

Meckel's diverticulum in adults: seldom suspected and frequently found

Chance S Friesen,¹ Thomas Mario Attard ,¹ Maria Cole,² Jay G Berry,³ Matt Hall⁴

¹Gastroenterology, Children's Mercy Hospitals and Clinics, Kansas City, Missouri, USA

²Biomedical Sciences, University of Missouri Kansas City, Kansas City, Missouri, USA

³Department of Pediatrics, Harvard Medical School, Boston Children's Hospital, Boston, Massachusetts, USA

⁴Children's Hospital Association, Overland Park, Kansas, USA

Correspondence to

Dr Thomas Mario Attard, Gastroenterology, Children's Mercy Hospitals and Clinics, Kansas City, MO 64108-4619, USA; tmattard@cmh.edu

Accepted 1 December 2020

ABSTRACT

Meckel's diverticulum (MD) is a well-defined diagnosis in children presenting with either bleeding or obstruction. Although anecdotally adult patients may present with complications from MD, their presentation seems to be different, with a reported predominance of non-bleed-related presentations. Reports in this population, however, are limited, and little is known of the epidemiology of MD in older patients. We performed a retrospective analysis of the Agency of Healthcare Research and Quality National Inpatient Sample of all US hospital discharges from 2012 to 2016. We identified patients with a primary discharge diagnosis of MD. Data were abstracted as raw numbers and population weighted rates of discharge with age group, income level, length of stay (LOS) and hospital charges as additional information. On average, 2030 individuals were discharged annually; most (71.1%) were adults (>18 years). Although MD was predominant in males in all age groups, the gender ratio decreased with older age categories from 3.5:1.0 (1–17 years) to 1.6:1.0 (65–84 years). LOS averaged 5.3 days with no clear relationship to other parameters. Median income category, however, closely correlated ($R^2=0.9996$) with diagnosis in older age categories. MD may be significantly more prevalent in adult patients than was previously understood. Differences in gender preponderance suggest that gender may influence the pattern of presentation. Diagnosis in older individuals is closely associated with income or socioeconomic status but not hospital charges or LOS.

BACKGROUND

Meckel's diverticulum (MD) is the most common congenital abnormality of the gastrointestinal (GI) tract and is found in 2%–4% of the population.¹ Developmentally, it is the most common phenotype of failure of obliteration of the embryonic omphalomesenteric (vitellointestinal) duct connecting the fetal yolk sac to the intestine. The diverticulum is usually lined with typical ileal mucosa but can harbor ectopic gastric mucosa, which precipitates ulceration as a cause of GI bleeding, whereas intussusception or volvulus associated with a residual fibrous cord may result in obstruction.¹ Meckel's may be a coincidental finding noted during abdominal surgery. It is considered rare in adults, prompting the adage attributed to Charles W Mayo that 'Meckel's diverticulum

is frequently suspected, often looked for and seldom found' in clinical practice.² Accordingly, Meckel's is routinely investigated in pediatric GI hemorrhage but seldom emphasized in the differential diagnosis of obstruction or bleeding in adult textbooks. Preoperatively, MD can be diagnosed, in order of accuracy, by balloon enteroscopy (85.0%), small bowel follow through (62.5%), capsule endoscopy (35.7%), CT (31.8%), and technetium-99 pertechnetate scan (21%).³ The preponderance of MD being diagnosed in children is poorly understood. One possible explanation is early ulceration from heterotopic gastric mucosa, but this fails to explain obstruction related to a fibrous cord, which should persist into adulthood. Given the perceived discrepancy in age-related presentation, we undertook a data-analytical approach to determine the incidence of symptomatic MD in adults in comparison with children and to define the gender differences in MD incidence over time.

METHODS

Design and data source

This is a retrospective cohort study of hospitalizations in the Healthcare Cost and Utilization Project's National Inpatient Sample, which includes administrative and demographic data from a 20% sample of all inpatient hospitalizations in the USA from 2012 to 2016.⁴

Inclusion and exclusion criteria

International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) and International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) were used to define the cohort being studied. Patients were included in the cohort if they had a principal diagnosis of MD during January 1, 2012–December 31, 2016 (2012–2015; ICD-9-CM 751.0, 2016; ICD-10-CM Q43.0).

Details regarding age, sex, insurance status, household income, and geographical location of care were obtained for the extracted cases. Median household income of residents in the patient's zip code was categorized as low (at or below the lowest 25th percentile) or not low (above the lowest 25th percentile).



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To cite: Friesen CS, Attard TM, Cole M, et al. *J Investig Med Epub ahead of print: [please include Day Month Year].* doi:10.1136/jim-2020-001581

Table 1 Demographic characteristics of patients with a principal diagnosis of Meckel's diverticulum

		Mean annual* discharges, N (%)	Mean annual rate per 100 000 persons (SE)
Discharges		2030	0.64 (0.04)
Age (years)	<1	81 (4)	2.08 (0.54)
	1–17	541 (26.7)	0.79 (0.09)
	18–44	636 (31.3)	0.55 (0.05)
	45–64	472 (23.3)	0.58 (0.06)
	65–84	262 (12.9)	0.65 (0.09)
	85+	N/A	N/A
Gender	Male	1447 (71.3)	0.93 (0.06)
	Female	582 (28.7)	0.36 (0.04)
Median household income	Low	469 (23.1)	0.59 (0.06)
	Not low	1535 (75.6)	0.65 (0.04)
Length of stay (days)	Mean (SE)	5.3 (0.2)	

*2015 not used in determining the mean number of discharges.
N/A, not available.

Statistical analysis

Age group was categorized in years, calculated on the basis of the admission date to the emergency department or the hospital. Discharge rates were calculated using national population estimates that correspond to the year of Healthcare Cost and Utilization Project (HCUP) data.⁵ Statistical analyses were performed using MedCalc and Microsoft Excel (version 2011). Payer category was analyzed and defined as expected payer, based on the first-listed payer. The χ^2 test was used to compare categorical variables, and the 2-proportion Z-test was used to compare rates.

RESULTS

During the study period (2012–2016), a mean of 2030 individuals were discharged annually from inpatient care with a principal discharge diagnosis of MD representing a population rate of 0.64 per 100,000 persons (table 1).

The highest incident rates were in the pediatric age range (<1 year, 2.08, and 1–18 years, 0.79 per 100 000), although the majority of cases (71.1%) were diagnosed in individuals older than 18 years of age. The incident rate showed a general downward trend over age (table 1). When computing MD-related inpatient length of stay (LOS) or incident rate by region in the USA, no significant trends were noted. The median LOS category was shortest for 1–18 years of age (4 days), increasing thereafter, being highest in the 65–84 age group (6 days). The median cost of admission with MD was \$12,409 and was highest in males over 65 years of age.

The gender distribution for this cohort was male:female, 2.5:1; that is, 71.3% were males. Although predominant, the number and incident rate of MD in males decreased as age increased; no female patients were reported under 1 year of age but represented 37% of patients diagnosed at the 65–84 age range (figure 1A). Thus, the gender ratio of MD as principal discharge diagnosis is significantly different ($p < 0.001$) in older (>18) patients.

Interestingly, MD in older patients seemed to be related to economic status. In HCUP, the median income by patient residential zip code is categorized as low (≤ 25 th percentile) or not low, with the former being a surrogate for lower socioeconomic (SE) status. On comparing the ratio of not low to low income in patients with MD in contrast to all discharge

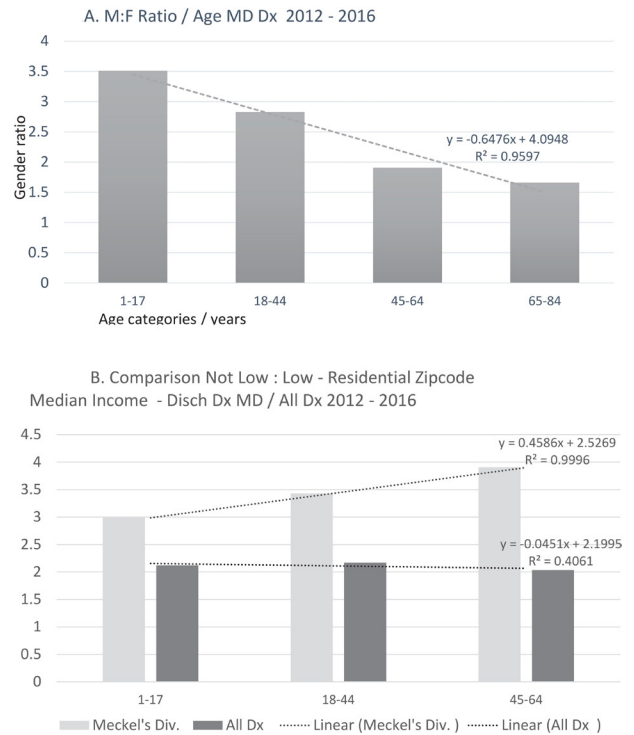


Figure 1 (A) Gender ratio by age category of patients diagnosed with MD. (B) Income ratio of patients with MD compared with all diagnoses by age category. Dx, diagnosis; F, female; M, male; MD, Meckel's diverticulum.

diagnoses, MD was more likely diagnosed in older, more affluent patients (figure 1B). Although mean hospital charges were higher (\$58,134 compared with \$55,019) for more affluent patients, the mean LOS was longer in the less affluent patients, although we could not test for statistical significance.

DISCUSSION

Our study represents the largest cohort of patients identified with MD reported in the literature to date. Our study population is derived from a robust sample of all inpatient admissions across the country so that longitudinal and categorical data subsets retain significance despite an overall relatively rare disease. MD is the most common congenital anomaly of the GI tract; as such, it is not surprising that it would manifest most often in childhood but that presentation later in life would also occur. Our study is the first to suggest that MD, in fact, presents more often in the adult population. The manner of presentation of MD at any age either relates to its expression of heterotopic gastric mucosa resulting in bleeding or, through intussusception or adhesion, resulting in obstruction. Less often, MD may present through poorly understood mechanisms, with inflammation or diverticulitis. These are dramatically different pathophysiological mechanisms so that age, and possibly gender-dependent differences in presentation, may be observed. Intestinal hemorrhage is thought to be more common in children possibly, as ulceration will rapidly and inevitably complicate actively acid-secretory gastric heterotopic mucosa. Obstruction from intussusception or band adhesion-associated volvulus can apparently complicate at any age, whereas inflammation of an MD tends to present

at an older age group. In some cases, luminal obstruction from fecolith development is observed and thought to drive the inflammatory sequence; this may be a process that requires time resulting in later presentation.

The presence of gastric heterotopic tissue is almost ubiquitous in the presentation of MD with bleeding,⁶ whereas diverticulum size (length) and the presence of bands, predisposing to volvulus, are risk factors for inflammation and obstruction, respectively.⁷

Adult patients with MD clearly have a different presentation than those presenting during childhood—the most common presentation is diverticulitis (35.1%) or obstruction (35.1%) and within that population, presentation with bleeding is significantly more likely in patients under 40 years of age.⁸ Relatedly, heterotopic mucosa is present in only 16% of adult patients with MD in one cohort⁹ but seems to relate to the presence of symptoms and therefore to the likelihood for need to resect in adults in another series.¹⁰ In adults, the majority of resections of MD are for incidentally discovered diverticula during laparotomy for another cause⁷; the appropriate management of asymptomatic MD is in fact still controversial. In our study, we purposefully limited our analysis to⁸ patients where MD was cited as the principal discharge diagnosis, so it is unlikely that we included asymptomatic adults wherein resection may not have been indicated.

The age-associated different presentations of MD have diagnostic implications. The traditional mainstay of diagnosis, 99mTc scan, has a notoriously low sensitivity.¹¹ This is in part because the test is specific to detecting heterotopic gastric mucosa, which will not be the predominant mechanism in adult patients. Specifically, in these patients, diagnosis has to be established through small bowel contrast studies or capsule endoscopy.

Our observation of a relationship between a surrogate index of SE status and the discharge diagnosis of MD in older individuals is interesting. Median residential income by zip code is an established surrogate of SE status. We have shown that, for all discharge diagnoses pooled, the ratio of non-low to low median income across age categories does not change, whereas it increases progressively for MD. The drivers of this relationship remain obscure; the LOS was longer in lower SE status patients, but the overall cost was slightly higher in patients with higher SE. Even within countries with a socialized model of healthcare delivery, lower SE status correlates with worse health outcomes.¹² The drivers of disparities in health outcomes by SE status are complex and include differences in use of diagnostic imaging¹³ and subsequent management. Given the limitations of our resources, any explanation of our observed relationship between SE status and MD diagnosis remains speculative.

Our study has several limitations; the use of a nationwide, multicenter sampling strategy allows for the analysis of a large cohort but is limited by possible data entry errors and limited granularity of the data recorded. In our cohort definition the diagnostic codes identifying MD are different from those related to other diverticular diseases so that we would anticipate that misidentification of another diverticular disease as MD would be relatively rare. Specifically, with the National Inpatient Sample, our observations are of hospitalization events or discharges rather than unique

patients. However, we feel that the likelihood of repeated admissions with the traditionally identified presentations—bleeding, obstruction, or inflammation—peritonitis would be unlikely. Finally, our study does not allow us to determine specific symptoms on presentation limiting our assessment of age and gender influences on MD presentation.

Our study suggests that MD is more prevalent in adults than has previously been appreciated. Placed in the context of existing literature, our study supports MD as a continuum of clinical presentations that evolve by age with early presentation, predominantly in males, with bleeding and with gastric heterotopic tissue and therefore more likely detectable on 99mTc scan. Later presentation is predominantly with obstruction and inflammation, either through intussusception or volvulus or poorly understood diverticulitis. Non-GI bleeding presentations exhibit less male preponderance and may be undetectable on 99mTc scan requiring alternative diagnostic modalities. The cause of the striking disparities in the diagnosis based on income in older age categories remains elusive and requires further study.

Contributors CSF, TMA, MC, JGB and MH contributed to the conception and design of the work, TMA, JGB and MH contributed to the acquisition, analysis and interpretation of data for the work. CSF, TMA, MC, JGB and MH contributed to the drafting of the work, revising it critically for important intellectual content and the final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval As this study did not involve any protected health information, it was deemed exempt (non-human subject research) from Children's Mercy Hospital's institutional board review.

ORCID iD

Thomas Mario Attard <http://orcid.org/0000-0002-7480-4437>

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