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DISORDERS OF THE DIGESTIVE-SYSTEM IN THE ELDERLY

Robert D. Shamburek
Virginia Commonwealth University

John T. Farrar
Hunter Holmes McGuire

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GERIATRICS

DISORDERS OF THE DIGESTIVE SYSTEM IN THE ELDERLY

ROBERT D. SHAMBUREK, M.D.,
AND JOHN T. FARRAR, M.D.

CHANGES in the anatomy and physiology of the epithelium of the digestive organs because of aging are slight.[1] The functional capacity of both the secretory and absorptive cells of the gut is so great that a decrease to as little as 5 to 10 percent of normal function is required for a clinical effect to be evident. In contrast to the epithelial-cell reserve, connective-tissue changes are manifested in midlife, and age-related changes in these tissues are responsible for many digestive disorders, such as colonic vascular ectasias and diverticula of the gut.

The anatomical and physiologic changes that do occur in the elderly may be due to the vicissitudes of life (intercurrent disease or the effects of the environment, nutrition, alcohol, tobacco, or other drugs) or to specific disease rather than to aging alone. The decreased effectiveness of the immune system in the elderly[2] may influence the course of diseases of the gastrointestinal tract. The number of antibodies to foreign antigens decreases with aging, whereas the number of autoantibodies increases.[3] Alterations in T-cell function occur more frequently than changes in B-cell function in the elderly.[3] Little is known about how such immunologic changes affect the course of specific diseases of the digestive system.

The polypharmacy that is common among the elderly[4] complicates the evaluation and treatment of digestive disorders in these patients. The indiscriminate and inappropriate use of medications to treat gastrointestinal disorders should be avoided in order to prevent some of the adverse reactions, such as delirium from cimetidine, constipation from iron supplements and aluminum-containing antacids, and diarrhea from magnesium-containing antacids and prostaglandin analogues.[4,5]

This review will consider some of the age-related changes of the digestive organs and some of the diseases to which the elderly are particularly vulnerable. Neoplasms will not be discussed.

OROPHARYNX

The number of acinar cells of the salivary glands is decreased in the elderly.[6] However, the decrease in the rate of salivary flow, both stimulated and unstimulated, is slight, depending on the stimulus and method of collection.[7] Major decreases in salivary flow and xerostomia are more likely to be due to systemic illness or concomitant medications than to aging itself.[8]

The number of taste buds varies widely from person to person but does not decline with age.[9] The thresholds of taste detection are slightly raised in the elderly, but this does not alter the perception of taste, since most food provides stimuli far above the threshold. Age-related changes in the olfactory system may account for some of the reported decrease in taste perception.[10] However, the perceived flavor of food is influenced by many other factors, including the integration of the central nervous system, medication, nutrition, and oral hygiene.

Disorders of swallowing are very common in the elderly and result in increased morbidity and mortality from malnutrition and aspiration pneumonia. Aging itself causes a progressive slowing of the caudad movement of a bolus in the oropharynx,[11] but this change does not usually cause symptoms. Many neurologic and muscular diseases, such as Parkinson's disease, stroke, diabetic neuropathy, and polymyositis, affect the oropharynx and result in dysphagia.

ESOPHAGUS

Presbyesophagus is the term coined by Soergel et al. in a study describing the esophageal dysfunction attributed to aging.[12] Many of the patients included in that study had neurologic disorders, including diabetes mellitus, that may have caused alterations in esophageal manometry. Subsequent studies of the esophagus in the elderly have revealed only mild manometric changes, including a decrease in the amplitude of contractions, a slight increase in the number of disordered contractions in the body of the esophagus, and a decrease in the regularity with which primary peristaltic waves occur after a swallow.[1,13,14] However, these age-related changes are usually asymptomatic. Very little is known about the effect of aging on gastroesophageal reflux.

STOMACH AND DUODENUM

Basal and maximal gastric-acid output decreases with aging.[15] These decreases correlate closely with the increased prevalence of the continuum of conditions ranging from superficial gastritis to atrophic gastritis to gastric atrophy.[16,17] Whether age-related de-

From the Division of Gastroenterology of the Department of Medicine, Medical College of Virginia, Virginia Commonwealth University, and Hunter Holmes McGuire Department of Veterans Affairs Medical Center, all in Richmond. Address reprint requests to Dr. Farrar at Hunter Holmes McGuire Department of Veterans Affairs Medical Center, 1201 Broad Rock Blvd., Richmond, VA 23249.

creases in gastric-acid secretion occur in the absence of histologic changes in the gastric mucosa is not known.

Over the past 20 years, the incidence of peptic ulcers requiring hospitalization or surgery and the mortality from such ulcers have decreased in all age groups except the elderly,[18,19] among whom hemorrhage from gastric ulcers accounts for many of the hospitalizations. An increased incidence of gastric ulcers is particularly striking in women over 65 years of age[20,21] but has also been noted in men over 85 years of age.[19] The rate of duodenal ulcer disease does not increase correspondingly with age in the United States.

Melena is the most frequent presenting symptom of peptic ulcer in the elderly.[22] Epigastric pain occurs in less than half of the persons who present with melena, and in one series[23] many patients were asymptomatic before they were found to have a hemorrhage or perforation that ultimately proved fatal.

Nonsteroidal antiinflammatory drugs have been implicated as a cause of the increased morbidity and mortality from painless bleeding or perforated gastric ulcers[24,25] in the elderly, although this association remains controversial.[26] Of the patients who regularly consume these drugs for arthritis and other chronic pain syndromes, between 40 and 50 percent are over the age of 60.[24,25] At least 25 percent of the upper gastrointestinal bleeding in the elderly is associated with the use of the drugs, with an associated mortality rate of 10 percent or higher.[27] Misoprostol, a synthetic prostaglandin analogue, has recently been shown to be effective in reducing the incidence of gastric ulcers induced by nonsteroidal antiinflammatory drugs over a three-month period.[28] Long-term studies of misoprostol and its effect on the rate of complications from such ulcers are pending.

Helicobacter pylori, a bacterium heretofore considered quite benign, has recently been suspected as a cause of gastritis and peptic ulcers.[29] The prevalence of *H. pylori* rises with age and correlates strongly with the presence of acute and chronic gastritis. Antibodies to *H. pylori* occur in more than half of Americans over 60,[30] and the organism has been isolated from the stomach in over 80 percent of those in this age group.[31] In persons between 20 and 39 years of age, the prevalence of antibodies is under 10 percent, and *H. pylori* is present in 24 percent. The age-related increase of the population of *H. pylori* may represent a secondary colonization of the mucosa due to decreased gastric acidity or to damaged mucosa.[32] However, the strong association of *H. pylori* with acute and chronic gastritis, especially in the antrum, supports the theory of a causal relation rather than simple colonization. Despite the association of the bacterium with duodenal ulcers in the majority of persons and with gastric ulcers in up to 75 percent,[29] the classic factors in the pathogenesis of peptic ulcer (increased acid output, decreased mucosal resistance, nonsteroidal antiinflammatory drugs, and other drugs) are still important. Further studies establishing *H. pylori* as a causal factor in the pathogenesis of gastritis and duodenal ulcer will have an important effect on treatment and prevention.

The use of partial gastrectomy as a treatment for peptic ulcer has decreased over the past decade, partly because of the availability of effective agents to reduce gastric acidity. However, the long-term consequences of gastric surgery can show up in elderly patients who had surgery decades earlier. One such consequence is carcinoma of the stomach. Patients who have been followed for more than 20 years after a partial gastrectomy have an increased incidence of stomach cancer. This risk is four times higher after a Billroth II resection than after a Billroth I.[33,34]

Pancreas

Despite the infiltration of fat and fibrous tissue in the pancreas in the elderly, serious pancreatic exocrine dysfunction does not occur more commonly in the aged. The great reserve capacity of the secretory cells in the pancreas prevents the impairment of digestion with aging.[35]

Gallbladder and Biliary Tract

The true incidence of cholelithiasis in different age groups is unknown, but clearly the prevalence of gallstones rises with age. Gallstones occur more frequently in women of all ages than in men, and in the United States they are formed predominantly of cholesterol. It is attractive to attribute the formation of these stones in the elderly to increased hepatic secretion of cholesterol and decreased hepatic synthesis of bile acid, both of which occur with aging[36,37] and contribute to the production of lithogenic bile. However, these secretory changes do not account for the predominance of gallstones among women. Pigmented stones occur equally in men and women,[38] and their numbers increase substantially with age, particularly in patients over 70 years old.[39] When one considers all gallstones, both the pigmented type and those made of cholesterol, only approximately 15 percent of patients proved to have stones ever have symptoms[40] attributable to them.

In the elderly, biliary disease is associated with a higher mortality and a higher rate of complications than are seen in younger patients.[41,42] The clinical presentation is similar to that seen in younger patients, but frequently the symptoms do not correlate well with the severity of the biliary disease.[41,42] For instance, elderly patients with suppurative and gangrenous cholecystitis may present with deceptively benign symptoms.

Early surgery for symptomatic cholelithiasis is desirable in the elderly. Elective surgery has a mortality rate of 1.7 percent, as compared with 11 percent for emergency or urgent surgery.[41] Many authors have testified to the safety and efficacy of cholecystectomy in the elderly.[42,43]

The nonsurgical treatment of gallstones with chemolytic agents such as chenodiol and ursodiol, endo-

scopic sphincterotomy with basket retrieval, percutaneous transhepatic dissolution,[44] and extracorporeal shock-wave lithotripsy[45,46] have not yet had a long enough follow-up to permit firm indications for their use. It seems likely that several of these nonoperative forms of therapy will be very useful in such select groups of patients as the frail elderly.

Stones in the common bile duct, in the United States almost always originating in the gallbladder, are increasingly prevalent in the elderly, with or without symptoms.[47] Elderly patients who retain a stone after cholecystectomy and later have cholangitis or a stricture have a mortality rate of 20 percent.[47,48]

Surgery for stones in the common bile duct is not without its mortality, and nonsurgical measures are preferable. Endoscopic sphincterotomy to remove the stone before cholecystectomy in one series of patients over the age of 75 reduced the mortality rate to that of simple cholecystectomy without common-bile-duct stones.[49] This preoperative measure also obviated the need for intraoperative cholangiography. Preoperative endoscopic sphincterotomy is probably indicated only in the frail elderly and others deemed to be poor surgical risks.

Acalculous cholecystitis accounts for only a small percentage of the cases of cholecystitis (under 10 percent) in all age groups, but the percentage increases substantially in patients over 60 years old. Prompt diagnosis is important, because 40 to 100 percent of such patients have empyema, gangrene, or perforation of the gallbladder at the time of surgery.[50] Unexplained fever was the initial symptom in 25 percent of one series of elderly patients with acalculous cholecystitis.[50]

Liver

With age, the volume of the liver decreases. Similarly, the blood flow to the liver decreases with age on the order of 1 percent per year. The resulting decrease in perfusion of the hepatocytes may result in alterations in the clearance of many drugs that are metabolized in the liver.[51,52] Such metabolism usually occurs by two general mechanisms: microsomal oxidation and hydrolysis on the one hand, and conjugation with glucuronic acid or other moieties on the other. The former are impaired more consistently in the elderly than the latter,[52] although formal studies of drug elimination often yield unpredictable results. Since the hepatic clearance and metabolism of some drugs are decreased with age,[4] the best rule is to use smaller doses of any drug in older patients.

Serum albumin levels decline only 0.54 g per liter per decade.[53] Decreased serum albumin levels and other signs of malnutrition should not be attributed to normal aging. Mean serum alkaline phosphatase[54] and serum amylase levels[55] increase slightly in healthy persons over the age of 60, approaching the upper limits found in younger persons. The increase in the amylase level results in part from the age-related decline in renal function.[55] The results of other clinical assays for hepatic enzymes and tests of synthetic function have not been shown to be affected substantially by aging.

The precise immunologic response of the liver to the aging process is unknown, but it is likely that such changes occur and are important in altering the clinical course of infectious and inflammatory disorders. Acute viral hepatitis B in the elderly is often characterized pathologically by milder liver-cell necrosis than that found in younger patients.[56] This finding has been attributed to a diminished immune response. A cholestatic pattern may be present at any age, but in the elderly the serum bilirubin and alkaline phosphatase levels are higher[56] than in younger patients. Additional differences between older and younger patients that may be due to decreased effectiveness of the immune system include the facts that the mortality from fulminant hepatitis B is much higher in the elderly[57] and that the numbers of carriers of subclinical hepatitis B are increased among the elderly at institutions in which there is a high prevalence of hepatitis B e antigen.[58] The persistence of this antigen reflects continued viral replication, a high rate of infectivity, and an inability to eradicate the infection.

The clinical features of primary biliary cirrhosis are similar in all age groups, but some differences are noted in the elderly. A higher proportion of elderly patients have asymptomatic disease. In addition, symptomatic elderly patients have less severe symptoms, fewer physical signs, and a serum bilirubin level that rises more slowly than in younger patients.[59] The overall liver-related mortality from primary biliary cirrhosis does not appear to increase in the elderly.

Alcoholic liver disease remains a major problem despite the current decrease in alcohol consumption in the elderly.[60] In patients over the age of 60, alcoholic cirrhosis carries a one-year mortality of 50 percent, appreciably higher than in younger patients.[61]

Small Intestine and Colon

Idiopathic Inflammatory Bowel Disease

Idiopathic inflammatory bowel disease accounts for 5 to 10 percent of all cases of inflammatory bowel disease after the age of 65.[62] The constellation of symptoms in the elderly on presentation is similar to that in younger patients, but they are often mistaken for symptoms of diverticular disease, infectious diarrhea, or ischemic colitis, with consequent delays in diagnosis and treatment.[63,64] Some authors have reported that there are fewer palpable masses, less pain, and increased rectal bleeding in the elderly with Crohn's disease.[64] The consensus among most authors, however, is that there are no major differences between elderly and younger patients with respect to the symptoms or site of occurrence of Crohn's disease.[65] Whether the symptoms of ulcerative colitis differ in the elderly is also questionable, but one study has shown that elderly patients may have more diarrhea and weight loss, with a higher incidence of left-sided disease.[66]

Whether age alters the natural history of idiopathic inflammatory bowel disease remains controversial.

Some authors report a prognosis similar to that in the younger patient,[67,68] whereas others[69,70] report a much worse prognosis. Surgical morbidity and mortality in patients with Crohn's disease are increased in the elderly,[70] but this may be related to concomitant disease. In patients with longstanding ulcerative colitis, the risk of colon cancer is independent of the age at onset and appears to correlate best with the total duration of the disease.[71,72]

In summary, the features of idiopathic inflammatory bowel disease are not substantially different in the elderly, as was once thought. In any elderly patient presenting with abdominal pain, diarrhea, weight loss, or hematochezia, idiopathic inflammatory bowel disease should be considered.

Appendicitis

The incidence of acute appendicitis decreases with aging, but patients more than 60 years old still account for approximately 7 percent of the total cases.[73] The mortality rate in patients with appendicitis who are older than 80 is 23 percent.[74,75] The earlier view of an atypical presentation in the elderly (one with absent or very subtle signs and symptoms) has been sharply contested.[73,75,76] The higher mortality from appendicitis in elderly patients is now attributed to a delay in their seeking medical care, concomitant medical problems, and a faster progression of the disease to perforation of the appendix and peritonitis.[73-76] Decreased vascularity, thinning of the mucosa, fibrosis of the musculature, fatty infiltration of the wall, and luminal narrowing have all been reported on pathological examination of the appendix in the elderly.[77] These findings have been used to explain the fast progression of inflammation, resulting in earlier perforation and the formation of abscesses. The incidence of perforation in the elderly ranges from 32 percent to 77 percent.[73-76] Early surgical intervention remains the best means of reducing morbidity and mortality.

Diverticulosis

The incidence of colonic diverticula in Western society increases progressively with age,[78,79] rising from 5 percent among persons in the fifth decade to 50 percent in the ninth decade.

The pathogenesis of these pseudodiverticula, which are herniations through the tunica muscularis, is unknown, although for some years it was believed that they were caused by disturbances in the smooth-muscle function of the colon. The theory was that the low-fiber diet in Western society resulted in low bulk in the colon and that the narrow lumen caused increased pressure on the wall of the colon, until eventually a diverticulum formed. This theory still has appeal, but no solid proof has been forthcoming. It seems possible that a high-fiber diet may prevent the formation of diverticula, and certainly little is lost by increasing the amount of dietary fiber to 30 or 40 g per day. With regard to preventing constipation, possibly preventing diverticulosis, and conceivably reducing the risk of colon cancer, much may be gained from following a high-fiber diet.

The most reasonable theory for the formation of diverticula in the colon is that the normal intraluminal pressure causes herniation of the mucosa through gaps in the muscularis that are protected only by fibrous tissue. With age, this tissue and its principal protein, collagen, become less elastic and allow pseudodiverticula to form.

Constipation

Constipation is a common symptom in the elderly, with a slight predominance among women.[80] A variety of subjective criteria have been used to define constipation, including hard stools, small-caliber stools, straining, infrequent defecation, and incomplete evacuation. However, these subjective definitions overestimate the occurrence of constipation when they are compared with the definition of less than three bowel movements per week that is frequently used by physicians.[81] The prevalence of constipation increases in the elderly; it may be multifactorial and related to a diet low in fiber, sedentary habits, medications, and a variety of disease processes that impair neural and motor control. Excess endogenous opioid activity in the colon[82] and impairment of the rectal perception of the presence of feces[83,84] are among the physiologic alterations that may contribute to constipation. Normal aging slightly decreases the force of smooth-muscle contractions in the gut. Whether these changes contribute to constipation is not clear.

Fecal impaction is a common consequence of constipation because of impairment of rectal sensation and abnormalities of motor function related to drugs or disease.[5,82] Institutionalized persons with neurologic impairment and persons with chronic renal failure or cancer are at highest risk of fecal impaction.

Fecal incontinence occurs most commonly in elderly patients in hospitals and nursing homes as a result of several mechanisms. Decreased sphincter tone or an increase in the liquidity of stools as in diarrhea are common causes of incontinence. Cognitive impairment as a result of dementia or drugs and lack of access to toilet facilities are potentially reversible causes. Overflow incontinence resulting from fecal impaction is the most common type in the elderly. Fecal incontinence causes social isolation and physical dependence, in addition to the common sequelae of decubitus ulcers and urinary tract infections.

Vascular Ectasia

Vascular ectasias are a common cause of bleeding from the cecum and the proximal ascending colon in the elderly, which presents as a chronic anemia or an acute, intermittent lower intestinal hemorrhage.[85] The diagnosis is frequently overlooked by pathologists, endoscopists, and surgeons because of the focal distribution and small size of the lesions. Selective angiography is often helpful in identifying the bleeding lesions, but coexistent lesions within the gastrointestinal tract must be excluded. The cause of vascular ectasias

remains controversial, with theories ranging from chronic intermittent low-grade obstruction of the submucosal veins[85] to mucosal ischemia that results in chronic submucosal arteriovenous shunting.[86] Recently, investigators have questioned the association between vascular ectasias and aortic stenosis.[87] Regardless of the cause, vascular ectasias appear to be acquired degenerative lesions associated with aging.

Conclusion

Age-related changes in the gastrointestinal tract are difficult to differentiate from changes that are induced genetically, geographically, or environmentally (by toxins or medications). The clinical picture of most gastrointestinal disorders in the elderly does not differ substantially from that in younger patients. Diagnosis can be delayed in the elderly because of the absence or blunting of symptoms or because benign symptoms can mask a clinical course that proceeds more rapidly than expected. Such delays and the concomitant medical problems, coupled with the tendency of many elderly patients to delay seeking medical care, contribute to increased morbidity and mortality. The treatment of some disorders is less satisfactory in the elderly because of preexisting cardiovascular disease, diabetes, osteoporosis, or polypharmacy.

References

1. Shamburek RD, Scott RB, Farrar JT. Gastrointestinal and liver changes. In: Katlic MR, ed. Geriatric surgery: comprehensive care of the elderly patient. Baltimore: Urban & Schwarzenberg (in press).
2. Schmucker DL, Daniels CK. Aging, gastrointestinal infections, and mucosal immunity. J Am Geriatr Soc 1986; 34:377-84.
3. Schwab R, Walters CA, Weksler ME. Host defense mechanisms and aging. Semin Oncol 1989; 16:20-7.
4. Montamat SC, Cusack BJ, Vestal RE. Management of drug therapy in the elderly. N Engl J Med 1989; 321:303-9.
5. Wrenn K. Fecal impaction. N Engl J Med 1989; 321:658-62.
6. Scott J. Quantitative age changes in the histological structure of human submandibular salivary glands. Arch Oral Biol 1977; 22:221-7.
7. Baum BJ. Salivary gland fluid secretion during aging. J Am Geriatr Soc 1989; 37:453-8.
8. Thorselius I, Emilson CG, Osterberg T. Salivary conditions and drug consumption in older age groups of elderly Swedish individuals. Gerodontics 1988; 4:66-70.
9. Bradley RM. Effects of aging on the anatomy and neurophysiology of taste. Gerodontics 1988; 4:244-8.
10. Chauhan J, Hawrysh ZJ, Gee M, Donald EA, Basu TK. Age-related olfactory and taste changes and interrelationships between taste and nutrition. J Am Diet Assoc 1987; 87:1543-50.
11. Sonies BC, Parent LJ, Morrish K, Baum BJ. Durational aspects of the oral-pharyngeal phase of swallow in normal adults. Dysphagia 1988; 3:1-10.
12. Soergel KH, Zboralske FF, Amberg JR. Presbyesophagus: esophageal motility in nonagenarians. J Clin Invest 1964; 43:1472-9.
13. Hollis JB, Castell DO. Esophageal function in elderly men: a new look at "presbyesophagus." Ann Intern Med 1974; 80:371-4.
14. Khan TA, Shragge BW, Crispin JS, Lind JF. Esophageal motility in the elderly. Am J Dig Dis 1977; 22:1049-54.
15. Steinheber FU. Ageing and the stomach. Clin Gastroenterol 1985; 14:657-88.
16. Kekki M, Samloff IM, Ihamaki T, Varis K, Siurala M. Age- and sex-related behaviour of gastric acid secretion at the population level. Scand J Gastroenterol 1982; 17:737-43.
17. Ihamaki T, Saukkonen M, Siurala M. Long-term observation of subjects with normal mucosa and with superficial gastritis: results of 23–27 years' follow-up examinations. Scand J Gastroenterol 1978; 13:771-5.
18. Sonnenberg A. Changes in physician visits for gastric and duodenal ulcer in the United States during 1958–1984 as shown by National Disease and Therapeutic Index (NDTI). Dig Dis Sci 1987; 32:1-7.
19. Kurata JH, Corboy ED. Current peptic ulcer time trends: an epidemiological profile. J Clin Gastroenterol 1988; 10:259-68.
20. Walt R, Katschinski B, Logan R, Ashley J, Langman M. Rising frequency of ulcer perforation in elderly people in the United Kingdom. Lancet 1986; 1:489-92.
21. Kurata JH, Haile BM, Elashoff JD. Sex differences in peptic ulcer disease. Gastroenterology 1985; 88:96-100.
22. Permutt RP, Cello JP. Duodenal ulcer disease in the hospitalized elderly patient. Dig Dis Sci 1982; 27:1-6.
23. Pounder R. Silent peptic ulceration: deadly silence or golden silence? Gastroenterology 1989; 96:Suppl:626-31.
24. Barrier CH, Hirschowitz BI. Controversies in the detection and management of nonsteroidal antiinflammatory drug-induced side effects of the upper gastrointestinal tract. Arthritis Rheum 1989; 32:926-32.
25. Fries JF, Miller SR, Spitz PW, Williams CA, Hubert HB, Bloch DA. Toward an epidemiology of gastropathy associated with nonsteroidal antiinflammatory drug use. Gastroenterology 1989; 96:Suppl:647-55.
26. Langman MJ. Epidemiologic evidence on the association between peptic ulceration and antiinflammatory drug use. Gastroenterology 1989; 96: Suppl:640-6.
27. Langman MJ. Ulcer complications and nonsteroidal anti-inflammatory drugs. Am J Med 1988; 84:Suppl 2A:15-9.
28. Soll AH, Kurata J, McGuigan JE. Ulcers, nonsteroidal antiinflammatory drugs, and related matters. Gastroenterology 1989; 96:Suppl:561-8.
29. Graham DY. *Campylobacter pylori* and peptic ulcer disease. Gastroenterology 1989; 96:Suppl:615-25.
30. Perez-Perez GI, Dworkin BM, Chodos JE, Blaser MJ. *Campylobacter pylori* antibodies in humans. Ann Intern Med 1988; 109:11-7.
31. Graham DY, Klein PD, Opekun AR, Boutton TW. Effect of age on the frequency of active *Campylobacter pylori* infection diagnosed by the [13C]urea breath test in normal subjects and patients with peptic ulcer disease. J Infect Dis 1988; 157:777-80.
32. Blaser MJ. Gastric Campylobacter-like organisms, gastritis, and peptic ulcer disease. Gastroenterology 1987; 93:371-83.
33. Caygill CPJ, Hill MJ, Kirkham JS, Northfield TC. Mortality from gastric cancer following gastric surgery for peptic ulcer. Lancet 1986; 1:929-31.
34. Lundegårdh G, Adami H-O, Helmick C, Zack M, Meirik O. Stomach cancer after partial gastrectomy for benign ulcer disease. N Engl J Med 1988; 319:195-200.
35. Gullo L, Ventrucci M, Naldoni P, Pezzilli R. Aging and exocrine pancreatic function. J Am Geriatr Soc 1986; 34:790-2.
36. Einarsson K, Nilsell K, Leijd B, Angelin B. Influence of age on secretion of cholesterol and synthesis of bile acids by the liver. N Engl J Med 1985; 313:277-82.
37. Valdivieso V, Palma R, Wunkhaus R, Antezana C, Severin C, Contreras A. Effect of aging on biliary lipid composition and bile acid metabolism in normal Chilean women. Gastroenterology 1978; 74:871-4.
38. Soloway RD, Trotman BW, Ostrow JD. Pigment gallstones. Gastroenterology 1977; 72:167-82.
39. Trotman BW, Soloway RD. Pigment vs cholesterol cholelithiasis: clinical and epidemiological aspects. Am J Dig Dis 1975; 20:735-40.
40. McSherry CK, Ferstenberg H, Calhoun WF, Lahman E, Virshup M. The natural history of diagnosed gallstone disease in symptomatic and asymptomatic patients. Ann Surg 1985; 202:59-63.
41. Harness JK, Strodel WE, Talsma SE. Symptomatic biliary tract disease in the elderly patient. Am Surg 1986; 52:442-5.
42. Margiotta SJ Jr, Horwitz JR, Willis IH, Wallack MK. Cholecystectomy in the elderly. Am J Surg 1988; 156:509-12.
43. Gutman H, Kott I, Haddad M, Reiss R. Changing trends in surgery for benign gallbladder disease. Am J Gastroenterol 1988; 83:545-8.
44. Thistle JL, May GR, Bender CE, et al. Dissolution of cholesterol gallbladder stones by methyl *tert*-butyl ether administered by percutaneous transhepatic catheter. N Engl J Med 1989; 320:633-9.
45. Sauerbruch T, Stern M. Fragmentation of bile duct stones by extracorporeal shock waves: a new approach to biliary calculi after failure of routine endoscopic measures. Gastroenterology 1989; 96:146-52.
46. Sackmann M, Delius M, Sauerbruch T, et al. Shock-wave lithotripsy of gallbladder stones: the first 175 patients. N Engl J Med 1988; 318:393-7.
47. Johnson AG, Hosking SW. Appraisal of the management of bile duct stones. Br J Surg 1987; 74:555-60.
48. Houghton PW, Jenkinson LR, Donaldson LA. Cholecystectomy in the elderly: a prospective study. Br J Surg 1985; 72:220-2.
49. Duron JJ, Roux JM, Imbaud P, Dumont JL, Dutet D, Validire J. Biliary lithiasis in the over seventy-five age group: a new therapeutic strategy. Br J Surg 1987; 74:848-9.
50. Johnson LB. The importance of early diagnosis of acute acalculus cholecystitis. Surg Gynecol Obstet 1987; 164:197-203.
51. Wynne HA, Cope LH, Mutch E, Rawlins MD, Woodhouse KW, James OF. The effect of age upon liver volume and apparent liver blood flow in healthy man. Hepatology 1989; 9:297-301.
52. Greenblatt DJ, Sellers EM, Shader RI. Drug disposition in old age. N Engl J Med 1982; 306:1081-8.
53. Campion EW, deLabry LO, Glynn RJ. The effect of age on serum albumin in healthy males: report from the Normative Aging Study. J Gerontol 1988; 43:M18-M20.
54. Reichling JJ, Kaplan MM. Clinical use of serum enzymes in liver disease. Dig Dis Sci 1988; 33:1601-14.
55. Segawa K, Nakazawa S, Yamao K, et al. Age and sex-dependent changes in serum amylase in an apparently healthy population. Am J Gastroenterol 1989; 84:514-6.

56. Zauli D, Crespi C, Fusconi M, Bonazzi L, Bianco Bianchi F, Pisi E. Different course of acute hepatitis B in elderly adults. J Gerontol 1985; 40: 415-8.
57. Bernuau J, Goudeau A, Poynard T, et al. Multivariate analysis of prognostic factors in fulminant hepatitis B. Hepatology 1986; 6:648-51.
58. Chiaramonte M, Floreani A, Naccarato R. Hepatitis B virus infection in homes for the aged. J Med Virol 1982; 9:247-55.
59. Lehmann AB, Bassendine MF, James OF. Is primary biliary cirrhosis a different disease in the elderly? Gerontology 1985; 31:186-94.
60. Scott RB, Mitchell MC. Aging, alcohol, and the liver. J Am Geriatr Soc 1988; 36:255-65.
61. Potter JF, James OF. Clinical features and prognosis of alcoholic liver disease in respect of advancing age. Gerontology 1987; 33:380-7.
62. Holt PR. The small intestine. Clin Gastroenterol 1985; 14:689-723.
63. Foxworthy DM, Wilson JA. Crohn's disease in the elderly: prolonged delay in diagnosis. J Am Geriatr Soc 1985; 33:492-5.
64. Harper PC, McAuliffe TL, Beeken WL. Crohn's disease in the elderly: a statistical comparison with younger patients matched for sex and duration of disease. Arch Intern Med 1986; 146:753-5.
65. Shapiro PA, Peppercorn MA, Antoniolo DA, Joffe N, Goldman H. Crohn's disease in the elderly. Am J Gastroenterol 1981; 76:132-7.
66. Zimmerman J, Gavish D, Rachmilewitz D. Early and late onset ulcerative colitis: distinct clinical features. J Clin Gastroenterol 1985; 7:492-8.
67. Gupta S, Saverymuttu SH, Keshavarzian A, Hodgson HJ. Is the pattern of inflammatory bowel disease different in the elderly? Age Ageing 1985; 14:366-70.
68. Softley A, Myren J, Clamp SE, Bouchier IA, Watkinson G, de Dombal FT. Inflammatory bowel disease in the elderly patient. Scand J Gastroenterol Suppl 1988; 144:27-30.
69. Brandt LJ, Boley SJ, Mitsudo S. Clinical characteristics and natural history of colitis in the elderly. Am J Gastroenterol 1982; 77:382-6.
70. Rusch V, Simonowitz DA. Crohn's disease in the older patient. Surg Gynecol Obstet 1980; 150:184-6.
71. Albert MB, Nochomovitz LE. Dysplasia and cancer surveillance in inflammatory bowel disease. Gastroenterol Clin North Am 1989; 18:83-97.
72. Collins RH Jr, Feldman M, Fordtran JS. Colon cancer, dysplasia, and surveillance in patients with ulcerative colitis: a critial review. N Engl J Med 1987; 316:1654-8.
73. Lau WY, Fan ST, Yiu TF, Chu KW, Lee JM. Acute appendicitis in the elderly. Surg Gynecol Obstet 1985; 161:157-60.
74. Smithy WB, Wexner SD, Dailey TH. The diagnosis and treatment of acute appendicitis in the aged. Dis Colon Rectum 1986; 29:170-3.
75. Owens BJ, Hamit HF. Appendicitis in the elderly. Ann Surg 1978; 187:392-6.
76. Freund HR, Rubinstein E. Appendicitis in the aged: is it really different? Am Surg 1984; 50:573-6.
77. Thorbjarnarson B, Loehr WJ. Acute appendicitis in patients over the age of sixty. Surg Gynecol Obstet 1967; 1254:1277-80.
78. Thompson WG, Patel DG. Clinical picture of diverticular disease of the colon. Clin Gastroenterol 1986; 15:903-16.
79. Parks TG. Natural history of diverticular disease of the colon. Clin Gastroenterol 1975; 4:53-69.
80. Sonnenberg A, Koch TR. Physician visits in the United States for constipation: 1958 to 1986. Dig Dis Sci 1989; 34:606-11.
81. Whiteway J, Morson BC. Elastosis in diverticular disease of the sigmoid colon. Gut 1985; 26:258-66.
82. Szurszewski JH, Holt PR, Schuster M. Proceedings of a workshop entitled "Neuromuscular function and dysfunction of the gastrointestinal tract in aging." Dig Dis Sci 1989; 34:1135-46.
83. Read NW, Abouzekry L, Read MG, Howell P, Ottewell D, Donnelly TC. Anorectal function in elderly patients with fecal impaction. Gastroenterology 1985; 89:959-66.
84. Bannister JJ, Abouzekry L, Read NW. Effect of aging on anorectal function. Gut 1987; 28:353-7.
85. Boley SJ, Brandt LJ. Vascular ectasias of the colon — 1986. Dig Dis Sci 1986; 31:Suppl:26S-42S.
86. Baum S, Athanasoulis CA, Waltman AC, et al. Angiodysplasia of the right colon: a cause of gastrointestinal bleeding. AJR 1977; 129:789-94.
87. Imperiale TF, Ransohoff DF. Aortic stenosis, idiopathic gastrointestinal bleeding, and angiodysplasia: is there an association? A methodologic critique of the literature. Gastroenterology 1988; 95:1670-6.

DRUG THERAPY

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PROPHYLAXIS AND TREATMENT OF INFLUENZA

R. GORDON DOUGLAS, JR., M.D.

IT has been over 20 years since there has been a severe influenza pandemic. Nevertheless, influenza remains an important epidemic viral infection with the potential to return to its former magnitude.[1-4] The Centers for Disease Control documented 10,000 or more excess deaths in the United States in each of 19 epidemics from 1957 to 1986, and more than 40,000 deaths in several of them.[5] The major causes of death are pneumonia and the exacerbation of cardiopulmonary and other conditions,[6-10] and 80 to 90 percent of those who die are 65 years of age or older. In addition, substantial morbidity occurs almost every year, resulting in absenteeism from work and school, an increase in the number of visits to emergency rooms and physicians' offices and in the number of hospital admissions, and a concomitant rise in health care costs. Schoenbaum has estimated that the direct costs of influenza exceed $1 billion per year and may reach $3 to $5 billion.[11] Total costs may be two to three times higher.

Influenza virus infection produces an acute febrile infection of the respiratory tract characterized by abrupt onset, prominent myalgias, headache, and cough — findings that help distinguish it from other respiratory tract disorders. Pneumonia is the most frequent complication; it may be primary viral (due to direct viral invasion of lung parenchyma), secondary bacterial, or mixed viral and bacterial pneumonia. It may be severe and progressive or mild and segmental, not requiring hospitalization.[12] Other complications occur much less frequently and include Reye's syndrome in children from six months to 18 years of age (aspirin ingestion is also a risk factor), myocarditis, pericarditis, myositis (sometimes with myoglobinuria), Goodpasture's syndrome, encephalopathy, and transverse myelitis.

The influenza virus is medium sized, contains RNA, has an envelope, and is covered with surface projections, or "spikes."[13] These glycoprotein projections possess either hemagglutinin or neuraminidase activity and are the relevant antigens in host immunity. Internally, there are eight ribonucleoprotein complexes, each consisting of multiple copies of a single species of nucleoprotein, one molecule of viral RNA, and one or more copies of each of three polymerases. Each ribonucleoprotein complex contains one of eight RNA segments. The nucleoprotein and matrix (M1 and M2) proteins (associated with the viral envelope) possess type-specific antigenicity, which rarely varies and forms the basis for classification as influenza A and B

From the Department of Medicine, New York Hospital–Cornell University Medical College, 525 E. 68th St., New York, NY 10021, where reprint requests should be addressed to Dr. Douglas.