Fecal Incontinence: Epidemiology, Impact, and Treatment

Katarzyna Bochenska, MD¹ Anne-Marie Boller, MD²

¹Female Pelvic Medicine and Reconstructive Surgery, Department of Obstetrics and Gynecology, Northwestern University Feinberg School of Medicine, Chicago, Illinois

²Division of Gastrointestinal Surgery, Department of Surgery, Northwestern University Feinberg School of Medicine, Chicago, Illinois

Address for correspondence Katarzyna Bochenska, MD, Division of Female Pelvic Medicine and Reconstructive Surgery, Department of Obstetrics and Gynecology, Northwestern University Feinberg School of Medicine, Prentice Women's Hospital, 250 East Superior, Suite 05-2370, Chicago, IL 60611 (e-mail: kbochens@nm.org).

Clin Colon Rectal Surg 2016;29:264–270.

Abstract

Keywords

- fecal incontinence
- treatment
- anal sphincter repair

Fecal incontinence (FI) is a chronic and debilitating condition that carries a significant health, economic, and social burden. FI has a considerable psychosocial and financial impact on patients and their families. A variety of treatment modalities are available for FI including behavioral and dietary modifications, pharmacotherapy, pelvic floor physical therapy, bulking agents, anal sphincteroplasty, sacral nerve stimulation, artificial sphincters, magnetic sphincters, posterior anal sling, and colostomy.

Fecal incontinence (FI) is a chronic and debilitating condition that carries a significant health, economic, and social burden. A variety of treatment modalities for FI are available.

Definitions and Etiology

FI is the symptom of involuntary loss of feces which includes (a) solid feces; (2) liquid feces; (3) passive FI defined as soiling without sensation or warning or difficulty wiping clean; and (4) coital FI. Additionally, flatal incontinence is defined as the involuntary loss of flatus; and fecal urgency is a sudden compelling, difficult to defer desire to defecate.¹

The primary factors necessary for fecal continence are an enteric content that is substantially firm and bulky, a passively distensible reservoir which is capable of evacuation, and an effective barrier to outflow. Therefore, changes in the quantity or quality of stool presented to the sphincter, the inability of the rectum to accommodate stool, damage to the anal sphincter mechanism, or an impaired sensation can result in FI.² As a result, common etiologies of FI include diarrhea, decreased rectal compliance (i.e., ulcerative proctitis and radiation proctitis), anal sphincter damage (i.e., trauma, obstetrical injury, and surgery), decreased perception of rectal sensation (i.e., spinal cord injury, multiple sclerosis, and diabetes mellitus), and overflow incontinence secondary to

fecal retention and impaction. Other contributing factors may include psychosis with willful soiling, medication effects (i.e., laxatives, anticholinergics, antidepressants, and caffeine), and food intolerance (lactose, fructose, and sorbitol). It is also important to note that FI is often multifactorial and, thus, multiple conditions may be contributing to patients' symptoms.

Epidemiology

Accurate reporting of the incidence and prevalence of FI is challenging due to variations in the definitions of FI and the populations studied. Ng et al recently completed a systematic review on the prevalence of and factors associated with FI among community-dwelling adults. Across all 38 studies included in the review, the median prevalence of FI was 7.7%; however, this prevalence ranged from 2.0 to 20.7%. This wide range is reflective of the substantial heterogeneity of diagnostic criteria, population characteristics, and study design between the included studies. In this review, FI equally affected men (median, 8.1%; range, 2.3–16.1%) and women (median, 8.9%; range, 2.0–20.7%) and increased with age (15–34 years, 5.7%; >90 years, 15.9%).³ Similarly, Wu et al analyzed the National Health and Nutritional Examination Survey (NHANES) between 2005 and 2010 and identified a

population-based FI prevalence of 9.4% (95% confidence interval [CI]: 8.6, 10.2).⁴

Risk factors for developing FI include increasing age, obstetric factors, and medical comorbidities such as obesity and diabetes mellitus. Obstetric anal sphincter injury and operative vaginal delivery (forceps or vacuum) have been established as predisposing factors for FI.⁵⁻⁷ Rates of FI are also higher in obese patients compared with nonobese patients, and FI improved in patients following Roux-en-Y bypass.⁸ Additionally, FI rates are higher in patients with diabetes mellitus as compared with the general population.⁹

Institutionalized patients appear to be a particularly vulnerable population for the development of FI. In an observational study that included 5,560 Australian women aged 82 to 87 years, the prevalence of FI was significantly higher among institutionalized versus community-based women (14 vs. 10%).¹⁰ Similarly, Chassagne et al enrolled 1,186 patients 60 years of age and older who were living in long-term care facilities and did not have FI. Patients were followed for 10 months to determine the incidence of FI, defined as at least one involuntary loss of feces. FI occurred in 234 patients (20%), and was usually associated with acute diarrhea or fecal impaction. The authors identified five risk factors for the development of FI, including a history of urinary incontinence, neurological disease, poor mobility, severe cognitive decline, and age older than 70 years. Ten-month mortality in the 89 patients with long-term (≥ 8 days) incontinence was 26%, significantly greater than that observed in the continent group (6.7%) or in the 145 patients with transient incontinence (10%).¹¹

Impact: Psychosocial and Financial

FI has significant psychosocial and financial implications for patients and their families. Individuals who are incontinent may carry an emotional burden of shame and embarrassment as well as the physical discomfort and disruption of their lives that occur with episodes of incontinence. They may experience anxiety and depression stemming from "accidents," social isolation, and social exclusion.¹² The impact of FI on quality of life has been linked to symptom severity.¹³ Based on a questionnaire mailed to an age-stratified random sample of women in Minnesota, 6% of women with mild symptoms, 35% of women with moderate symptoms, and 82% of women with severe FI symptoms reported a moderate or severe impact on one or more domains of quality of life.¹⁴ Additionally, incontinence of liquid stool compared with flatal incontinence is associated with higher levels of depression and embarrassment as well as poorer quality of life.¹⁵

FI significantly impacts sexual function. In a cross-sectional study of 2,269 women, Imhoff et al found that in comparison to women without fecal or flatal incontinence, women with FI were more likely to report low sexual desire, low sexual satisfaction, and limitation of sexual activity by physical health. Among sexually active women, women with FI were more likely than women without fecal or flatal incontinence to report difficulties with lubrication, pain, and orgasm.¹⁶ Similarly, Cichowski et al showed that in a group of

1,115 women, FI was not associated with sexual activity status, but was associated with worse Pelvic Organ Prolapse Incontinence Sexual Questionnaire-12 (PISQ-12) scores. Specifically, women with FI reported more dyspareunia, fear, and avoidance of sexual activity than women without FI.¹⁷

Barriers to seeking care for FI are numerous. In addition to traditional barriers to care seeking for any condition (i.e., cost, transportation, fear, and inconvenience), patients with FI may face embarrassment, discomfort discussing such issues with one's physician, perception of the condition as a normal part of aging, and perception of a lack of available or successful treatments.¹⁸ In a study of 938 American women with accidental bowel leakage, more than two-thirds had never discussed their condition with a physician. Those women who had sought care were more likely to have a primary care physician, to have heard of FI, and to have suffered for longer with more severe leakage.¹⁹ Moreover, only 10% of women with FI had discussed the symptom with a physician in the preceding year.¹⁴ For patients who do seek care, many leave without knowledge of the therapies to cope with FI symptoms even when seeing specialists, and despite having symptoms of FI for an average of 10 years.²⁰

Healthcare expenses associated with FI have been challenging to assess because treatment may be complex and divergent approaches have been used to estimate costs. In a secondary analysis of a large prospective study assessing the impact of chronic constipation on quality of life and healthcare costs at a health management organization, Dunivan et al aimed to estimate healthcare costs associated with FI. The authors showed that patients who had frequent FI had an average of \$2,897 per year higher healthcare costs than their continent peers, which amounted to 55% higher total healthcare costs and 77% higher gastrointestinal-related healthcare costs.²¹ Xu et al found that the average annual direct medical cost of FI was \$2,353 per person (standard deviation [SD] = 4,005), whereas the annual direct nonmedical cost averaged \$209 (SD = 323) in 2010 US dollars, including transportation to care, use of absorbent or protective products, and laundry and dry cleaning.²² Using the Nationwide Inpatient Sample from 1998 to 2003, Sung et al showed that a total of 21,547 women underwent inpatient surgery for FI during the study period. They found that charges increased from \$34 million in 1998 to \$57.5 million in 2003, indicating a significant economic impact on the healthcare system.²³

The indirect economic impact of FI is also substantial. Drossman et al surveyed a representative sample of 5,400 U.S. adults and found that 13.2% of those with any FI and 29.4% of those with large-volume FI, as opposed to only 4.2% of those without any gastrointestinal symptoms, described themselves as too sick to work or go to school. Those with large-volume FI reported missing an average of 50 days from work or school in the past year due to illness, as compared with 4.9 days for those participants without gastrointestinal symptoms.²⁴ The indirect economic impact of FI includes the payment of disability claims for patients with incontinence who are no longer able to work and the lost wages related to quitting work or retiring prematurely due to incontinence. Loss of income for family members or friends who must leave their jobs to help incontinent patients

must also be considered. Estimation of the cost in this sector is elusive but is believed to be hundreds of millions of dollars per year.²⁵

The burden of FI also extends to patients' families, friends, and caregivers. Incontinence requires greater amounts of informal and formal caregiving. Informal caregivers are usually family members or friends who give unpaid assistance and formal caregivers are those paid to provide that assistance.¹² Informal caregivers have expressed feelings of depression, frustration, social isolation, embarrassment, trouble sleeping, and disrupted daily routine.²⁶ These feelings commonly lead to patients being placed in nursing homes. Physicians are also more likely to refer patients for nursing home placement if FI is present. In a survey of members of the American Geriatrics Society, FI alone was associated with a 10 to 15% likelihood of referral, and it added approximately 17% to the probability of referring to a nursing home when other risk factors were present such as cognitive deficits, impaired mobility, and chronic illness.²⁷

Treatment

Behavioral and Dietary Modifications and Pharmacotherapy

Conservative management options for FI include behavioral modifications such as scheduled toileting and dietary fiber supplementation. Few studies address prompted voiding for the treatment of FI and have shown limited treatment benefit.²⁸ For instance, Ouslander et al showed that prompted voiding did not change the frequency of incontinent bowel movements in their sample of nursing home residents; however, the number of continent bowel movements and the percentage of bowel movements that were continent did increase.²⁹

Fiber supplementation may decrease FI by improving stool consistency, promoting a more complete elimination of feces, by increasing rectal distension, and improving sensory awareness of the need to defecate.^{30,31} Lower dietary fiber intake is also associated with FI.³² In a single-blind, randomized controlled trial comparing the effects of three dietary fiber supplements (carboxymethylcellulose, gum arabic, and psyllium) to placebo, only dietary supplementation with psyllium was found to reduce the frequency of FI episodes.³³ The authors also indicated that their findings provide preliminary evidence of a possible mechanism for psyllium's reduction in FI frequency due to the formation of a gel by unfermented psyllium and fecal water. Psyllium has also been compared with loperamide for the treatment of FI. In a recent randomized, double-blind, placebo-controlled crossover trial, Markland et al compared the effectiveness and tolerability of loperamide and psyllium for the reduction of FI. Both loperamide and psyllium were found to reduce FI episodes and improve symptom severity and quality of life, although constipation occurred in 29% of patients in the loperamide group compared with 10% of the psyllium group.³⁴

Loperamide, a synthetic μ -opioid receptor agonist, is recommended as the first-line pharmacologic therapy for

FI.³⁵ In a systematic review of medical therapies for FI, 16 randomized studies with 558 participants were identified. Four randomized trials compared loperamide or diphenoxylate plus atropine to placebo, demonstrating a reduction in fecal urgency, FI episodes, unformed stool, and use of pads in the medication groups. The authors concluded that larger, well-designed controlled trials are necessary.³⁶ Diphenoxylate has also been found to have more side effects on the central nervous system than loperamide.³⁷ In addition to loperamide and diphenoxylate, other possible pharmacologic interventions for FI include amitriptyline, topical phenylephrine, and cholestyramine.³⁸

Pelvic Floor Physical Therapy, Biofeedback, and Electrical Stimulation

Pelvic floor physical therapy is used to successfully treat FI, although most data are from nonrandomized cohort studies. In more than 70 uncontrolled studies of biofeedback and pelvic floor muscle therapy, all but one study reported improved patient symptoms after treatment. Cure and improvement rates following pelvic floor physical therapy and/or biofeedback ranged from 50 to 80%.³⁹ In a retrospective analysis of 778 women who were referred for pelvic floor therapy for urinary, bowel, pelvic pain, and sexual symptoms over the course of 4 years, patients who completed at least five therapy sessions reported a mean symptom improvement of 80% in each of the three main categories analyzed, namely, urinary incontinence, defecatory dysfunction, and pelvic pain.⁴⁰ A limitation of pelvic floor physical therapy is patient compliance with the prescribed regimen. In a retrospective review of 1,544 women who presented to care for pelvic floor dysfunction including urinary incontinence, FI, and pelvic organ prolapse, only 48% of patients completed their prescribed pelvic floor muscle training program.⁴¹

Biofeedback has been used alone or as an adjunct to pelvic floor physical therapy to treat FI. In a Cochrane review evaluating the effects of biofeedback and/or anal sphincter exercises/pelvic floor muscle training for the treatment of FI in adults, the authors identified 21 eligible studies with a total of 1,525 participants.⁴² The authors found some evidence that biofeedback and electrical stimulation may enhance treatment outcomes compared with electrical stimulation or exercises alone. Pelvic floor exercises appeared to be less effective than an implanted sacral nerve stimulator for the treatment of FI. Recent studies have also demonstrated the comparable effectiveness of a home electrical stimulation device as compared with standardized biofeedback training in females with FI.⁴³

Bulking Agents

Perianal bulking agents have been utilized to enhance resting anal pressures and, thereby, improve passive FI. In a recent Cochrane review, the authors identified five eligible randomized trials with a total of 382 patients who were treated with perianal injections of bulking agents. In their analysis, the authors concluded that there is limited evidence to demonstrate clinical benefit of silicone biomaterial and carbon-coated beads but that dextranomer in stabilized hyaluronic

acid (NASHA Dx) improved FI for a little over half of patients in the short term.⁴⁴ This conclusion was primarily based on the work of Graf et al who performed a randomized, double blind, sham-controlled trial comparing transanal submucosal injections of NASHA Dx to sham injections. In this trial, 52% of patients who received NASHA Dx injections had a 50% or greater reduction in the number of incontinence episodes compared with 22 (31%) in the sham treatment group at 6 months.⁴⁵ In a follow-up study, successful decrease in FI symptoms was sustained at 12 months (57%) and 36 months (52%) following injection with NASHA Dx.⁴⁶ Similarly, La Torre et al performed a 24-month follow-up assessment under open-label conditions of patients who had received NASHA Dx injections and found that the mean number of FI-free days increased from 14.6 at baseline to 21.7 at 24 months ($p < 0.001$).⁴⁷

Anal Sphincteroplasty

In addition to conservative, nonoperative interventions and bulking agents, sphincteroplasty has been utilized to treat FI, especially in patients with a documented anal sphincter defect. The overlapping sphincteroplasty technique was described by Parks and McPartlin in 1971, and expounded upon by Fang et al in 1984 who recommended that the patient must have an intact neuromuscular bundle with detectable voluntary sphincter contraction; that if primary repair has failed, a minimum duration of 3 months should elapse before overlapping sphincteroplasty is attempted; scar tissue from the severed muscles should not be excised; the internal and external sphincter muscles should not be separated; and that a temporary concomitant colostomy is not necessary.^{48,49} In a 2013 Cochrane review comparing the effectiveness of repairing obstetric anal sphincter injuries in an overlapping or end-to-end fashion, the authors concluded that immediate primary overlapping repair of the external anal sphincter compared with immediate primary end-to-end repair appears to be associated with lower risks of developing fecal urgency and anal incontinence symptoms, although at the end of 36 months, there were no differences in flatal incontinence or FI between the two techniques.⁵⁰

In a follow-up series of 55 women who underwent anterior overlapping sphincter repair in the setting of FI related to obstetric trauma, 79% of women were continent of solid and liquid stool at a median of 15 months. At a median of 77-month follow-up, outcome failure was identified in 50% of patients indicating that short-term improvement in continence is not always maintained in the long term.⁵¹ Similarly, Lamblin et al demonstrated a progressive decline in continence following overlapping sphincteroplasty such that fecal continence was maintained in 85% of patients at 1 year, 74% at 48 months, 67% at 60 months, and 48% at 84 months on Kaplan-Meier analysis.⁵² Likewise, Grey et al evaluated surgical outcomes in 46 patients who underwent overlapping sphincteroplasty. In this cohort, the vast majority of patients had early symptom improvement postoperatively, but only 60% of patients maintained this success at 5 or more years.⁵³

Therefore, sphincteroplasty is an effective treatment for FI, although therapy benefits appear to decline with time.

Sacral Nerve Stimulation

Sacral nerve stimulation (SNS) is a more novel treatment option for FI. The exact mechanism of action of SNS in the treatment of FI has not been elucidated. In a systematic review, Carrington et al concluded that the majority of recent studies do not support the initial hypothesis that the mechanism of SNS was primarily peripheral motor neurostimulation. Due to the large body of evidence demonstrating effects outside of the anorectum, it appears that the influence of SNS on anorectal function occurs at a pelvic afferent or central level.⁵⁴ SNS is performed in two stages (Stage 1, trial phase; Stage 2, definitive implant). Stage 1 is diagnostic and involves placement of leads into the S3 foramen that are connected to an external stimulator. If Stage 1 lead implantation confers at least 50% improvement of FI symptoms (as recorded on a diary or by means of an incontinence score), Stage 2 with implantation of a definitive stimulator is performed approximately 2 weeks later.⁵⁵ SNS is increasingly replacing anal sphincteroplasty for the surgical treatment of patients with sphincter defects of less than 180 degrees secondary to emerging data showing poor long-term effectiveness of sphincteroplasty. Additionally, for patients who remain incontinent despite a satisfactory sphincteroplasty, SNS is recommended.⁵⁶

In a Cochrane review evaluating the effectiveness of SNS for the treatment of FI, the authors identified four crossover trials and two parallel group trials and concluded that SNS can improve continence in a population of patients with FI.⁵⁷ Specifically, in the parallel group trial conducted by Tjandra et al, participants with severe FI in the SNS group experienced fewer episodes of FI at 12 months compared with the control group who received a combination of medical therapy including pelvic floor exercises and dietary manipulation.⁵⁸ In the other parallel group trial performed by Thin et al, participants in the SNS group experienced fewer episodes of FI as compared with the percutaneous tibial nerve stimulation (PTNS) group.⁵⁹ Moreover, the three crossover trials included in this Cochrane review reported improvement in FI with activation of the SNS device.⁶⁰⁻⁶² The most commonly reported adverse effects in this review included pain at the stimulator implant site, hematoma, and wound infection. Overall, infection rates of SNS implanted to treat FI are low.⁶³ Additionally, therapeutic effects appear to be maintained over time. In a multicenter prospective trial, Hull et al followed up 76 patients for a minimum of 5 years and noted that at 5 years, 89% of patients had $\geq 50\%$ improvement in FI symptoms and 36% of patients had complete continence.⁶⁴

Artificial Sphincter

The artificial bowel sphincter (ABS) may be an option for patients with FI refractory to other more conservative therapies and/or who are unsuitable for SNS. An example is the Acticon Neosphincter (American Medical Systems Inc. Minnetonka, MN) which was approved by the Food and Drug Administration (FDA) in 2001. Components of the ABS include

a cuff that is implanted around the anal canal, a pressure regulating balloon, and a control pump that is placed in the labia in women and in the scrotum in men.⁶⁵ In a systematic review and meta-analysis of 47 articles published between 1987 and 2012, a total of 541 patients were divided into three groups based on follow-up time interval after ABS implantation: 1 to 2.9 years (Group I), 3 to 4.9 years (Group II), and more than 5 years (Group III). The pooled improvement rates were 75, 60, and 55% in Groups I, II, and III, respectively, indicating that continence decreased with time. The pooled device explantation rates were 24, 36, and 39% in Groups I, II, and III, respectively. The most common reasons for device removal were infection (56%) and erosion (37%).⁶⁶ Overall, the artificial sphincter appears to be an effective treatment modality for FI, albeit carrying a higher risk of infection than other treatment options.

Magnetic Sphincter

The magnetic sphincter, which has not yet been approved by the FDA, is an anal occlusion device consisting of a string of titanium beads with a magnetic core that are implanted to encircle the anus. The act of expelling stool generates sufficient force to break the magnetic attraction, allowing the beads to separate and the anal canal to open to allow stool passage.⁵⁵ Several small prospective studies have shown improvement in FI symptoms following device implantation.^{67–69} Moreover, these favorable results appear to be stable over time.⁷⁰ Additional larger studies are ongoing and needed to determine the role of the magnetic sphincter as a treatment modality for FI.⁷¹

Posterior Anal Sling

Successful treatment of FI with a perineal puborectalis sling has been reported in pilot studies.⁷² This procedure is started by making a 3- to 4-cm curvilinear incision posterior to the anus and by opening the intrasphincteric spaces bilaterally. A 2-cm suprapubic incision is made and a trochar is passed on either side of the rectum from the perineum to the suprapubic incision. A polyester mesh string is passed through each incision and tied anteriorly.⁵⁵ Mellgren et al recently reported 1-year outcome data from a prospective, multicenter study of 152 women who were implanted with the Transobturator Posterior Anal Sling (TOPAS, American Medical Systems) at 14 centers in the United States. At 12 months, 69% of patients met the criteria for treatment success (reduction in number of FI episodes $\geq 50\%$ compared with baseline) and 19% of patients reported complete continence.⁷³

Colostomy

Colostomy to divert the fecal stream may be the only remaining option in patients with intractable symptoms who have failed or are not candidates for other therapies. In most cases, a sigmoid colostomy is performed and a laparoscopic approach allows ideal positioning of the stoma on the abdominal wall.⁷⁴ While colostomy or ileostomy may prevent all instances of FI, it is important to counsel patients that they may experience episodic leakage of mucus if they retain their rectum.

Conclusion

FI is a chronic and debilitating condition that confers substantial health, economic, and social hardship for patients. In this review, we presented a variety of treatment modalities for FI. Additional study and treatment options are needed for this vexing condition.

References

- Haylen BT, de Ridder D, Freeman RM, et al; International Urogynecological Association; International Continence Society. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. *Neurourol Urodyn* 2010;29(1):4–20
- Lazarescu A, Turnbull GK, Vanner S. Investigating and treating fecal incontinence: when and how. *Can J Gastroenterol* 2009;23(4):301–308
- Ng KS, Sivakumaran Y, Nassar N, Gladman MA. Fecal incontinence: community prevalence and associated factors—a systematic review. *Dis Colon Rectum* 2015;58(12):1194–1209
- Wu JM, Vaughan CP, Goode PS, et al. Prevalence and trends of symptomatic pelvic floor disorders in U.S. women. *Obstet Gynecol* 2014;123(1):141–148
- Bharucha AE, Fletcher JG, Melton LJ III, Zinsmeister AR. Obstetric trauma, pelvic floor injury and fecal incontinence: a population-based case-control study. *Am J Gastroenterol* 2012;107(6):902–911
- Huebner M, Gramlich NK, Rothmund R, Nappi L, Abele H, Becker S. Fecal incontinence after obstetric anal sphincter injuries. *Int J Gynaecol Obstet* 2013;121(1):74–77
- Richter HE, Nager CW, Burgio KL, et al; NICHD Pelvic Floor Disorders Network. Incidence and predictors of anal incontinence after obstetric anal sphincter injury in primiparous women. *Female Pelvic Med Reconstr Surg* 2015;21(4):182–189
- Poylin V, Serrot FJ, Madoff RD, et al. Obesity and bariatric surgery: a systematic review of associations with defecatory dysfunction. *Colorectal Dis* 2011;13(6):e92–e103
- De La Luz Nieto M, Wu JM, Matthews C, Whitehead WE, Markland AD. Factors associated with fecal incontinence in a nationally representative sample of diabetic women. *Int Urogynecol J* 2015;26(10):1483–1488
- Halland M, Koloski NA, Jones M, et al. Prevalence correlates and impact of fecal incontinence among older women. *Dis Colon Rectum* 2013;56(9):1080–1086
- Chassagne P, Landrin I, Neveu C, et al. Fecal incontinence in the institutionalized elderly: incidence, risk factors, and prognosis. *Am J Med* 1999;106(2):185–190
- Landefeld CS, Bowers BJ, Feld AD, et al. National Institutes of Health state-of-the-science conference statement: prevention of fecal and urinary incontinence in adults. *Ann Intern Med* 2008;148(6):449–458
- Bordeianou L, Rockwood T, Baxter N, Lowry A, Mellgren A, Parker S. Does incontinence severity correlate with quality of life? Prospective analysis of 502 consecutive patients. *Colorectal Dis* 2008;10(3):273–279
- Bharucha AE, Zinsmeister AR, Locke GR, et al. Prevalence and burden of fecal incontinence: a population-based study in women. *Gastroenterology* 2005;129(1):42–49
- Boreham MK, Richter HE, Kenton KS, et al. Anal incontinence in women presenting for gynecologic care: prevalence, risk factors, and impact upon quality of life. *Am J Obstet Gynecol* 2005;192(5):1637–1642

- 16 Imhoff LR, Brown JS, Creasman JM, et al. Fecal incontinence decreases sexual quality of life, but does not prevent sexual activity in women. *Dis Colon Rectum* 2012;55(10):1059–1065
- 17 Cichowski SB, Komesu YM, Dunivan GC, Rogers RG. The association between fecal incontinence and sexual activity and function in women attending a tertiary referral center. *Int Urogynecol J* 2013; 24(9):1489–1494
- 18 Rimmer CJ, Gill KA, Greenfield S, Dowswell G. The design and initial patient evaluation of an integrated care pathway for faecal incontinence: a qualitative study. *BMC Health Serv Res* 2015; 15:444
- 19 Brown HW, Wexner SD, Lukacz ES. Factors associated with care seeking among women with accidental bowel leakage. *Female Pelvic Med Reconstr Surg* 2013;19(2):66–71
- 20 Cichowski SB, Dunivan GC, Rogers RG, Komesu YM. Patients' experience compared with physicians' recommendations for treating fecal incontinence: a qualitative approach. *Int Urogynecol J* 2014;25(7):935–940
- 21 Dunivan GC, Heymen S, Palsson OS, et al. Fecal incontinence in primary care: prevalence, diagnosis, and health care utilization. *Am J Obstet Gynecol* 2010;202(5):493.e1–493.e6
- 22 Xu X, Menees SB, Zochowski MK, Fenner DE. Economic cost of fecal incontinence. *Dis Colon Rectum* 2012;55(5):586–598
- 23 Sung VW, Rogers ML, Myers DL, Akbari HM, Clark MA. National trends and costs of surgical treatment for female fecal incontinence. *Am J Obstet Gynecol* 2007;197(6):652.e1–652.e5
- 24 Drossman DA, Li Z, Andruzzi E, et al. U.S. householder survey of functional gastrointestinal disorders. Prevalence, sociodemography, and health impact. *Dig Dis Sci* 1993;38(9):1569–1580
- 25 Miner PB Jr. Economic and personal impact of fecal and urinary incontinence. *Gastroenterology* 2004;126(1, Suppl 1):S8–S13
- 26 Cassells C, Watt E. The impact of incontinence on older spousal caregivers. *J Adv Nurs* 2003;42(6):607–616
- 27 Grover M, Busby-Whitehead J, Palmer MH, et al. Survey of geriatricians on the effect of fecal incontinence on nursing home referral. *J Am Geriatr Soc* 2010;58(6):1058–1062
- 28 Schnelle JF, Leung FW, Rao SS, et al. A controlled trial of an intervention to improve urinary and fecal incontinence and constipation. *J Am Geriatr Soc* 2010;58(8):1504–1511
- 29 Ouslander JG, Simmons S, Schnelle J, Uman G, Fingold S. Effects of prompted voiding on fecal continence among nursing home residents. *J Am Geriatr Soc* 1996;44(4):424–428
- 30 Bliss DZ, Jung HJ, Savik K, et al. Supplementation with dietary fiber improves fecal incontinence. *Nurs Res* 2001;50(4):203–213
- 31 Hoffmann BA, Timmcke AE, Gathright JB Jr, Hicks TC, Opelka FG, Beck DE. Fecal seepage and soiling: a problem of rectal sensation. *Dis Colon Rectum* 1995;38(7):746–748
- 32 Markland AD, Richter HE, Burgio KL, Bragg C, Hernandez AL, Subak LL. Fecal incontinence in obese women with urinary incontinence: prevalence and role of dietary fiber intake. *Am J Obstet Gynecol* 2009;200(5):566.e1–566.e6
- 33 Bliss DZ, Savik K, Jung HJ, Whitebird R, Lowry A, Sheng X. Dietary fiber supplementation for fecal incontinence: a randomized clinical trial. *Res Nurs Health* 2014;37(5):367–378
- 34 Markland AD, Burgio KL, Whitehead WE, et al. Loperamide versus psyllium fiber for treatment of fecal incontinence: the Fecal Incontinence Prescription (Rx) Management (FIRM) Randomized Clinical Trial. *Dis Colon Rectum* 2015;58(10):983–993
- 35 Norton C, Thomas L, Hill J; Guideline Development Group. Management of faecal incontinence in adults: summary of NICE guidance. *BMJ* 2007;334(7608):1370–1371
- 36 Omar MI, Alexander CE. Drug treatment for faecal incontinence in adults. *Cochrane Database Syst Rev* 2013;6:CD002116
- 37 Palmer KR, Corbett CL, Holdsworth CD. Double-blind cross-over study comparing loperamide, codeine and diphenoxylate in the treatment of chronic diarrhea. *Gastroenterology* 1980;79(6): 1272–1275
- 38 Lee D, Arora G. Medical management of fecal incontinence in challenging populations: a review. *Clin Colon Rectal Surg* 2014; 27(3):91–98
- 39 Norton C, Whitehead WE, Bliss DZ, Harari D, Lang J; Conservative Management of Fecal Incontinence in Adults Committee of the International Consultation on Incontinence. Management of fecal incontinence in adults. *Neurourol Urodyn* 2010;29(1):199–206
- 40 Starr JA, Drobnis EZ, Lenger S, Parrot J, Barrier B, Foster R. Outcomes of a comprehensive nonsurgical approach to pelvic floor rehabilitation for urinary symptoms, defecatory dysfunction, and pelvic pain. *Female Pelvic Med Reconstr Surg* 2013;19(5):260–265
- 41 Tibaek S, Dehlendorff C. Do women with pelvic floor dysfunction referred by gynaecologists and urologists at hospitals complete a pelvic floor muscle training programme? A retrospective study, 1992–2008. *Int Urogynecol J* 2013;24(8):1361–1369
- 42 Norton C, Cody JD. Biofeedback and/or sphincter exercises for the treatment of faecal incontinence in adults. *Cochrane Database Syst Rev* 2012;7:CD002111
- 43 Cohen-Zubary N, Gingold-Belfer R, Lambort I, et al. Home electrical stimulation for women with fecal incontinence: a preliminary randomized controlled trial. *Int J Colorectal Dis* 2015;30(4): 521–528
- 44 Maeda Y, Laurberg S, Norton C. Perianal injectable bulking agents as treatment for faecal incontinence in adults. *Cochrane Database Syst Rev* 2013;2:CD007959
- 45 Graf W, Mellgren A, Matzel KE, Hull T, Johansson C, Bernstein M; NASHA Dx Study Group. Efficacy of dextranomer in stabilised hyaluronic acid for treatment of faecal incontinence: a randomised, sham-controlled trial. *Lancet* 2011;377(9770):997–1003
- 46 Mellgren A, Matzel KE, Pollack J, Hull T, Bernstein M, Graf W; NASHA Dx Study Group. Long-term efficacy of NASHA Dx injection therapy for treatment of fecal incontinence. *Neurogastroenterol Motil* 2014;26(8):1087–1094
- 47 La Torre F, de la Portilla F. Long-term efficacy of dextranomer in stabilized hyaluronic acid (NASHA/Dx) for treatment of faecal incontinence. *Colorectal Dis* 2013;15(5):569–574
- 48 Parks AG, McPartlin JF. Late repair of injuries of the anal sphincter. *Proc R Soc Med* 1971;64(12):1187–1189
- 49 Fang DT, Nivatvongs S, Vermeulen FD, Herman FN, Goldberg SM, Rothenberger DA. Overlapping sphincteroplasty for acquired anal incontinence. *Dis Colon Rectum* 1984;27(11):720–722
- 50 Fernando RJ, Sultan AH, Kettle C, Thakar R. Methods of repair for obstetric anal sphincter injury. *Cochrane Database Syst Rev* 2013; 12:CD002866
- 51 Malouf AJ, Norton CS, Engel AF, Nicholls RJ, Kamm MA. Long-term results of overlapping anterior anal-sphincter repair for obstetric trauma. *Lancet* 2000;355(9200):260–265
- 52 Lamblin G, Bouvier P, Damon H, et al. Long-term outcome after overlapping anterior anal sphincter repair for fecal incontinence. *Int J Colorectal Dis* 2014;29(11):1377–1383
- 53 Grey BR, Sheldon RR, Telford KJ, Kiff ES. Anterior anal sphincter repair can be of long term benefit: a 12-year case cohort from a single surgeon. *BMC Surg* 2007;7:1
- 54 Carrington EV, Evers J, Grossi U, et al. A systematic review of sacral nerve stimulation mechanisms in the treatment of fecal incontinence and constipation. *Neurogastroenterol Motil* 2014;26(9): 1222–1237
- 55 Kaiser AM, Orangio GR, Zutshi M, et al. Current status: new technologies for the treatment of patients with fecal incontinence. *Surg Endosc* 2014;28(8):2277–2301
- 56 Abrams P, Andersson KE, et al. 4th International Consultation on Incontinence: Evaluation and treatment of urinary incontinence, pelvic organ prolapse, and fecal incontinence. *Neurourol Urodyn* 2010;29(1):213–240
- 57 Thaha MA, Abukar AA, Thin NN, Ramsanahie A, Knowles CH. Sacral nerve stimulation for faecal incontinence and constipation in adults. *Cochrane Database Syst Rev* 2015;8:CD004464

- 58 Tjandra JJ, Chan MK, Yeh CH, Murray-Green C. Sacral nerve stimulation is more effective than optimal medical therapy for severe fecal incontinence: a randomized, controlled study. *Dis Colon Rectum* 2008;51(5):494–502
- 59 Thin NN, Taylor SJ, Bremner SA, et al; Neuromodulation Trial Study Group. Randomized clinical trial of sacral versus percutaneous tibial nerve stimulation in patients with faecal incontinence. *Br J Surg* 2015;102(4):349–358
- 60 Leroi AM, Parc Y, Lehur PA, et al; Study Group. Efficacy of sacral nerve stimulation for fecal incontinence: results of a multicenter double-blind crossover study. *Ann Surg* 2005;242(5):662–669
- 61 Duelund-Jakobsen J, Dudding T, Bradshaw E, et al. Randomized double-blind crossover study of alternative stimulator settings in sacral nerve stimulation for faecal incontinence. *Br J Surg* 2012;99(10):1445–1452
- 62 Kahlke V, Topic H, Peleikis HG, Jongen J. Sacral nerve modulation for fecal incontinence: results of a prospective single-center randomized crossover study. *Dis Colon Rectum* 2015;58(2):235–240
- 63 Wexner SD, Hull T, Edden Y, et al. Infection rates in a large investigational trial of sacral nerve stimulation for fecal incontinence. *J Gastrointest Surg* 2010;14(7):1081–1089
- 64 Hull T, Giese C, Wexner SD, et al; SNS Study Group. Long-term durability of sacral nerve stimulation therapy for chronic fecal incontinence. *Dis Colon Rectum* 2013;56(2):234–245
- 65 Gregorcyk SG. The current status of the Acticon Neosphincter. *Clin Colon Rectal Surg* 2005;18(1):32–37
- 66 Hong KD, Dasilva G, Kalaskar SN, Chong Y, Wexner SD. Long-term outcomes of artificial bowel sphincter for fecal incontinence: a systematic review and meta-analysis. *J Am Coll Surg* 2013;217(4):718–725
- 67 Lehur PA, McNevin S, Buntzen S, Mellgren AF, Laurberg S, Madoff RD. Magnetic anal sphincter augmentation for the treatment of fecal incontinence: a preliminary report from a feasibility study. *Dis Colon Rectum* 2010;53(12):1604–1610
- 68 Wong MT, Meurette G, Stangherlin P, Lehur PA. The magnetic anal sphincter versus the artificial bowel sphincter: a comparison of 2 treatments for fecal incontinence. *Dis Colon Rectum* 2011;54(7):773–779
- 69 Pakravan F, Helmes C. Magnetic anal sphincter augmentation in patients with severe fecal incontinence. *Dis Colon Rectum* 2015;58(1):109–114
- 70 Barussaud ML, Mantoo S, Wyart V, Meurette G, Lehur PA. The magnetic anal sphincter in faecal incontinence: is initial success sustained over time? *Colorectal Dis* 2013;15(12):1499–1503
- 71 Williams AE, Croft J, Napp V, et al. SaFaRI: sacral nerve stimulation versus the FENIX™ magnetic sphincter augmentation for adult faecal incontinence: a randomised investigation. *Int J Colorectal Dis* 2016;31(2):465–472
- 72 Yamana T, Takahashi T, Iwadare J. Perineal puborectalis sling operation for fecal incontinence: preliminary report. *Dis Colon Rectum* 2004;47(11):1982–1989
- 73 Mellgren A, Zutshi M, Lucente VR, Culligan P, Fenner DE; TRANSFORM Study Group. A posterior anal sling for fecal incontinence: results of a 152-patient prospective multicenter study. *Am J Obstet Gynecol* 2015. pii: S0002–9378(15)01276–4
- 74 Meurette G, Duchalais E, Lehur PA. Surgical approaches to fecal incontinence in the adult. *J Vis Surg* 2014;151(1):29–39