Hospitalization for Fractures and Bone Loss in Adults

Why do We Regard These Phenomena as Dull?

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WHEN GEORGE BERNARD SHAW, within 5 years of his centenary, fell from a tree and slipped smoothly through the lax fingers of his attending physicians, no voluntary agency raised its aggressive flag of leadership for the better control of hip fractures. After all, as suggested by common sense and social attitudes, the elderly are expected to die soon, even when still able to climb trees; and furthermore, as pondered by the health care providers, one must die from something, and perhaps a fractured femur is as good a cause as any.

Somewhat ahead of common sense and current values, however, has been the recent massing of knowledge to show that serious fractures are important setbacks to the quality of life at ages much younger than the last decades (*1*). Furthermore, the increasing data suggest that the epidemiology of these fractures relates less to the frequency of grave and forceful accidents and more to adverse and potentially controllable changes in middle-aged and older people (*2*).

Data from numerous studies, gathered and analyzed by many investigators, have contributed to the growing but dormant knowledge in this passionless area. Almost neglected, however, has been the abundance of hospital figures that cover wide population groups—more data than we can collect and deal with in special studies funded in times of austerity. To fill part of this gap, I have used hospital discharge figures for different geographic areas to document more strongly than before that:

- White women, at every age beginning from late reproductive life, and certainly before the onset of menopause, sustain more serious fractures than do contemporary white men.
- Older black women do not endure this adverse experience so virulently when compared with black and white men in the later decades of life.
- The rapid rise in serious fractures with increasing age that occurs widely in both sexes and races is caused primarily by the progressive loss of bone with age. This insidious and "dull" change should offer possibilities for prevention and control in the coming decades.

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Hospitalization for Fractures, United States

According to the National Center for Health Statistics (*3, 4*) the mean U.S. annual discharge rates from short-term hospitals per 100,000 population for all causes and all fractures for 1971–72 by age were as follows:

Age group (years)	*All causes, rate*	*All fractures*	
		Rate	*Percent, all causes*
All ages	15,032	540	3.6
Under 15	7,199	338	4.7
15–45	15,371	448	2.9
46–64	17,025	531	3.1
65 and older	31,934	1,538	4.8

Since total hospital discharge rates for all causes are also high among persons 65 and older, the proportion for fractures does not seem remarkable—about the same as for those under 15 years. A second source of U.S. hospital data, the enrollees in the hospital insurance program of Medicare, gives more abundant figures for older groups for 1967 (*5*). Based on all discharges paid for by this program, and not merely on a sample of discharges as used in the Hospital Discharge Survey, the Medicare data permit subdivision into more detailed age groups.

The following Medicare data show that as a result of fractures (ICDA code No. 800–829) the number of discharges per 100,000 enrollees rose steadily with advancing age (*5*).

Age group (years)	*All causes, rate*	*All fractures*	
		Rate	*Percent, all causes*
All ages, 65 and older	25,931	1,364	5.3
65–69	20,871	747	3.6
70–74	24,105	1,014	4.2
75–79	29,065	1,544	5.3
80–84	33,707	2,384	7.1
85 and older	37,007	3,784	10.2

At age 85 or older, nearly 4 percent of the total population sustained serious fractures each year,

accounting for 10 percent of all hospital discharges at that age. Placing these data in perspective, one views the rapid rise in serious fractures as occurring at a time when physical activity slows with age. Thus, the phenomenon being assayed is not a marked rise in the incidence of forceful accidents but a declining ability of aging people to withstand the minor accidents common at all ages.

Discharge Rates for Fractures, by Sex and Race

How do men differ from women in their hospital discharge rates for all fractures? Because the Hospital Discharge Survey does not publish separate age-specific figures for men and women, we look first to England and Wales for a partial answer to this question. Hospital discharge rates for all fractures per 100,000 population in England and Wales for 1972, by age and sex, were as follows (*6*):

Age group (years)	*Men*	*Women*
All ages [1]	351	304
25–34	331	74
35–44	258	88
45–64	269	218
65–74	329	561
75 and older	878	1,962

[1] Includes patients under 25 years of age.

The total discharge rate for fractures (ICDA code No. 800–829) in England and Wales in 1972 was about 60 percent of that for the United States in 1971–72. This difference is an artifact, however, that mainly reflects the greater abundance of hospital beds in the United States, which has higher hospitalization rates for many causes.

The broad age groups used for England and Wales suggest that fracture rates began to rise markedly for women as they approached 50 years of age, while the rates for men rose only after 70 years of age. At younger ages, men had higher rates, corresponding to their more common and forceful accidents (*7*), with women approaching and then surpassing the rates for men as they reached 50 or 60 years of age. The broad age groups make it difficult to focus on the more precise ages at which the hospital discharge figures rapidly change. Fortunately, the hospital figures published for Saskatchewan, with a smaller and more rural population than those in the United States or England and Wales, use narrow age groups. The mean annual discharge rates for all fractures (ICDA code No. 800–829) per 100,000 population in Saskatchewan, 1966–68, by age and sex (*8–10*) were:

Age group (years)	*Men*	*Women*
All ages [1]	648	560
30–34	418	268
35–39	478	272
40–44	581	318
45–49	571	420
40–54	538	548
55–59	587	849
60–64	727	1,036
65–69	704	1,324
70–74	803	1,744

[1] Includes rates for patients under 30 years and 75 and older.

The Saskatchewan figures for men remained low until 60 years, and then they began to rise rapidly until advanced age. For women the figures rose swiftly from age 45 before all had reached the menopause; they approached the rates for men around 50 years and surpassed them at age 55 and older. However, more men than women in Saskatchewan continued to be exposed to more numerous and more serious occupational accidents beyond age 45. For example, Saskatchewan's hospital admission rates for residents that involve no fracture—dislocations, sprains, and strains (ICDA code No. 830–848)—are higher for men than women through age 64. Thus, the higher fracture rates for women resulted mainly from a weakened ability to withstand the less common and physically less forceful accidents in their lives. Clearly, the falling ability to withstand relatively minor accidents also began earlier in women than in men and became more severe in women than in men at ages after the late fifties.

Frequent comments and clinical impressions have been published that the black population has fewer fractures at the older ages than whites. Of the countries for which hospital discharge data are available, only the United States has a black population over 65 years that is large enough to produce figures of some reliability. We thus return to data from the Medicare program in 1967, when 1.5 million enrollees were nonwhite and mainly black (*5*). In doing so, we must first be aware that hospital discharge rates for all causes were lower for black than for white Medicare enrollees.

Table 1 shows hospital discharge rates for all fractures (ICDA code No. 800–824) per 100,000 enrollees in each age-sex-race-specific group. Among men, the discharge rates at each age were consistently lower for blacks than for whites; moreover, the rise with age was more gradual for blacks than for whites. Thus, white men aged 85 and older had rates 4 times those of white men aged 65–69; the equivalent rise for black men was less than twofold.

Among women, the discharge rates for blacks were about one-third of those for whites of the same age. For both white and black women the rise with age was steep; women 85 and older had 5 times the discharge rate of those aged 65–69.

When we compare groups of the same age and race, the rates for white women were about twice those of white men. Black women also had higher rates, but less markedly so, than black men. The discharge rates for black women, however, were consistently below the lowest rates for whites of either sex.

We have reason to believe that non-fracture accidents (ICDA code No. 830–848) were lower among older blacks than among whites, but not low enough to reflect the low fracture discharge rates for blacks. The data in table 1, therefore, tend to confirm the widely held impression that blacks who survive into the older ages are a biological elite, with greater power to withstand environmental onslaughts of all types than whites of the same advanced age. In addition, black women seem more able to maintain bone strength than whites of either sex, although by no means being exempt from bone loss with age.

Discharge Rates for Fractured Femur

The characteristic and most widely known fracture in older persons is the fractured hip (ICDA code No. 820, 821), occurring most often at the upper end of the femur. Table 2 shows hospital discharge rates for this condition among white Medicare enrollees in 1967 (*5*). Once again the rates for fractured femur were much higher for women than for men and rose steeply for both sexes with advancing age.

A fractured femur (ICDA code No. 820, 821) was

Table 1. Discharge rates from short-term hospitals per 100,000 enrollees in Medicare, all fractures (ICDA code No. 800-829), by age, sex, and race

Age group (years)	Total	Men		Women	
		White	Black [1]	White	Black
All 65 and older	1,364	806	450	1,852	546
65–69	747	536	450	987	301
70–74	1,014	608	393	1,407	423
75–79	1,544	881	459	2,120	642
80–84	2,384	1,365	623	3,202	854
85 and older	3,784	2,342	894	4,808	1,644

[1] Includes all nonwhites.
SOURCE: reference 5.

Table 2. Discharge rates from short-term hospitals per 100,000 white enrollees in Medicare, all fractures (ICDA code No. 800-829) and fractured femur (ICDA code No. 820,821), 1967, by age and sex

Age group (years)	Men			Women		
	All fractures, rate	Fractured femur		All fractures, rate	Fractured femur	
		Rate	Percent		Rate	Percent
65 and older	806	335	42	1,852	909	49
65–69	536	133	25	987	300	30
70–74	608	201	33	1,407	562	40
75–79	881	370	42	2,120	1,054	50
80–84	1,365	737	61	3,202	1,870	58
85 and older	2,342	1,515	65	4,808	3,262	68

SOURCE: reference 5.

the primary diagnosis from hospitals in 42 percent of all fracture discharges (ICDA code No. 800–829) for men and 49 percent for women. Table 2 shows that this percentage rose with increasing age, from 25 to 65 percent for men and from 30 to 68 percent for women. In most age groups, the percentage of all fractures formed by fractured femur was higher for women than for men. Thus, the total discharge rates for fractures are much influenced by the rates for fractured femur, particularly in the advanced ages. Moreover, the rise with age of persons discharged from the hospital is much steeper for fractured femur than for all fractures.

Hospital Data as Reflectors of Incidence Rates

Before discussing the implications of the earlier sections, I must place in perspective the value and limitations of the data. If all new cases of fractures were known for large population groups, hospitalized or not, these incidence figures would lead to more valid conclusions than hospital data. Since fractures are not reportable, however, such incidence rates are not available, and the use of hospital discharge rates is a second and suboptimal choice, because they are available.

Such hospital data are more useful, however, than death rates for two reasons. First, many of the less severe fractures require hospitalization but are not fatal, even in persons of advanced age; thus, they do not appear in the death statistics. Second, the hospital data include diagnoses that tend to be more valid than diagnoses at death. The introduction of Medicare in the United States in 1966 and the existence of hospital care without direct charge in England and Wales and Saskatchewan encourage admission of older persons to hospitals: therefore, hospitalized patients represent a high proportion of all serious fractures.

Hospital data do not distinguish between old and new events, however, and some persons are admitted twice or more during 1 year. In 1967, for example, 75 percent of Medicare patients with all diagnoses were discharged once, while 25 percent were discharged twice or more; the equivalent figures for those with fractures are not available. It is certain, however, that these percentages overstate the problem of repeat admissions in this study. Many second admissions of Medicare patients are for diagnoses different from those of the first admission; thus, repeat admissions do not greatly inflate the fracture discharge rates.

Clearly, however, we must acknowledge that repeat admissions do contaminate the hospital discharge data, preventing their comparability to incidence rates. In acting on that knowledge, we decide either to tolerate the contamination or to delay using hospital data until first admissions only can be analyzed. The tables presented earlier are based, therefore, on a judgment that the margin of error is tolerable, and that appropriately used hospital data on fractures can contribute significantly to data collected through more expensive means in the past.

Bone Loss and Fractures

Hospital discharge rates for fractures show that the risk of sustaining serious fractures rises steeply between 40 and 90 years and is greater among women than among men of the same race and age. This pattern, by sex, differs from the epidemiology of forceful accidents which involve men more often than women (*2, 7*). Thus, we reach the need to examine our current knowledge about bone loss with age, perhaps the most powerful host factor to dominate the picture of fractures in the elderly.

The composition of bone qualitatively remains about the same in adult years (*11*); but all persons lose quantities of bone from the skeleton as they age (*12*). While this loss is usually termed osteoporosis, the change is not an increase in porosity of bone, but rather a decrease in its physical density, measured in terms of weight-per-unit volume (*11*). Such information first came from extensive cross-sectional data that involved problems of different nutrition, physical activity, selective mortality, and other possible contaminating factors. In recent years, however, impressive longitudinal data from successive X-ray studies show more definitively that the decrease in bone weight with advancing age is a true cohort phenomenon (*13*).

Thoughtful reviews of the abundantly available data show that bone loss is not a simply explained or a brief-to-describe change. Dequeker (*11*) and Garn (*14*) are among several researchers who cover its many facets and intricacies well. Their reviews show clearly that bone is a more volatile and less permanent tissue than many conceive it to be. Throughout life, bone is constantly being removed and replaced by new deposits. After the age of 40, however, bone is removed from the inside medullary cavities more rapidly than it is deposited on the outside, periosteal surfaces of expanding human bone (*14*). Thus, bone loss with age is caused by a speeding resorption of bone, both from within the shafts and also from the trabecular bone in such areas as the neck of the femur, without a corresponding rise in the

formation of new bone. The bone that exists is normal in quality, but progressively diminishes in total amount and becomes less able to withstand physical stresses.

In addition to accelerating with age, bone loss proceeds faster in women than in men and probably faster in whites than in blacks (*15*). This pattern coincides roughly with the frequency of hospital discharge rates for fractures presented earlier in this paper.

Since bone loss is so universal with advancing age, we may feel little justification for regarding osteoporosis as a disease (*12*). Whether we call it a disease or not, the condition nevertheless resembles the ambiguous state of pregnancy in that it significantly raises the use of health care and markedly increases the risk of impairment and death. What, then, are the current possibilities for slowing or preventing its progress?

Steps in Prevention and Control of Bone Loss

The possibilities of prevention and control of bone loss with age have been assessed in three major areas: (*a*) diet, particularly the intake of calcium, vitamin D, and fluoride, (*b*) physical activity, and (*c*) hormones. Let us briefly examine each possibility.

Dietary intake. In studies of persons with osteoporosis, most were found to have normal intakes of calcium and vitamin D (*16*). When these constituents are added to diets that already contain adequate amounts, the further loss of bone does not seem to decline. The additional intake of fluoride has not produced clear findings in animals. In North Dakota, however, Bernstein and co-workers found that women in an area with drinking water high in fluoride had less osteoporosis than those in a low fluoride area (*17*); men in the two areas showed little difference.

The possibility exists, but needs better documentation, that increased fluoride intake may slow bone loss—in women if not in men. Meanwhile, it is currently recommended in some medical textbooks and by many physicians that patients with osteoporosis be given high calcium diets. The prescription is based on hope more than on scientific evidence (*16*).

Physical activity. Both young and older persons lose bone when muscle activity is lowered by confinement to bed (*14*). The possibility is also debated that physical activity, greater in the black than the white population, may help to slow bone loss with advancing age. However, the effect of increased activity has not undergone controlled study for a period sufficiently long enough to assure that it retards the progress of osteoporosis. Nevertheless, the pervasive additional benefits of physical activity in middle and older ages perhaps justify its prescription even before the effect on osteoporosis is clearly established.

Hormones. Early removal of the ovaries in women is known to cause premature bone loss (*14*). Animal studies have documented that estrogens protect bone against resorption by the hormone that is produced by the parathyroid glands (*11*). These and other findings have helped convince many physicians that placing women on low and prolonged dosage of estrogen will be worthwhile (*18*). To date, however, we do not know the long-term health effects of estrogen therapy, the fifth most frequently prescribed drug in the United States. Early findings range from a likely rise in the incidence of endometrial cancer to the cheerful view of a possible protective effect against all causes of death. Obviously, women who have undergone hysterectomies form a group with less risk of adverse effects.

Fortunately, estrogen therapy is being studied more thoroughly and definitively, and clearer guidelines on its risk-benefit status are likely to emerge soon. Meanwhile, Meema and Meema (*19*) have suggested a cautious compromise—that X-rays of the radii to be used to detect women in their early sixties whose bone loss has progressed more rapidly than usual. They advocate estrogen therapy for such women to prevent further bone loss and to lower the subsequent incidence of fractures. Their data from a cohort of 82 postmenopausal women are sufficiently promising to justify the controlled study of preventive estrogen treatment (*20*). Meanwhile, to insure the informed consent of patients, the FDA now requires a package insert, warning consumers of the risk of endometrial cancer.

Conclusions

In the coming decades, women of middle and older ages may no longer accept as natural the widespread bone loss and accompanying fractures that occur so frequently after the late reproductive years. Although readily available, the data that document these changes have had little effect in enticing the interest of health care providers and younger patients. Some steps may now be available to slow the progress of this widespread but "uninteresting" condition; how-

ever, the preventive and control techniques need more systematic and prolonged study to insure that they do significantly more good than harm. It seems essential, therefore, to pursue these studies swiftly, in the hope that we may deliver the more definitive knowledge that will satisfy a probable future expansion of demand for health care at older ages.

References

1. Goggin, J. E., et al.: Incidence of femoral fractures in postmenopausal women before and after water fluoridation. Public Health Rep 80: 1005–1012, November 1965.
2. Baker, S. P.: Determinants of injury and opportunities for intervention. Am J Epidemiol 101: 98–102, February 1975.
3. Utilization of short-stay hospitals, by diagnosis: United States, 1972. Monthly Vital Statistics Reports 23: 1–7 (suppl.) July 9, 1974.
4. Utilization of short-stay hospitals, by diagnoses, United States, 1972. Monthly Vital Statistics Report 22: 1–7 (suppl.) Sept. 14, 1973.
5. Guralnick, L.: Short-stay hospital discharge diagnosis for Medicare patients, 1967. Health Insurance Stat 66: 1–30, Mar. 14, 1975.
6. Report on hospital in-patient enquiry for the year 1972: Pt. I. Tables. Department of Health and Social Security and Office of Population Censuses and Surveys, Her Majesty's Stationery Office, London, 1974.
7. Haddon, W., Jr.: The prevention of accidents. *In* Textbook of preventive medicine, edited by D. W. Clark and B. MacMahan. Little, Brown and Company, Boston, 1967.
8. Statistical tables supplementing the annual report of the Saskatchewan Hospital Services Plan, 1966. Department of Public Health, Regina, Saskatchewan, 1967.
9. Statistical tables supplementing the annual report of the Saskatchewan Hospital Services Plan, 1967. Department of Public Health, Regina, Saskatchewan, 1968.
10. Statistical tables supplementing the annual report of the Saskatchewan Hospital Services Plan, 1968. Department of Public Health, Regina, Saskatchewan, 1969.
11. Dequeker, J.: Bone and ageing. Ann Rheum Dis 34: 100–115, February 1975.
12. Newton-John, H. F., and Morgan, D. B.: Osteoporosis: Disease or senescence? Lancet 1: 232–233, Feb. 3, 1968.
13. Garn, S. M.: Rohman, C. G., and Wagner, B.: Bone loss as a general phenomenon in man. Federation Proc 26: 1729–1736, November–December 1967.
14. Garn, S. M.: Bone loss and aging. *In* Physiology and pathology of human aging. Edited by M. Rockstein. Academic Press, 1975, New York City, pp. 39–87.
15. Garn, S. M.: The course of bone gain and the phases of bone loss. Orthop Clin North Am 3: 503–520, November 1972.
16. Garn, S. M.: Adult bone loss. Fracture epidemiology and nutritional implications. Nutrition 27: 107–115, April 1973.
17. Bernstein, D. S., et al: Prevalence of osteoporosis in high- and low-fluoride areas in North Dakota. JAMA 198: 499–504, Oct. 31, 1966.
18. Exton-Smith, A. N.: Bone aging and metabolic bone disease. *In* Textbook of geriatric medicine and gerontology, edited by J. C. Brocklehurst. Churchill Livingston, Edinburgh and London, 1973.
19. Meema, H. E., and Meema, S.: Involutional (physiologic) bone loss in women and the feasibility of preventing structural failure. J Am Geriat Soc 22: 443–452, October 1974.
20. Meema, S., Bunker, M. L., and Meema, H. E.: Preventive effect of estrogen on postmenopausal bone loss: A followup study. Arch Intern Med 135: 1436–1440, November 1975.

SYNOPSIS

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The epidemiology of serious fractures in adults relates less to the frequency of forceful accidents and more directly to the loss of bone in middle-aged and older people. To support this statement, hospital discharge rates for fractures in recent years are examined from different geographic areas.

Rates for the United States rise with age, so that serious fractures form 10 percent of all hospital discharges at 85 years and older. Saskatchewan data suggest that rates for men remain low until 60 years; for women the figures began to rise at 45 years, before many had reached the menopause. Rates are lower among women than men in Saskatchewan until around 50 years, surpassing those of men at age 55 and older.

Among Medicare enrollees in 1967 in the United States, women had higher discharge rates for fractures than men of the same age and race. Whites also had higher rates than blacks, so much so that white males had higher rates than black women of the same age. Such data confirm the past impression that blacks who survive into the older ages are a biological elite, more able to maintain bone strength than whites of either sex, although by no means being exempt from bone loss with age.

A fractured femur was the most frequent diagnosis, forming a higher percentage of all fractures in women than men, and rising steeply with age in both sexes. The pattern of fractures by sex differs from the epidemiology of forceful accidents, which more often involve men than women. Bone loss with age, or osteoporosis, is perhaps the most powerful host factor to dominate the picture of fractures in the elderly. The existing possibilities for preventing or slowing this change are thus assessed; women may no longer accept as natural the widespread bone loss and accompanying fractures that lower the quality of life in later years.