Introduction

The upper gastrointestinal endoscopic ultrasound (EUS) procedure has important clinical advantages including potential avoidance of surgery, hospital admission and associated risks, compared to standard endoscopy [1–4]. The relatively low Medicare reimbursement rate of EUS in the United States compared to its cost, however, may be a disincentive to its widespread adoption due to concerns with its financial viability [5–8]. Such a concern appears to have led to under-investment in training of clinicians [6, 9] and disseminating the benefits of the procedure at a larger scale [7, 8]. Moreover, there are concerns about whether EUS is financially viable given its utilization among the Medicare population and the lower reimbursement rate.
Maeng Daniel et al. Upstream and downstream ... Endoscopy International Open 2019; 07: E1316–E1321
and MS-DRG codes considered for this study are shown in Appendix Tables A1–A3. The upper gastrointestinal EUS-related care was then categorized into upstream and downstream services. Upstream services included selected radiology, electrocardiogram (EKG), and selected lab services, while downstream upper gastrointestinal-EUS related care included subsequent upper gastrointestinal EUS (i.e., occurring after the index date), esophagogastroduodenoscopy (EGD) or endoscopic retrograde cholangiopancreatography (ERCP), selected chemotherapy, radiation therapy, pathology, radiology, and consults that occurred within 180 days after the index upper gastrointestinal EUS cases. In addition, selected downstream inpatient upper gastrointestinal-related admissions (both surgical and medical admissions) were also considered and included in calculating the total downstream revenue.

Two sub-analyses of cost and utilization were also conducted. The first was to evaluate whether upstream and downstream patterns are different for cases who had a cancer diagnosis versus those without (refer to Appendix Table A4 for the upper gastrointestinal cancer-related diagnosis for this study), and the second was to compare if the patterns of care and costs were different for Medicare vs. commercial cases. All statistical analyses were conducted using Stata version 13.0 (StataCorp, College Station, TX, United States). The statistical significance of differences between Medicare Advantage and commercial plan patients as well as differences between cancer and non-cancer patients was obtained via t tests; 95% confidence intervals were obtained to compare the mean total upstream and downstream revenues between the cancer and non-cancer patients as well as between the Medicare Advantage and commercial plan members.

### Results

**Table 1** summarizes the patient demographics. The average age of the patients was 63 years and 54% of the 436 patients were female. Moreover, 56% of these patients had Medicare Advantage coverage. Comparing the cancer vs. non-cancer patients, cancer patients were older, more likely to have Medicare Advantage, and less likely to be female. The vast majority of patients (81%) go on to have further testing and other EUS-related utilizations following the index upper gastrointestinal EUS procedure.

**Table 2** shows the percentage of the upper gastrointestinal EUS patients who had received each of the categories of downstream and upstream care. Across all patients, the most frequent downstream healthcare utilization consisted of radiology (31%), pathology services (28%), and high-revenue services including chemotherapy (11%) and inpatient admissions (12%, including both medical and surgical admissions). The most common upstream utilization included radiology (18%) and lab services (22%). Comparing the cancer vs. non-cancer patients, cancer patients were significantly more likely than non-cancer patients to use every category of downstream care (apart from EGD), particularly the high-revenue care services (46% vs. 3% for chemotherapy and 47% vs. 4% for medical or surgical inpatient admissions). Furthermore, one-quarter of the subset of patients with cancer underwent ERCP either on the same day or in the downstream period, compared to only 13% among the non-cancer patients. For upstream care utilization, cancer patients were again likely to receive more care than non-cancer patients in general, but only for radiology was the difference statistically significant at the 5% level.

**Table 3** summarizes the mean total episode-of-care revenue to the hospital per patient. Across all patients in the sample, the mean total upstream revenue was $4373 per patient and the total downstream revenue was $34231 per patient. The mean total upstream and downstream revenues did not differ significantly between the Medicare Advantage and the commercial members; however, there were significant differences between the cancer and the non-cancer patients in terms of their mean total upstream and downstream revenues, suggesting that cancer patients were associated with total episode-of-care revenues that are nearly 3 to 4 times higher than those of non-cancer patients.

### Discussion

The findings from this study demonstrate the magnitude of impact that upper gastrointestinal EUS potentially can have on the provider’s revenue by using an episode-of-care approach to identify upper gastrointestinal EUS cases and to attribute financial values associated with the procedure from the provider’s
perspective. Specifically, this episode-of-care approach allows
the care provider to view the value of the upper gastrointestinal
EUS procedure not as an isolated single procedure but within
the broader context of comprehensive upstream and down-
stream of patient care. These results indicate that the estima-
ted total revenue associated with an episode-of-care in this
context can be quite substantial, especially if the downstream
care is associated with cancer care. To the extent that upper
gastrointestinal EUS enables a more accurate and timely diag-
nosis of cancer [16 – 19], the patterns of downstream care utili-
zation illustrated in this study provide insights on the intensity
of post-EUS care management as well as the clinical and finan-
cial justification for greater investment and adoption of EUS.

Although this is a single center study, the findings are con-
sistent with those from other similar studies published to date.

The earlier studies by Atkinson and Schmulewitz [13] and Hare-
wood et al. [8] have also shown large downstream revenues
post-EUS. The results from the cancer vs. non-cancer compari-
sions reported in this study are also comparable and consistent
with those reported by Sodikoff et al. [12] who demonstrated
care utilization differences between EUS patients with pancre-
atic cancer and those with non-pancreatic cancer. In that earlier
study, the authors reported that EUS patients with pancreatic
masses had a 29 % rate of surgery and 14 % chemoradiation
therapy, which is similar to this study’s finding of a 25 % surgery
admission rate among cancer patients.

Another important contribution of this study is the develop-
ment of a computer-programmable algorithm to identify upper
gastrointestinal EUS patients and the associated EUS-related
care utilizations from administrative data sources such as

table2

<table>
<thead>
<tr>
<th>Downstream utilization comparison by procedure category</th>
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<tbody>
<tr>
<td>All patients, n (%)</td>
</tr>
<tr>
<td>EGD (downstream or same day)</td>
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<tr>
<td>ERCP (downstream or same day)</td>
</tr>
<tr>
<td>EUS</td>
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<tr>
<td>Chemotherapy</td>
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<tr>
<td>Radiation Therapy</td>
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<td>Pathology</td>
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<tr>
<td>Radiology</td>
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<tr>
<td>Consults</td>
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<tr>
<td>Surgical Upper Gastrointestinal Admit</td>
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<tr>
<td>Medical Upper Gastrointestinal Admit</td>
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</tbody>
</table>

table3

<table>
<thead>
<tr>
<th>Sample category</th>
<th>Total upstream revenue, mean $ per case (95 %CI)</th>
<th>Total downstream revenue, mean $ per case (95 %CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sample (n = 436)</td>
<td>4373 (3227 – 5519)</td>
<td>34 231 (28 561 – 39 901)</td>
</tr>
<tr>
<td>By plan type: Commercial (n = 192)</td>
<td>3826 (2247 – 5406)</td>
<td>33 460 (26 971 – 39 950)</td>
</tr>
<tr>
<td>By plan type: Medicare (n = 244)</td>
<td>4803 (3167 – 6439)</td>
<td>34 837 (26 046 – 43 629)</td>
</tr>
<tr>
<td>By diagnosis1: Non-cancer (n = 351)</td>
<td>2663 (1634 – 3693)</td>
<td>23 377 (19 643 – 27 110)</td>
</tr>
<tr>
<td>By diagnosis1: Cancer (n = 85)</td>
<td>11 432 (7669 – 15 196)</td>
<td>79 053 (56 437 – 101 669)</td>
</tr>
</tbody>
</table>

CI, confidence interval.
1 Statistically significant at the 5 % level (P<0.0001).
claims data or existing EHR databases. The algorithm developed in this study uses information commonly available in large administrative data sources (CPT, Diagnosis Related Group (DRG), and International Classification of Diseases (ICD) 10 codes) to identify a large cohort of upper gastrointestinal EUS patients quickly and to capture all corresponding upper gastrointestinal-EUS related care utilization. This algorithm allows the methodological transparency needed to replicate readily the findings from this study in other settings. To our knowledge, no such method has been reported in previous studies.

This study is subject to several limitations. First, because this is a single center study, the generalizability of the findings is unknown. Geisinger is a major referral center in its service area and is the major provider of EUS and other specialty services in the area. Therefore, the downstream care capture rate is likely to be high, which may lead to an overestimation of downstream care utilization and revenue relative to other centers in different markets in which, for instance, patients may opt to have EUS treatment in one center but their follow-up care in other centers. At the same time, the capture of upstream utilization may be low because Geisinger is a tertiary care provider, which implies that not all of the upstream care provided to the patients in primary and secondary care is likely to be captured by Geisinger.

Second, the total revenue estimates were obtained from GHP, a single private health plan. To the extent that GHP may have unique contract arrangements with Geisinger and that GHP may employ its unique reimbursement and care management strategies, the upstream and downstream care utilization patterns reported in this study may reflect such unique plan-specific characteristics. Therefore, it is not clear how the results may differ if a similar study were to be conducted using data from the traditional fee-for-service Medicare rather than from a Medicare Advantage plan.

Third, the lengths of time used to define the upstream and downstream periods (60 days and 180 days, respectively) in this study are arbitrary. The patterns of care utilization and total average revenues associated with an episode of care as described in this study are therefore likely to be sensitive to different lengths of time chosen to define an episode. Further studies are necessary to develop a more refined and reliable way to define an episode of care in this context. Lastly, the data presented in this study are not representative of all of the patients who undergo upper gastrointestinal EUS procedures at Geisinger, as the sample explicitly excluded patients with Medicaid coverage or those who did not have GHP insurance coverage. Future studies may explore how the results may or may not differ if the sample had focused exclusively on the Medicaid patient population.

The episode-of-care approach to quantifying the revenue impact of upper gastrointestinal EUS to the providers, as illustrated in this study, suggests there are substantial downstream as well as upstream revenues associated with upper gastrointestinal EUS procedures, largely driven by patients who are diagnosed with cancer by the EUS procedures and subsequently require oncologic care.

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Competing interests

Yes. Daniel Maeng, PhD, has no conflicts that are relevant to this manuscript and has nothing to disclose. Beth Wall, RN, MS, is a full-time employee in health economics and reimbursement at Olympus America, Inc. Dina Hassen, MPP, has no conflicts that are relevant to this manuscript and has nothing to disclose. David L. Diehl, MD FACP, FASGE, is a consultant and lecturer at Olympus America, Inc.

References


