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Optimising the indications for biliary stent placement during endoscopic retrograde cholangiopancreatography: a quality improvement initiative to enhance patient care and reduce healthcare resource utilisation

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ABSTRACT

Background A retrospective chart audit was performed to review biliary stent utilisation from January 2020 to January 2021. Non-guideline-based stent insertion was identified in 16% of patients with common bile duct (CBD) stones presenting for endoscopic retrograde cholangiopancreatography (ERCP). To improve this knowledge-practice gap, a quality improvement (QI) intervention was devised and trialled.

Aim To synchronise clinical indications for biliary stent insertion in patients with CBD stones in accordance with published guidelines.

Methods Using a QI pre–post study design, chart audits were completed and shared with the ERCP team (n=6). Indication for biliary stent insertion was compared to published guidelines assessed by two reviewers independently (*kappa* statistic calculated). The QI intervention included an education session and quarterly practice audits. An interrupted time series with segmented regression was completed.

Results A total of 661 patients (337 F), mean age 59±19 years (range 12–98 years), underwent 885 ERCPs during this postintervention period. Of 661 patients, 384 (58%) were referred for CBD stones. A total of 192 biliary stents (105 plastic, 85 metal) were placed during the first ERCP (192/661, 29%), as compared with the preintervention year (223/598, 37%, p=0.2). Furthermore, 13/192 stents (7%) were placed not in accordance with published guidelines (*kappa*=0.53), compared with 63/223 (28%) in the preintervention year (p<0.0001). A 75% reduction in overall avoidable stent placement was achieved with a direct cost avoidance of $C97 500. For the CBD stone subgroup, there was an 88% reduction in avoidable biliary stent placement compared with the preintervention year (8/384, 2% vs 61/375, 16%, p<0.0001).

Conclusions Education with audit and feedback supported the closing of a knowledge-to-practice gap for biliary stent insertion during ERCP, especially in patients with CBD stones. This has resulted in a notable reduction of avoidable stent placements and additional follow-up ERCPs and an overall saving of healthcare resources.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The decision to place a plastic or metal stent during endoscopic retrograde cholangiopancreatography (ERCP) is made at the endoscopist's discretion, though standard-of-care practice guidelines exist. There is no published literature on the appropriateness of adherence to published guidelines with respect to the use of biliary stents during ERCP.

WHAT THIS STUDY ADDS

⇒ Provides insight into endoscopist variability and compliance to ERCP practice guidelines.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study highlights the importance of providing ongoing education on practice guidelines as well as regular audit to support physician practice behaviour change. This will lead to an improvement in patient care with a reduction in unnecessary procedures and an overall saving of healthcare resources.

⇒ Dissemination of such quality improvement projects will aim to improve the overall delivery of healthcare.

INTRODUCTION

Over the last two decades, endoscopic retrograde cholangiopancreatography (ERCP) has evolved from being a primary diagnostic tool to a predominantly therapeutic modality in the treatment of pancreaticobiliary diseases. Among many of its therapeutic capabilities is the ability to place a stent within the bile duct or pancreatic duct. The indications for stent placement are generally categorised based on the nature of the pancreaticobiliary disease into benign and malignant. There are published guidelines that help guide endoscopists in determining these indications for stent placement.[1] Main indications for biliary stenting include failed extraction of common bile duct (CBD) stones, treatment of benign and malignant biliary strictures, treatment of bile leaks and biliary stenting after endoscopic ampullectomy.[1]

The decision for stent placement (plastic or metal) is usually at the discretion of the endoscopist although standard-of-care practice does have an expectation to conform with published practice guidelines. There are no published reports that address issues of endoscopists/physicians not adhering to clinical practice guidelines, although there are anecdotal reports outlining the possibility of such practice as well as a discussion around potential factors that might contribute to this.[2 3]

Temporary placement of a biliary stent requires a subsequent ERCP for removal. Therefore, stents placed for indications not in accordance with accepted and published guidelines not only expose patients to increased risks of an additional ERCP but also increase the overall health resource utilisation. In addition, biliary stent insertion carries its own risk of complications as well including migration, occlusion or infection. From a resource perspective, reducing the number of avoidable stents can also achieve a substantial reduction in healthcare cost. Gardner *et al* found that the total ERCP cost/patient for placing a fully covered metal stent would be US$22 729 whereas placing an uncovered metal or plastic stent would cost US$24 874 and US$18 701, respectively.[4] Additionally, the cost of procedure-related complications, including the cost of hospital stay, and repeat ERCPs can be avoided.

Recently, the nursing management in the endoscopy unit of our hospital had expressed concern regarding an increase in the orders placed for biliary stents. Contributing factors to explain this perceived increase in biliary stent utilisation include an increase in the total number of ERCP procedures and/or an increase in avoidable stent usage by endoscopists. A quality assurance (QA) chart review to provide a baseline understanding followed by a quality improvement (QI) intervention was conducted to further evaluate this perceived increase in biliary stent usage and to ensure compliance with published guidelines of the European Society for Gastrointestinal Endoscopy (ESGE). This study also included an assessment of the clinical and cost outcomes by comparing the practice patterns of endoscopists performing ERCP. The objective of this QI study was to identify gaps in the current practice patterns, if any, relative to published guidelines for biliary stent use during ERCP and to develop appropriate interventions, based on these gaps, that were then evaluated prospectively.

METHODS

Setting

This study was conducted at the University of Alberta Hospital (UAH), a major referral centre in the western Canadian city of Edmonton, Alberta. We have an eight-room endoscopy suite and perform >18 000 endoscopic procedures annually. Of the 25 physicians in the Division of Gastroenterology and Hepatology, six physicians perform ERCPs.

Approach

This study was conducted in two phases. The preintervention chart audit or QA phase (QA, group I) was to understand and determine the endoscopist team ERCP practice patterns. The second was the QI phase (group II) that included intervention development, trial and assessing postintervention impact (chart audit and statistical analysis).

Preintervention/QA phase (group I)

To assess the patterns of biliary stent usage during ERCP, all consecutive patients presenting to the UAH for an ERCP between January 2020 and January 2021 were included in the group I chart audit. Data variables collected included patient age, sex, indications for ERCP and biliary stent placement, type and size of stent placed, type of sedation, adverse events (AEs) of the initial ERCP, need for hospitalisation after the procedure, hospital length of stay (in days), need for a subsequent ERCP with type of intervention and stent indwell time (in days).

The data were extracted by two reviewers (AD and GS). Two other reviewers (IA and MA) independently reviewed anonymised endoscopy reports for those patients who underwent biliary stent placement. Indications for stent placement were then assessed as 'in accordance' or 'not in accordance' with the ESGE guidelines for biliary stent placement.

The intervention

Using an education and practice audit approach, the results of the chart audit for group I were presented to the ERCP endoscopist team. Anonymised results were presented at our weekly GI division rounds on Monday, 31 May 2021. Individual results were given confidentially to each of the six ERCP endoscopists by the director of endoscopy. The QI intervention components recommended by the endoscopists were a targeted educational session for biliary stent insertion in accordance with published ESGE guidelines, as well as monthly chart audits to be performed for the year following the intervention. Quarterly reports were monitored, and individual endoscopists would be provided an audit report for feedback if a deviation in the pattern of biliary stent placement was identified.

Postintervention/QI phase (group II)

After the intervention, all consecutive patients presenting to the UAH for an ERCP between July 2021 and June 2022 were included in the group II chart audit.

The same data variables were extracted for these patients as was done for group I. The same two reviewers (IA and MA) again independently reviewed anonymised endoscopy reports for those patients who underwent biliary stent placement. Indications for stent placement were again assessed as 'in accordance' or 'not in accordance' with the same ESGE guidelines for biliary stent placement as used for group I.

Data analysis

Cost analysis

A cost analysis was completed comparing groups I and II to assess for incremental costs associated with avoidable ERCPs related to stent placement that were determined to be not in accordance with standard guidelines. The actual costs were calculated based on the Alberta Health Services fee codes (online supplemental table 1).

Chart audit analysis

For the preintervention and postintervention chart audit groups I and II, a *kappa* coefficient[5] was calculated to determine the per cent agreement between the two reviewers. The two reviewers were provided with blinded ERCP procedure reports, and they independently assessed whether stent placement was in accordance with published ESGE guidelines or not. For the cases where there was disagreement, they were provided additional information, such as the fluoroscopic images, after which they reached a mutually acceptable consensus regarding appropriateness. To determine differences in proportions, a two-proportion z-test was used. The aforementioned statistical analyses were performed in Microsoft Excel (2018, V.16.17).

Interrupted time series (ITS) analysis

Monthly counts of avoidable stent placements were extracted from the chart audit between January 2020 and June 2022. An interrupted time series (ITS) graph[6] was developed to display the pattern of avoidable stent placement during this study timeframe (monthly). Power and sample size calculations are difficult to complete; therefore, a simulation study was used, suggesting a minimum of 12 data points preintervention and postintervention.[7] A total of 30 months (data points) with a minimum of 16 months preintervention of ERCP data were collected, and 14 months postintervention. To estimate the intervention's statistically significant effect, an ITS with segmented regression analysis was performed. A time series is a continuous sequence of observations (values) on a population, taken repeatedly over time.[8] When an intervention is introduced in a defined time period, it interrupts the time series, allowing for the identification of change in level (the value at the beginning of the segment in series) and trend (slope of the line) before and after an intervention.[8–11] ITS analysis was performed using SAS Enterprise Guide V.8.3 and PROC AUTOREG (procedure autoregression). The approach used was to estimate the change (either a drop or a drop with a change in slope) in avoidable stent counts before and after the intervention.

RESULTS

Group I (preintervention)

Between January 2020 and January 2021, 598 patients (316 females and 282 males) with a mean age of 60±19 years (range 3–99 years) underwent a total of 842 ERCPs. Clinical indications for the initial ERCP were CBD stones (375, 63%), malignant stricture (83, 14%), benign stricture (40, 8%), bile leak (27, 5%), stent removal (18, 3%) and others (47, 8%). Of the 244 patients who had a follow-up ERCP, the most common interventions performed were stent removal (126, 52%), stent replacement (61, 25%), stent placement (28, 11%) and stone extraction (8, 3%) (table 1). A total of 296 biliary stents were inserted, of which 223 stents (114 plastic, 109 metal) were inserted during the first ERCP (223/598, 37%) and 73 stents (43 plastic, 30 metal) during follow-up ERCP (73/244, 30%).

Of the 296 stents, 79 (27%) were inserted for indications not in accordance with published guidelines (63/223 initial ERCP and 16/73 follow-up ERCP, *kappa*=0.62). Most of these were placed in CBD stone cases (61/63 initial ERCP and 6/16 follow-up ERCP). In the subgroup of 375 patients with CBD stones, 61 (16%) underwent stent placement not in accordance with published guidelines. The total cost of such stent insertions and follow-up ERCPs for stent removal was $C130 000.

The reasons identified as stent placement indications not in accordance with published ESGE guidelines include facilitation of drainage for postsphincterotomy ampullary oedema (despite documented clearance of duct in CBD stone cases), to prevent Mirizzi's syndrome (despite no evidence on cholangiogram), for postsphincterotomy bleeding (despite no documentation of active bleeding and/or injection therapy first), for CBD stricture (although none described on radiologist report) and some with no documented indication.

Group II (postintervention)

Between July 2021 and June 2022, 661 patients (337 females, 322 males and two others) with a mean age of 59±19 years (range 12–98 years) underwent a total of 885 ERCPs during this postintervention period. Of the 661 patients, 384 (58%) were referred for CBD stones (table 1). A total of 192 biliary stents (105 plastic, 87 metal) were placed during the first ERCP (192/661, 29%), as compared with the preintervention year (223/598, 37%, p=0.2). However, only 13/192 stents (7%) were placed not in accordance with published guidelines (*kappa*=0.53), compared with 63/223 (28%) in the preintervention year (p<0.0001, table 2). This accounts for a 75% reduction in overall avoidable stent placement. This reduction was mainly seen in the CBD stone subgroup, where there was an 88% reduction in avoidable biliary stent placement compared with the preintervention year (8/384, 2% vs 61/375, 16%, p<0.0001). Even though the differences were seen with both plastic and metal stents, the reduction in metal stent placement was statistically significant (online supplemental table 2). This QI

Table 1 Demographics of patients in preintervention (group I) and postintervention (group II) groups

	Group I	Group II
Patients, n (%)	598	661
Female	316 (53)	337 (51)
Male	282 (47)	322 (48)
Other	0	2 (1)
Age in years, mean±SD (range)	60±19 (3–99)	59±19 (12–98)
Total number of ERCPs, n	842	885
Initial ERCP		
1	598	661
Follow-up (F/U) ERCPs	244	224
2	177	151
3	47	53
4	13	13
5	4	6
6	2	1
7	1	0
Indication for initial ERCP, n (%)	598	661
CBD stone	375 (63)	384 (58)
Malignant biliary stricture	83 (14)	108 (16)
Benign biliary stricture	40 (8)	50 (8)
Bile leak	27 (5)	20 (3)
Stent removal	18 (3)	18 (3)
Chronic pancreatitis	9 (2)	21 (3)
Balloon-assisted ERCP	5 (1)	17 (3)
Sphincter of Oddi dysfunction	7 (1)	11 (2)
Acute pancreatitis	9	8
Occluded stent	5	6
Ampullectomy	7	4
Mirizzi's syndrome	0	4
Pancreatic leak	5	4
Cholangioscopy	1	2
Postsphincterotomy bleed	1	2
Pancreatitis prophylaxis	2	1
Unclear	1	1
Abdominal pain	1	0
Recurring pancreatitis	2	0
Intervention during F/U ERCP, n (%)	244	224
Stent removal	126 (52)	91 (41)
Stent replacement	61 (25)	39 (17)
Stent placement	28 (11)	48 (21)
Stone extraction	8 (3)	11 (5)
No intervention	15	12 (5)
Dilation	1	9
Failed cannulation	1	9
Sphincterotomy only	4	3
Brushings/biopsy	0	1
Rendezvous ERCP	0	1

Continued

Table 1 Continued

CBD, common bile duct; ERCP, endoscopic retrograde cholangiopancreatography.

intervention yielded a cost avoidance of $C97 000 (calculated based on percentage reduction) in avoidable stent-related expenses (cost of stent and follow-up ERCP for stent removal).

Interendoscopist variability

Table 3 shows the rate of interendoscopist variability in avoidable stent placement in groups I and II. Endoscopist 1 had the greatest number of avoidable stent placements in group I but demonstrated a significant reduction in such placements in group II (57/79 vs 7/23, respectively, p=0.02). None of the other endoscopists demonstrated significant rates of avoidable stent placement or any change in practice between groups I and II.

In terms of experience, two endoscopists had <5 years, one had 5–10 years, two had 10–20 years and one had >20 years of practice doing ERCP. The most senior endoscopist did not have a dedicated training year in advanced endoscopy whereas the remaining five had undergone dedicated advanced endoscopy training in reputable centres in North America and Europe. Training and experience were not seen to be associated with a higher likelihood of placing stents not in accordance with published guidelines.

Table 2 Proportion of avoidable stent placement in total cohort and in subgroup of those with CBD stones

	Group I	Group II	P value
Patients, n	598	661	
Total ERCPs	842	885	
a) 1 ERCP	598	661	
b) >1 ERCP	244	224	
Patients with CBD stones, n	375	384	
Total biliary stents, n			
a) Initial ERCP	223	192	
b) Follow-up (F/U) ERCP	73	78	
Avoidable stents, n (%)			
a) In total cohort	63/598 (11)	13/661 (2)	<0.0001
b) In CBD subgroup	61/375 (16)	8/384 (2)	<0.0001
c) Proportion of total stents	63/223 (28)	13/192 (7)	<0.0001

CBD, common bile duct; ERCP, endoscopic retrograde cholangiopancreatography.

Table 3 Avoidable stent placement between groups I and II by endoscopist

Endoscopist	Group I			Group II			P value
	First ERCP (n=598)	F/U ERCP (n=244)	Total (n=842)	First ERCP (n=661)	F/U ERCP (n=224)	Total (n=885)	
1	44/144	13/73	57/217	4/109	3/22	7/131	0.02
2	11/141	1/61	12/202	2/170	3/48	5/218	10.38
3	5/98	1/49	6/147	5/111	3/58	8/169	74.95
4	2/9	0/2	2/11	2/93	1/41	3/134	0.04*
5	1/129	1/36	2/165	0/105	0/21	0/126	4.37
6	0/77	0/23	0/100	0/73	0/34	0/107	ns†
Total	63/598	16/244	79/842	13/661	10/224	23/885	

*Endoscopist #4 had just been recruited shortly before the end of the chart audit for group 1, thereby explaining the small number of cases. Therefore, even though the p value=0.04, it is likely because of the extremely small sample size in group 1 and is not valid.
†Endoscopist #6 had no inappropriate stent placements in either group I or II, and therefore the p value could not be computed.
ERCP, endoscopic retrograde cholangiopancreatography ; F/U, follow-up.

Adverse events

AEs were defined based on published criteria.[12] There were no significant differences in the AEs between patients who received avoidable or guideline-based stents in groups I and II (online supplemental table 3).

As most of the stents not in accordance with guidelines were placed in patients with CBD stones, we looked at the AEs in this subgroup between patients who received a stent compared with those who did not.

In group I, 375 patients had CBD stones. Of these, 107 patients had stents placed (101 biliary, and six pancreatic) and 268 had no stents placed. In the 101 patients who had biliary stents placed, 10 AEs were identified (five stent migration, three cholangitis, one postsphincterotomy bleeding and one duodenal perforation). Five patients were already admitted, one required admission after the procedure, and five did not require admission. Repeat ERCP was performed in 14 patients but only two of these required intervention for an AE (both cholangitis). In the 268 patients who had no stents placed, we were only aware of three AEs (all postsphincterotomy bleeding). One patient was already admitted, one required admission, and one did not require admission. Repeat ERCP was required in 22 patients, and none in those with an identified AE. There was a statistically significant difference in the observed AEs between those who had biliary stents compared with those that did not (10/101 vs 3/268, p=0.01).

In group II, 384 patients had CBD stones. Of these, 49 patients had stents placed (42 biliary and seven pancreatic) and 335 had no stents placed. In the 42 patients who had biliary stents placed, six AEs were identified (all postsphincterotomy bleeding). All six patients were already admitted. Repeat ERCP was performed in 13 patients but none for an AE. In the 335 patients who had no stents placed, we are only aware of 11 AEs (six postsphincterotomy bleeding, two deaths, one cholangitis, one post-ERCP pancreatitis and one respiratory insufficiency). Seven patients were already admitted, one required admission and three did not require admission. Repeat ERCP was required in 18 patients, but only two of these required intervention for an AE (both postsphincterotomy bleeding). There was no statistically significant difference in the observed AEs between those who had biliary stents compared with those who did not (6/42 vs 11/335, p=0.29).

Also, there was no statistically significant difference between the patients who had stents placed in group I compared with those with stents placed in group II (10/101 vs 6/42, p=50.17).

Furthermore, we also looked at the indications for repeat ERCP in those patients with CBD stones who did not have a stent placed. In group I, 22/268 patients who did not have stents placed underwent repeat ERCP. The reasons for repeat ERCP were stent removal in eight (one prior inappropriately placed stent, one pancreatic stent placed during prior ERCP, one for suspected stent occlusion and five prior appropriately placed stents), sphincterotomy only in three (two prior failed cannulations and one patient presented postlaparoscopic cholecystectomy (LC), where there was a suspected stone but none extracted on balloon sweep), stone extraction in eight (three with prior failed cannulations, two with recurrent stones after prior LC and three prior to LC) and no intervention in three (two prior to LC and one after, but no stone seen on cholangiogram in any patient). In group II, 18/335 patients who did not have stents placed underwent repeat ERCP. The reasons for repeat ERCP were stent removal in three (one prior inappropriately placed stent, one pancreatic stent placed during prior ERCP and one where multiple large stones underwent mechanical lithotripsy previously but duct could not be completely cleared), sphincterotomy only in three (one prior failed cannulation, one patient was on rivaroxaban during prior ERCP and one where there was a suspected stone but none extracted on balloon sweep), stone extraction in nine (six with prior failed cannulations, two with recurrent stones after prior LC and only one

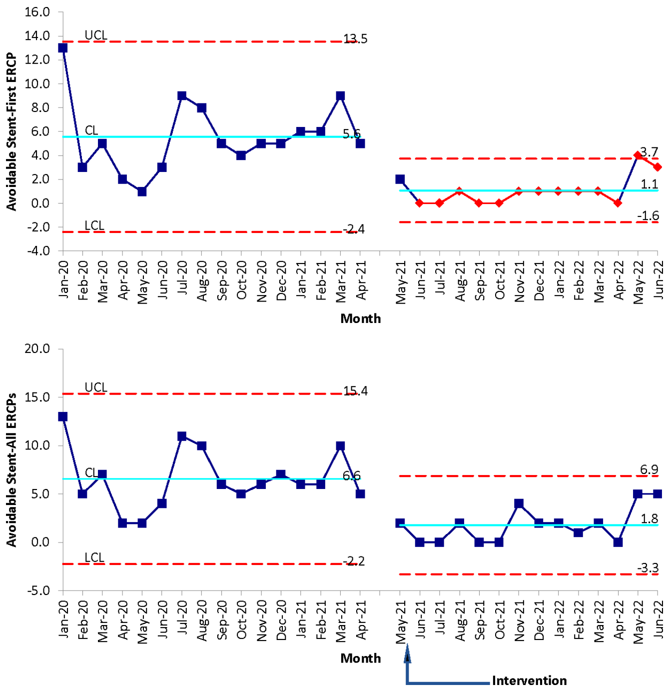

Figure 1 Interrupted time series graph showing the pattern of avoidable stent placement by month during the study period, before and after the intervention. ERCP, endoscopic retrograde cholangiopancreatography.

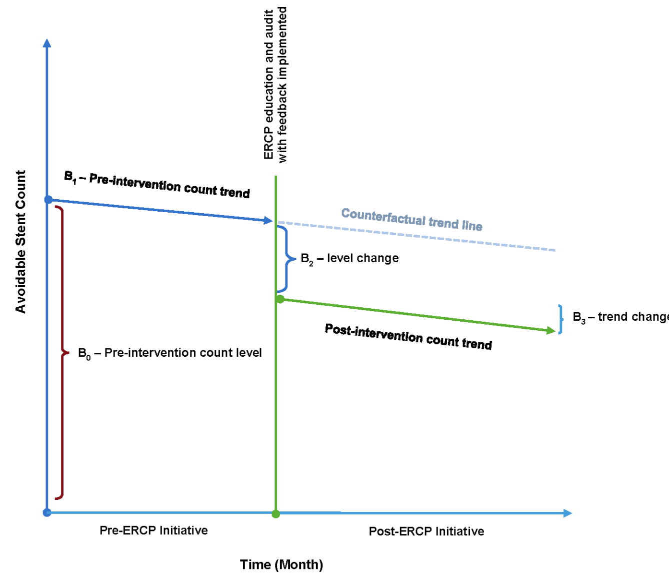

Figure 2 Impact model for segmented regression analysis of interrupted time series data with one interruption. ERCP, endoscopic retrograde cholangiopancreatography.

prior to LC in a 92-year male where LC was not considered due to age and comorbidity), no intervention in one (stone suspected but none seen on cholangiogram) and failed prior cannulation in two. There was no statistically significant difference between the two groups (22/268 vs 18/335, p=19.3).

Single series ITS with segmented regression

The ITS graph shows the pattern of avoidable stent placement both for the first ERCP and for all ERCPs over the duration of the study period (figure 1). Test statistics for the regression model (figure 2) suggested that the data had positive autocorrelation (Durbin-Watson (DW)=1.623, p value <DW=0.0472), and data was stationary (p value (Dickey-Fuller test)=0.0127). Autocorrelation function and partial autocorrelation function were used to identify the number of significant lags, where a lag is the number of time points between an observation and its previous values. As a result, an AR (1) model (or autoregressive (1) model, is one in which the current value of the variable is based on the immediately preceding value)[11] was employed for this analysis. Online supplemental table 4 shows the parameter estimates from ITS regression. Before the beginning of the intervention timeframe, the number of avoidable stents was 6.3. During the preintervention period, the regression slope was −0.03 and showed no significant month-to-month change (p=0.825). At the time of the intervention, there was an immediate significant drop by 6.1 (p=0.0088) in avoidable stents count. The post-intervention timeframe indicated no significant change in the month-to-month slope after the intervention (p=0.3051) suggestive of a sustained reduction (online supplemental file: statistical analysis).

DISCUSSION

The results of the preintervention chart audit confirmed the perception of the increase in biliary stent placement during ERCP and validated the need for an improvement initiative. Further evaluation by two independent and blinded reviewers confirmed that 13% of patients who underwent ERCP had biliary stents placed for indications that were not in accordance with published guidelines. This constituted 27% of the total number of stents inserted during the preintervention/QA phase. A subgroup analysis concluded that most of these avoidable stents were inserted in patients who presented with CBD stones.

QI interventions encompass a range of approaches that are innovative and diverse. One such frequently employed intervention involves conducting systematic audits, organising educational sessions and providing feedback. This has been consistently shown to lead to favourable outcomes.[13 14] Our QI intervention consisted of an educational session provided to the UAH endoscopist team and quarterly audit reports. The objectives of this session were to update the physicians about the findings of the QA study, review the published ESGE guidelines and increase awareness of the QI intervention with prospective chart audits.

Despite no statistically significant reduction in the total number of biliary stents inserted between the two phases, there was a statistically significant reduction in the total number of avoidable biliary stent insertions in the post-intervention Group II. This was mainly achieved by reducing the number of avoidable biliary stent insertions in patients with CBD stones. In addition, there was a notable reduction in costs associated with this reduction when accounting for the cost of stent and follow-up ERCP for stent removal. However, despite the differences in the rate of avoidable stent placement between groups I and II, there was no increase in the rates of AEs. The outcomes of our study are regarded as service or program-related improvement,[13 14] and our future initiatives to ensure long-term viability involve annual educational sessions and developing online modules to assess and prompt endoscopists regarding revised guidelines. Additionally, anonymous data charts can be generated using electronic medical records on an annual basis and shared with endoscopists, showing their patterns of practice in comparison to peers at their centre as well as at a provincial/national level.

Our study has limitations as it was conducted at a single centre, involving a small sample size using retrospective data. To ensure objectivity in our assessment, we adhered to the published guidelines of the ESGE, and to prevent bias, independent assessors were unaware of the identity of the physicians who performed the procedure. Also, as our study was a retrospective chart audit, rigorous follow-up was a limitation, especially considering that a large proportion of patients are referred to us from urban, suburban, and rural community hospitals for the procedure and then returned to their referring hospital afterwards. We are not always notified of every AE, and occasionally patients may get referred to another hospital for management of an AE ensuing from our procedure.

The reasons for placement of avoidable stents can be categorised into clinical and personal categories. The clinical reason could be attributed to uncertainty about diagnosis, while some of the personal reasons may relate to lack of awareness and/or adherence to published guidelines, lack of training or experience (although admittedly, there are a number of situations in which placing a stent could be equivocal for which experience and having another opinion can be key in making decisions), reluctance to change practice patterns due to habit or inertia, influence of local culture or practice environment or due to conflict of interest. Conflict of interest is defined as 'a set of circumstances that creates a risk that professional judgement or actions regarding a primary interest will be unduly influenced by a secondary interest'.[2] Secondary interests include financial gain and/or professional prestige or advancement.[3]

Some clinical indications may warrant deviation from published guidelines, and if there is a need to place a biliary stent in the opinion of the endoscopist, it would be an acceptable practice, provided there is a reasonable indication. However, complete clearance of the CBD on occlusion cholangiography, postsphincterotomy oedema, and prophylactic placement of a metal stent to prevent postsphincterotomy bleeding do not appear to be valid reasons for stent placement after CBD stone clearance. These are some examples of indications used to justify stent placement in those deemed not in accordance with published guidelines. Moreover, only one endoscopist used these criteria as indications for stent placement. This was not in keeping with peer practice at our centre as the other five endoscopists did not use these indications for stent placement after CBD stone clearance, and there was no difference in clinical outcomes in their cases. Furthermore, the endoscopist in question clearly changed practice after the results of the preintervention analysis were shared with the group, as evidenced by the postintervention analysis. The number of inappropriate stent placements was significantly reduced and none of the above-listed indications were used for stent placement in the postintervention phase.

Despite these findings, we felt that in order to encourage a positive change in practice among our endoscopist team and to not isolate any physician member, a non-punitive approach using education and a reflection of practice report audit and feedback was more favourably viewed as a change management strategy rather than using punitive methods. That is why we chose not to pursue any secondary interests, such as financial gain, as possible explanations. Even though we can only speculate on the reasons behind the interendoscopist differences seen in avoidable stent placement, it is encouraging that our QI intervention has led to a significant alignment with published guidelines.

In conclusion, this study showed that a combination of education with physician-level audit reports resulted in a significant reduction in avoidable biliary stent insertion. This was mainly achieved by reducing the number of avoidable biliary stents in the CBD stone group and resulted in notable savings in healthcare resources. We are recommending that changes be made to our electronic medical record system to ensure that indications for biliary stent placement during ERCP are made a mandatory quality criterion in order to simplify auditing for purposes of ongoing quality assessment. Extending such interventions to other jurisdictions will help to attain an optimal patient-centred medical care approach that aligns with guideline-directed therapy and leads to tangible reductions in healthcare costs.

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Contributors Guarantor of the article: GS; specific author contributions: SA—data review and critical review of the manuscript; IA—drafting and critical review of the manuscript; MA—data review and critical review of the manuscript; AD—data retrieval and critical review of the manuscript; MM—critical review of the manuscript; SZ-G—critical review of the manuscript; PM—statistical analysis and critical review of the manuscript; JZ—statistical analysis and critical review of the manuscript; GS—study concept, data retrieval and database entry, statistical analysis, drafting and critical review of the manuscript.

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Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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REFERENCES

1 Dumonceau J-M, Tringali A, Papanikolaou IS, *et al*. Endoscopic biliary stenting: indications, choice of stents, and results: European Society of Gastrointestinal Endoscopy (ESGE) Clinical Guideline - Updated October 2017. *Endoscopy* 2018;50:910–30.
2 Lo B, Field MJ. Conflict of interest in medical research, education, and practice. In: *Institute of medicine committee on conflict of interest in medical research*. Washington, D.C: National Academies Press, 2009.
3 Ginsburg S, Levinson W. Is There a Conflict of Interest? *JAMA* 2017;317:1796–7.
4 Gardner TB, Spangler CC, Byanova KL, *et al*. Cost-effectiveness and clinical efficacy of biliary stents in patients undergoing neoadjuvant therapy for pancreatic adenocarcinoma ina randomized controlled trial. *Gastrointest Endosc* 2016;84:460–6.
5 Cohen J. A coefficient of agreement for nominal scales. *Educ Psychol Meas* 1960;20:37–46.
6 Chatfield C. *The analysis of time series: an introduction*. 6th edn. Chapman and Hall/CRC, 2003.
7 Zhang F, Wagner AK, Ross-Degnan D. Simulation-based power calculation for designing interrupted time series analyses of health policy interventions. *J Clin Epidemiol* 2011;64:1252–61.
8 Bernal JL, Cummins S, Gasparrini A. Interrupted time series regression for the evaluation of public health interventions: a tutorial. *Int J Epidemiol* 2017;46:348–55.
9 Linden A. Conducting interrupted time-series analysis for single- and multiple-group comparisons. *Stata J* 2015;15:480–500.
10 Ramsay CR, Matowe L, Grilli R, *et al*. Interrupted time series designs in health technology assessment: lessons from two systematic reviews of behavior change strategies. *Int J Technol Assess Health Care* 2003;19:613–23.
11 Wagner AK, Soumerai SB, Zhang F, *et al*. Segmented regression analysis of interrupted time series studies in medication use research. *J Clin Pharm Ther* 2002;27:299–309.
12 Dumonceau J-M, Kapral C, Aabakken L, *et al*. ERCP-related adverse events: European Society of Gastrointestinal Endoscopy (ESGE) Guideline. *Endoscopy* 2020;52:127–49.
13 Dilley JA, Bekemeier B, Harris JR. Quality improvement interventions in public health systems: a systematic review. *Am J Prev Med* 2012;42:S58–71.
14 Itri JN, Bakow E, Probyn L, *et al*. The Science of Quality Improvement. *Acad Radiol* 2017;24:253–62.