and total hip region" were transferred to Statistical Package of Social Science (SPSS) software. Regardless of the age and race, the lumbar spine and total hip region T-scores were classified into two groups of women (247 women without bone fractures and 147 with bone fractures group), by using Receiver Operating Characteristic Curve analysis (ROC) in order to set the arbitrarily rapid best T-score cut-off values with the highest sensitivity and specificity. In addition, their 95% confidence interval (CI) for screening and detection of bone fractures.

Results

In Table I, the recorded variables for 394 women included in this study as of the follow: age [51.6 ± 14.1, 95% CI; 50.2 to 53.0 years], weight [70.3 ±

17.9, 95% CI; 68.5 to 72.1 kg], height [150.4 ± 6.4, 95% CI; 159.7 to 170.0 cm], BMI [27.3 ± 6.6, 95% CI; 26.6 to 27.9], lumbar spine bone mineral density (BMD) [0.759 ± 0.25, 95% CI; 0.734 to 0.784 gm/cm^2], lumber spine T-score [-1.3 ± 1.64, 95% CI; -1.5 to -1.8], total hip region BMD [0.818 ± 0.20, 95% CI; 0.798 to 0.837 gm/cm^2], and total hip region T-score [-0.982 ± 1.25, 95% CI; -1.1 to -0.9].

In Table II, the DEXA results for the lumbar spine BMD and T-score, referenced to WHO criteria of the correspondent age and race. 12.9% of women had osteopenia [BMD = 0.673 ± 0.13 gm/cm^2, 95% CI; 0.636 to 0.710 gm/cm^2, T-score; -1.8 ± 0.56] and 21.1% had osteoporosis [BMD = 0.518 ± 0.11 gm/cm^2, 95% CI; 0.494 to 0.542 gm/cm^2, T-score; -3.5 ± 0.67].

In Table III, the DEXA results for the total hip BMD and T-score, referenced to WHO criteria of the correspondent age and race. 17.5% of women had osteopenia [BMD = 0.711 ± 0.09 gm/cm^2, 95% CI; 0.690 to 0.732 gm/cm^2, T-score; -1.8 ± 0.52] and 10.7% had osteoporosis [BMD = 0.543 ± 0.07 gm/cm^2, 95% CI; 0.520 to 0.566 gm/cm^2, T-score; -3.2 ± 0.45].

As shown in Table IV, the age specific frequency of osteoporosis was higher in the older age women. Below the age of 50 years, the frequency of osteoporosis in the results of DEXA for lumber spine and hip were 6.1% and 2.8% respectively. Between ages 50-65 year, the age specific frequencies were 7.4% and 3.8%. Above the age of 65 years, the age specific frequencies were 7.6% and 4.1% respectively. The spine-to-hip osteoporosis ratio was 2:1 (21.1/10.7).

In table V and VI for both DEXA of lumbar spine and total hip BMD T-score classifications, the weight and height in this study were negatively associated with the presence of osteoporosis (osteoporosis was more likely increased with low weight and short height), on other hand BMI did not correlate with the presence of osteoporosis.

In Table VII, a DEXA lumbar spine T-score in women with bone fractures (-2.6 ± 1.3) was significantly higher than in women without bone fractures group (-0.6 ± 1.3) (P-value < 0.001). On other hand a DEXA of total hip T-score was also significantly higher in women with bone fractures (-1.8 ± 1.2) (P-value < 0.001).

In Table VIII, Figure 1 and Figure 2, the DEXA lumber spine best T-score cut-off value for prediction bone fractures was ≤ -2.5, with sensitivity 91.2% (95% CI; 85.3-95.2%) and specificity 89.9% (95% CI; 85.4-93.3%). On other hand for the total hip region the findings were somewhat similar to lumbar spine, the best T-score cut-off value was ≤ -2.4, sensitivity 93.9% (95% CI; 88.7-97.2%) and specificity 90.3% (95% CI; 85.9-93.7%).

Discussion

To the best of our knowledge, this is the first independent hospital-based study concerning the frequency of osteoporosis and fracture risk among women in the North of Jordan.

Using a T-score threshold of -2.5 (WHO), the frequency of osteopenia and osteoporosis in North of Jordan was 12.9% and 21.1%, for DEXA measures of the lumbar spine. Moreover, it was 17.5 and 10.7% for DEXA measures of total hip, respectively. At the other scale, the spine-to-hip osteoporosis frequency ratio was 2:1. This is somewhat consistent with a study among middle age Jordanian women attending the Orthopedics and Rheumatology out patient clinics at the Major Teaching Hospital in Amman, Jordan, that found 13% were found to be osteoporotic, 40% osteopenic and 46% had normal bone density in the lumbar spine. In the hip, only 1% of the women were diagnosed with osteoporosis, 26% with osteopenia and 72% with normal bone density.[12] In other community- base study among Jordanian women, 29.6% were identified as having osteoporosis, 43.8% were osteopenic.[10] A study in Saudi Arabia reported that the prevalence of osteopenia and osteoporosis in postmenopausal women were 30.6% and 39.5%, respectively.[5] Other study among Turkish women, aged 40-90 years, reported that the prevalence of osteoporosis for women was 30% and 22% for DEXA measurements of the lumbar spine and hip, respectively.[8] Wainwright *et al* explained the higher frequencies of lumbar spine osteoporosis and reported that the prevalent vertebral fracture, and lower total hip BMD, associated with increased fracture risk in women without hip osteoporosis. Together, these findings highlight the complex etiology of hip fracture and help begin to identify risk factors associated with higher bone density levels.[24]

In this study when the women were divided into age groups, the age specific rate of osteoporosis increased with age. The lumbar spine BMD T-scores indicated 6.1% of the less than 50-year age group

Table I. The study group mean +/- SD and 95% CI of age, weight, height, BMI, lumber spine BMD, T-score, total hip BMD and T-score

Variable	Mean ± SD	95% CI
Age/years	51.6 ± 14.1	50.2 - 53.0
Weight/kg	70.3 ± 17.9	68.5 - 72.1
Height/cm	150.4 ± 6.3	159.7 - 170.0
BMI	27.3 ± 6.6	26.6 - 27.9
lumber spine BMD gm/cm^2	0.759 ± 0.25	0.734 - 0.784
lumber spine T-score	-1.3 ± 1.64	-1.5 to -1.8
Total hip BMD gm/cm^2	0.818 ± 0.20	0.798 - 0.837
Total hip T-score	-0.982 ± 1.25	-1.1 to -0.9

Table II. Frequency of osteopenia and osteoporosis based on WHO classification, that is concordant with DEXA results of lumbar spine BMD and T-score

	N (%)	BMD gm/cm^2 Mean ± SD (95% CI)	T-score Mean ± SD (95% CI)
Normal	260 (66.0)	0.853 ± 0.24 (0.824 - 0.882)	-0.6 ± 1.33 (-0.7 to -0.4)
Osteopenia	51 (12.9)	0.673 ± 0.13 (0.636 - 0.710)	-1.8 ± 0.56 (-2.0 to -1.7)
Osteoporosis	83 (21.1)	0.518 ± 0.11 (0.494- 0.542)	-3.5 ± 0.67 (-3.6 to -3.3)

Table III. Frequency of osteopenia and osteoporosis based on WHO classification, that is concordant with DEXA results of total hip BMD and T-score

	N (%)	BMD gm/cm^2 Mean ± SD (95% CI)	T-score Mean ± SD (95% CI)
Normal	283 (71.8)	0.884 ± 0.19 (0.863 - 0.906)	-0.5 ± 0.96 (-0.6 to -0.3)
Osteopenia	69 (17.5)	0.711 ± 0.09 (0.690 - 0.732)	-1.8 ± 0.52 (-2.0 to -1.7)
Osteoporosis	42 (10.7)	0.543 ± 0.07 (0.520 - 0.566)	-3.2 ± 0.45 (-3.3 to -3.0)

Table IV. Frequencies of osteopenia and osteoporosis of DEXA results: for lumbar spine and total hip according to age group

	Lumber spine			Total hip region		
	Normal	Osteopenia	Osteoporosis	Normal	Osteopenia	Osteoporosis
Age < 50 years	210	24	24	218	29	11
N (%)	(53.3)	(6.1)	(6.1)	(55.3)	(7.4)	(2.8)
Age 50-65 years	33	18	29	40	25	15
N (%)	(8.4)	(4.6)	(7.4)	(10.2)	(6.3)	(3.8)
Age > 65 years	17	9	30	25	15	16
N (%)	(4.3)	(2.3)	(7.6)	(6.3)	(3.8)	(4.1)
Total	260	51	83	283	69	42
N (%)	(66.0)	(12.9)	(21.1)	(71.8)	(17.5)	(10.7)

Table V. The weight, height and BMI in correlation with osteoporosis based on DEXA of the lumbar spine BMD T-score

	Weight mean ± SD kg	Height mean ± SD cm	BMI mean ± SD
Normal	71.6 ± 18.9	161.9 ± 6.0	27.3 ± 7.0
Osteopenia	70.1 ± 13.9	158.9 ± 5.3	27.7 ± 5.2
Osteoporosis	66.4 ± 16.7	156.4 ± 5.9	25.9 ± 6.1
Average +/- SD of all groups	70.3 ± 17.9	160.3 ± 6.3	27.3 ± 6.6
Pearson Correlation (r)	-0.114	-0.354	-0.015
P-value	0.024	< 0.001	0.756

Table VI. The weight, height and BMI in correlation with osteoporosis based on DEXA of the total hip BMD T-score

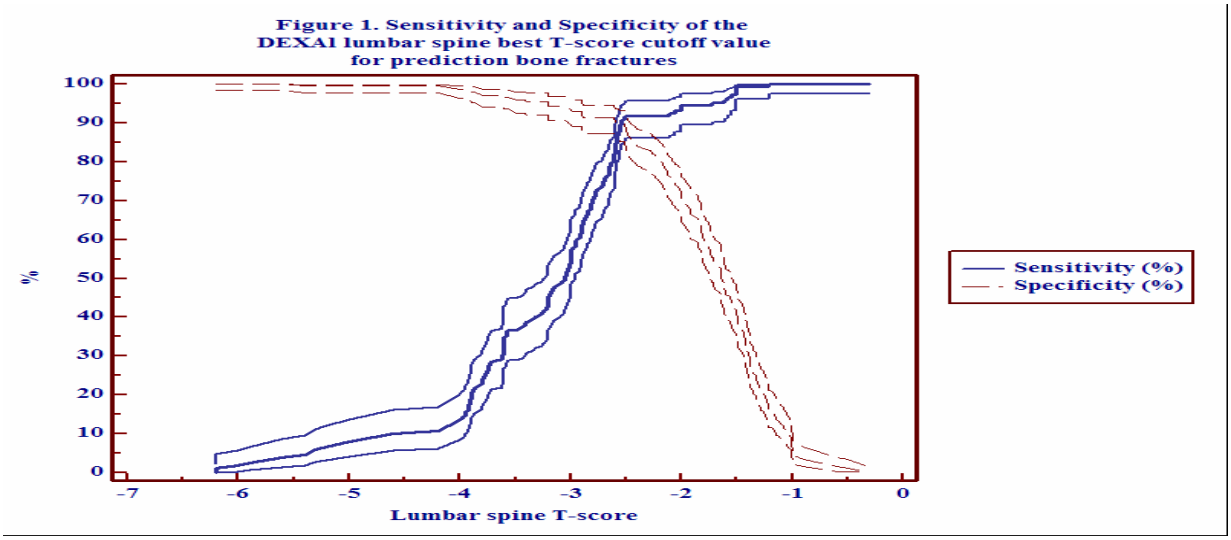
	Weight mean ± SD kg	Height mean ± SD cm	BMI mean ± SD
Normal	71.8 ± 18.4	161.7 ± 5.9	27.4 ± 6.8
Osteopenia	69.5 ± 14.2	158.6 ± 4.6	27.6 ± 5.4
Osteoporosis	61.4 ± 17.7	153.8 ± 6.3	25.8 ± 6.7
Average +/- SD of all groups	70.3 ± 17.9	160.3 ± 6.3	27.3 ± 6.6
Pearson Correlation (r)	-0.169	-0.404	-0.061
P-value	0.001	< 0.001	0.224

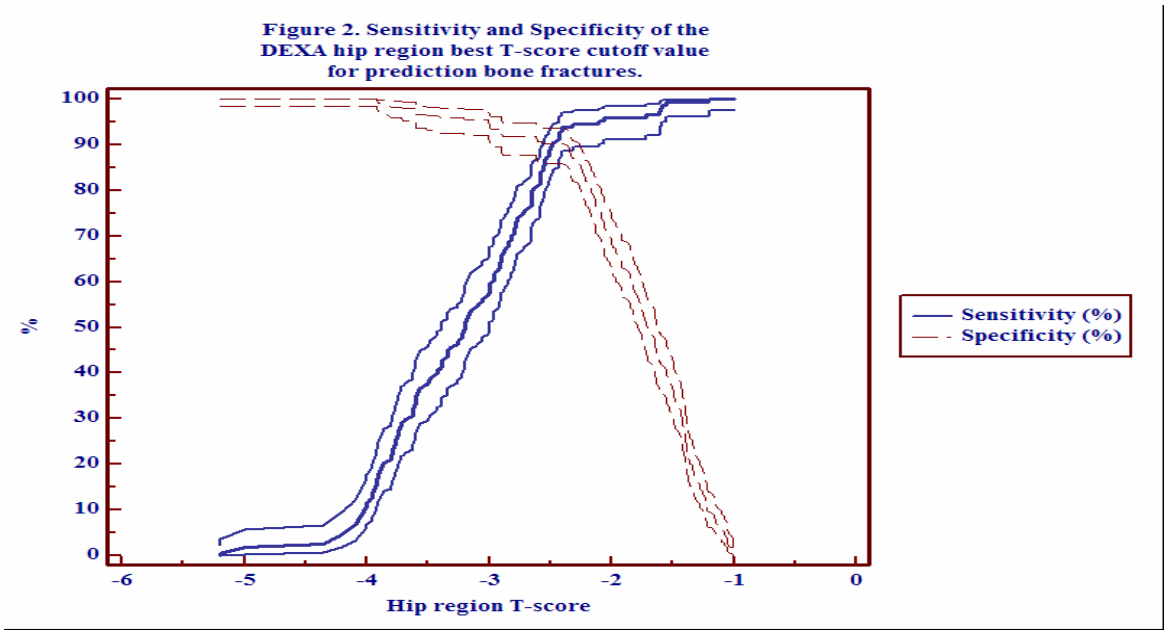
Table VII. The DEXA lumbar spine and total hip T-scores difference between women without and with bone fracture groups

	Without fractures group N = 247	With fractures group N = 147	P-value
Lumbar spine T-score mean ± SD	-0.6 ± 1.3	-2.6 ± 1.3	< 0.001
Total hip region mean ± SD	-0.5 ± 0.9	-1.8 ± 1.2	< 0.001

Table VIII. The best DEXA results cut-off values T-score of lumbar spine and total hip for prediction bone fractures

	Cut-off value	Sensitivity %	95% CI	Specificity %	95% CI
Lumbar spine T-score	≤ - 2.5	91.2	85.3-95.2	89.9	85.4-93.3
Total hip region T-score	≤ - 2.4	93.9	88.7-97.2	90.3	85.9-93.7





was osteoporotic, 7.4% of the 50-65 year age group and increasing to 7.6% of the women age group more than 65 year. The total hip BMD T-scores indicated 2.8% of the age group less than 50 year was osteoporotic, 3.8% of the 50-65 year age group and increasing to 4.1% of the women age group more than 65 year. Women's lumbar spine and total hip BMDs were grouped according to the T-score and then comparisons made between the three groups of women (osteoporotic, osteopenic and

normal). In a study conducted in UK by Patel *et al* demonstrated that both osteoporosis and fall-related risk factors become more common with increasing age.[25] Changes in bone turnover begin already in late premenopause in which bone formation may precede increased bone resorption induced by estrogen withdrawal. These changes remain largely unchanged in early menopause. They suggested an increased rate of bone turnover and remodeling in osteoporotic elderly women.[5,6,19-20]

People with a BMI of 21 or less have a higher rate of bone loss than those who are heavier, and obese people have lower rates of bone loss than those who are ideal weight[26] and our study found that, osteoporosis more likely increase in thin and short women, while BMI does not have a correlation with osteoporosis. These results were in agreement with Sordia *et al* in Mexico and Martini *et al* in Brazil, the postmenopausal women with low weight and short height, rather than patients with low BMI correlates in a better way with the diagnosis of osteoporosis. They recommend performing a bone mineral density study in this group of patients.[27,28]

Osteoporosis is often referred to as a "silent disease" because bone loss occurs without any symptoms. In fact, many people do not know that they have osteoporosis until they get an osteoporotic fracture. Thus, it is safe to say that osteoporosis is an under recognized and under treated disease. And while osteoporosis is a debilitating disease, medical experts agree that osteoporosis is a highly preventable and treatable, so that in this study, the high sensitive and specific T-score cut-off value for roughly screening fracture risk regardless of the age category by the DEXA lumber spine and total hip was about ≤ -2.5. This somewhat consistent with a study conducted in Iran used ROC curves, a T-score = -2.1 SD was found the optimum cut-off point of the dual x ray and laser technique in the diagnosis of osteoporosis in the lumbar spine, sensitivity and specificity were 82% and 79% respectively. The optimal cut-off point of the dual X ray and laser technique in the diagnosis of osteoporosis in the neck region of the femur was a T-score of -2.6 SD (sensitivity and specificity were 85 and 86%).[29] These results were in agreement with the WHO definition, the T-score of less than or equal to -2.5 is defined as osteoporosis.[1,5,30] The value of DEXA at this cut-off value in establishing the diagnosis of osteoporosis would eventually result in reduced bone strength and increased propensity to fractures.[1,30,31]

Limitation of the Study

The restricted sampling of women with frequent joints pain holding a military health insurance and who attended the physical and medical rehabilitation clinic at the Prince Rashid Bin Al-Hassan Military Hospital, North of Jordan where the study was conducted and therefore may not represent the whole population. Moreover, we did not study the socio-economic, demographic variables, nutritional, bio-chemical markers, hormonal markers and racial differences attributed to underlying cause of osteoporosis. Furthermore, no investigations were made regarding reports of previous fractures and family histories of fractures, which are risk factors frequently associated with osteoporosis and fractures.

Conclusion

Our results indicate that osteoporosis reported to be common among postmenopausal older age, short stature and low weight women in North of Jordan. In addition, the bone mineral density T-score < -2.5 seems to strongly suggest the likelihood of fracture risk. However, early diagnosis of the disease and initiate proper therapy for osteoporosis is available, but prevention is definitely more cost-efficient.

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