Challenging dogmas in pancreatic surgery: biliary drainage, outcome and beyond
van der Gaag, N.A.

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Chylous Ascites after Pancreato-duodenectomy: Introduction of a Grading System

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ABSTRACT

Background
Chylous ascites (CA) is a complication that follows thoracic and abdominal surgery, recognized after provocation by enteral feeding and characterized by its milky appearance from an elevated triglyceride level. The aim of this study was to evaluate incidence, management, and predisposing factors of CA and its impact on outcomes after pancreatoduodenectomy.

Study design
Between 1996 and 2007, 609 consecutive patients underwent pancreatoduodenectomy. Patients having a drain output with a milky appearance, and with a triglyceride level greater than 1.2 mmol/L, were compared with patients without significant drain production or with a low triglyceride level. Management of CA was reviewed.

Results
Sixty-six patients had isolated CA (11%) of any measurable volume, 440 patients (72%) had no CA, and 109 patients (16%) were excluded from analysis. CA was diagnosed on postoperative day 6 (median; interquartile range 5 to 8), generally after introduction of a normal (polymeric low-chain-triglyceride) diet. Female gender (odds ratio, 1.79; 95% CI, 1.05 to 3.03) and chronic pancreatitis at pathology (odds ratio, 2.52; 95% CI, 1.19 to 5.32) were independently associated with development of isolated CA. A low-chain-triglyceride–restricted diet was initiated in 47 patients, 3 were started on total parenteral nutrition, and an expectative approach was followed in 16 patients. CA resolved after 3.5 days (median; interquartile range, 2 to 5). Isolated CA was significantly associated with prolonged hospital stay (p=0.002).

Conclusions
We propose a novel definition and grading system for CA after pancreatoduodenectomy, according to which the incidence is 9%, with clinically significant CA occurring in 4% (grades B and C). Although female gender and (focal) chronic pancreatitis were associated with development of isolated CA, no predisposing factors that could readily anticipate CA were identified. Isolated CA was associated with prolonged hospital stay.
INTRODUCTION

Leakage of chyle is an uncommon but potentially hazardous complication in thoracic and head-and-neck surgery. Accumulation of chyle in the peritoneal cavity, termed chylous ascites (CA), is a rare condition in abdominal surgery, described mainly after aortic surgery and extended retroperitoneal lymphadenectomy for urologic malignancies. Postoperative CA usually develops as a result of direct operative trauma to the thoracic duct, cisterna chyli, or their major tributaries; the extensive loss of lymph nodes after resection procedures prohibits adequate drainage, causing congestion of upstream lymph ducts.

Chyle consists of intestinal lymphatic fluid enriched after feeding with fat-soluble vitamins and long-chain triglycerides (TG) incorporated in chylomicrons. The fat component accounts for the milky appearance of chyle. Because lymphatic fluid contains lymphocytes and immunoglobulins, loss of the fluid results in lymphocytopenia, which renders patients susceptible to infection-related complications. In thoracic surgery, leakage of chyle results in a significant increase of pulmonary complications and is associated with increased mortality. The most common presenting symptom after abdominal surgery is abdominal distention.

The mainstay of CA treatment is conservative management with dietary measures, involving a high-protein, low-fat, medium-chain-triglyceride (MCT)–containing diet or total parenteral nutrition (TPN), intended to decrease the flow of lymph. Administration of somatostatin has also been reported to be beneficial. In intractable cases of CA (repeated), paracentesis or surgical treatment by peritoneovenous shunting or direct suture ligation of leaking lymphatic channels are last-resort options.

Except for a few case reports and a recent small series, studies on CA in large series of patients who underwent a pancreatoduodenectomy (PD) do not exist. This might be because of its low incidence, but also from the lack of a clear definition of CA after this particular type of surgical intervention, resulting in the unavailability of data. So the aim of this study was to assess the incidence and management of CA in patients who underwent pancreatoduodenectomy with curative intent, to analyze predisposing factors, and to evaluate the impact on patient outcomes.
METHODS

Patients underwent a pancreatoduodenectomy, or the pylorus-preserving modification (PPPD), at the Academic Medical Center between January 1996 and December 2007. A prospective database collected clinicopathological data and postoperative dietary measures for each patient. The operations were performed with curative intent, i.e., in the absence of local irresectability or distant metastases.

Briefly, PPPD was the standard surgical procedure, with concomitant resection of the following lymph node groups: anterior and posterior pancreaticoduodenal lymph nodes (stations 11a/b, 17a/b), nodes of the anterior-superior region of the common hepatic artery (station 8a), nodes on the right side of the hepatoduodenal ligament (stations 12b/4, 12c), and lymph nodes to the right of the superior mesenteric artery (station 14a/b).23;24 When nodes at the celiac trunk (station 9) were positive at frozen section during laparotomy, resection was abandoned and a palliative biliary and gastric bypass was performed. In case of suspicious tumor ingrowth in the proximal duodenum or pylorus, a standard Whipple procedure was performed. Reconstruction consisted of a retrocolic jejunal loop with an end-to-side pancreaticojejunostomy, hepaticojejunostomy, and gastro- or duodenojejunostomy. In 2000 we abandoned the strategy of routine application of a feeding jejunostomy with early enteral feeding (within 24 hours), because a prospective study could not demonstrate any benefit.25 Drain management consisted of leaving a subhepatic silicone drain extending to the pancreatic anastomosis; output in the postoperative course was measured daily. The drain was removed when the output had fallen below 100 mL/day and had an amylase content lower than 3 times the upper normal serum value. Until 2004, somatostatin was administered routinely (0.1 mg octreotide, 3 times daily subcutaneously for 7 days) as a measure to prevent pancreatic leakage. Thereafter, administration of somatostatin was restricted to patients with a soft pancreas, as encountered during operation, or with a nondilated (< 3 mm) pancreatic duct.

A drain output with milky appearance, concurrent with the start of enteral feeding, with a TG concentration greater than 1.2 mmol/L, was defined as CA.26 For this study, patients with CA, a low TG level in drain output, or no significant drain output were included. Patients with a drain output on or after postoperative day 3 with an amylase content greater than three times the serum amylase activity, considered to indicate pancreaticojejunostomy leakage, were excluded. Patients with bilirubin in the drain output (leakage from the hepaticojejunostomy) and patients who lacked TG measurement of drain output were excluded so we could specifically assess the incidence of isolated CA, its management, and the outcomes of dedicated therapeutic measures. Leakage from pancreaticojejunostomy or hepaticojejunostomy requires mostly major interventions, including dietary measures, which, in the presence of CA, complicate analysis of treatment effect. In addition, amylase or bilirubin could interfere with the TG content of drain output, complicating the diagnosis of isolated CA. Generally, primary treatment of CA has consisted of a low-chain-triglyceride (LCT)–restricted diet with substitution of high protein content.
## Abbreviations and Acronyms

- **CA** = chylous ascites
- **IQR** = interquartile range
- **LCT** = low-chain triglyceride
- **OR** = odds ratio
- **PD** = pancreaticoduodenectomy
- **PPPD** = pylorus-preserving pancreaticoduodenectomy
- **TG** = triglyceride
- **TPN** = total parenteral nutrition

## Table 1
Clinicopathological characteristics of 66 patients (11%) with isolated CA and 440 patients (72%) without CA.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CA (N=66)</th>
<th>No leakage (N=440)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>63 (12)</td>
<td>63 (11)</td>
<td>0.935</td>
</tr>
<tr>
<td>Female gender, n (%)</td>
<td>36 (54)</td>
<td>185 (42)</td>
<td>0.056</td>
</tr>
<tr>
<td>ASA classification, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 1,2</td>
<td>54 (82)</td>
<td>362 (82)</td>
<td>0.928</td>
</tr>
<tr>
<td>Class 3</td>
<td>12 (18)</td>
<td>78 (18)</td>
<td></td>
</tr>
<tr>
<td><strong>Surgical management</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of operation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD, n (%)</td>
<td>10 (15)</td>
<td>45 (10)</td>
<td>0.231</td>
</tr>
<tr>
<td>PPPD, n (%)</td>
<td>56 (85)</td>
<td>395 (90)</td>
<td></td>
</tr>
<tr>
<td>Somatostatin, n (%)</td>
<td>57 (84)</td>
<td>371 (84)</td>
<td>0.668</td>
</tr>
<tr>
<td>Feeding jejunostomy</td>
<td>31 (47)</td>
<td>153 (35)</td>
<td>0.055</td>
</tr>
<tr>
<td>Blood transfusion (≤24hrs)</td>
<td>18 (27)</td>
<td>112 (26)</td>
<td>0.753</td>
</tr>
<tr>
<td>Pathology, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>46 (70)</td>
<td>326 (74)</td>
<td>0.451</td>
</tr>
<tr>
<td>Other (pre)malignancy</td>
<td>3 (5)</td>
<td>41 (9)</td>
<td>0.247</td>
</tr>
<tr>
<td>Cystic tumor</td>
<td>6 (9)</td>
<td>38 (9)</td>
<td>0.903</td>
</tr>
<tr>
<td>(Focal) chronic pancreatitis</td>
<td>11 (17)</td>
<td>35 (8)</td>
<td>0.022†</td>
</tr>
<tr>
<td>Tumor diameter, cm, median (min-max)</td>
<td>2.4 (0.5-11)</td>
<td>2.7 (0.5-11)</td>
<td>0.315</td>
</tr>
<tr>
<td>N stage, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N0</td>
<td>28 (54)</td>
<td>178 (40)</td>
<td>0.279</td>
</tr>
<tr>
<td>N1</td>
<td>24 (44)</td>
<td>210 (54)</td>
<td></td>
</tr>
<tr>
<td>Resected nodes, n, mean (SEM)</td>
<td>7 (0.65)</td>
<td>7 (0.29)</td>
<td>0.803</td>
</tr>
<tr>
<td>Positive nodes, n, mean (SEM)</td>
<td>1 (0.25)</td>
<td>2 (0.12)</td>
<td>0.224</td>
</tr>
<tr>
<td>Radicallty, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R0</td>
<td>40 (77)</td>
<td>277 (71)</td>
<td>0.404</td>
</tr>
<tr>
<td>R1</td>
<td>12 (23)</td>
<td>111 (29)</td>
<td></td>
</tr>
<tr>
<td>Differentiation (of adenocarcinoma), n (%)</td>
<td>14 (30)</td>
<td>142 (44)</td>
<td>0.091</td>
</tr>
<tr>
<td>Moderate/good</td>
<td>32 (70)</td>
<td>184 (56)</td>
<td></td>
</tr>
</tbody>
</table>

* Fisher’s exact test, chi-square test, Mann-Whitney U test with P<0.05 considered significant.
† P<0.05.
‡ Analyzed for patients with adenocarcinoma, other (pre)malignant or malignant cystic lesions.
ASA, American Society of Anesthesiologists; CA, chylous ascites; PD, pancreaticoduodenectomy; PPPD, pylorus-preserving PD; R0, microscopically radical resection; R1, microscopic tumor left behind.
Baseline characteristics, operative management, and pathologic findings for patients with or without isolated CA were compared. The incidence of additional surgical and nonsurgical complications, with the exception of anastomotic leakage, was assessed to evaluate the impact of isolated CA on outcomes. Type of management initiated for isolated CA and the results were analyzed.

SPSS statistical software, version 14.0.2 (SPSS, Inc), was used for statistical analysis. Mean ± SD, or median with range if not normally distributed, described continuous parameters. Student’s t-test, Mann-Whitney U test, or Fisher’s exact test, used where appropriate, analyzed the differences in the various parameters between patients with and patients without isolated CA. Logistic regression sought to identify factors associated with development of isolated CA, and linear regression investigated the impact of CA on ICU and hospital stay. A P-value less than 0.05 was considered statistically significant.

RESULTS

During the study period, 609 consecutive patients underwent a PD or PPPD for a suspected pancreatic or periampullary malignancy, and 1 patient for a traumatic pancreas rupture. Patients who underwent PD for pain associated with chronic pancreatitis were not included. Anastomotic leakage or the lack of TG-level measurement of drain output, precluding laboratory confirmation of CA, was the reason for exclusion of 103 of 609 patients (17%). Isolated CA occurred in 66 patients (11%); 440 patients (72%) had no significant drain output or a TG level below the cut-off level of 1.2 mmol/L.26

Laboratory-confirmed CA was diagnosed after a median of 6 days (range 3 to 52 days), with a 75th percentile of 8 days, i.e., three-quarters of CA cases were detected between postoperative days 3 and 8. Presentation of CA in all but three patients consisted of a drain output with milky appearance after the introduction of a polymeric LCT-containing diet; the patients remained clinically well. The remaining 3 patients complained of distended abdomen, for which paracentesis and analysis of aspirated fluid revealed CA (in 2 patients at readmission 2 weeks after discharge). The median TG concentration of drain output, with a median volume of 500 mL (range 15 to 2,100 mL), was 2.6 mmol/L (range 1.21 to 17.1 mmol/L) at time of diagnosis.

Table 1 summarizes the clinicopathological characteristics of patients with and without isolated CA. Baseline characteristics (age, gender, American Society of Anesthesiologists classification), perioperative characteristics (type of operation, feeding jejunostomy, routine somatostatin administration, perioperative blood transfusion), N stage, number of resected lymph nodes, and residual tumor status were not significantly different between groups. Focal chronic pancreatitis as final diagnosis at pathology was present significantly more often in patients with isolated CA (p<0.02). Regression analysis demonstrated that female gender, feeding jejunostomy, focal chronic pancreatitis, and differentiation grade of adenocarcinoma were associated

with development of isolated CA at the \( p \leq 0.1 \) level (Table 2). Multivariable analysis of these variables demonstrated that female gender (odds ratio [OR], 1.78; 95% CI, 1.05 to 3.03; \( p=0.034 \)) and chronic pancreatitis (OR, 2.52; 95% CI, 1.19 to 5.32; \( p=0.016 \)) were independent associated factors. When differentiation grade was entered into the model, a variable applicable only to patients with adenocarcinoma, female gender failed to reach significance (data not shown).

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Uni- and multivariable logistic regression for factors associated with development of chylous ascites.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Univariable</strong></td>
</tr>
<tr>
<td></td>
<td><strong>OR</strong></td>
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<tr>
<td>Patient factors</td>
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</tr>
<tr>
<td>Age, 1-year increments</td>
<td>1.00</td>
</tr>
<tr>
<td>Female gender</td>
<td>1.65</td>
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<tr>
<td>ASA classification 3 (compared with 1 and 2)</td>
<td>1.03</td>
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<tr>
<td>Surgical management</td>
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<tr>
<td>PPPD (compared with PD)</td>
<td>0.64</td>
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<tr>
<td>Routine somatostatin</td>
<td>1.18</td>
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<tr>
<td>Feeding jejunostomy</td>
<td>1.66</td>
</tr>
<tr>
<td>Blood transfusion within ( \leq 24 ) hrs</td>
<td>1.01</td>
</tr>
<tr>
<td>Pathology</td>
<td></td>
</tr>
<tr>
<td>Histology</td>
<td></td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>0.80</td>
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<tr>
<td>Other (pre)malignancy</td>
<td>0.46</td>
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<tr>
<td>Cystic tumor</td>
<td>1.06</td>
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<tr>
<td>(Focal) chronic pancreatitis</td>
<td>2.31</td>
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<tr>
<td>Tumor diameter &gt;2.6 cm (median)</td>
<td>0.76</td>
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<tr>
<td>Presence of lymph node metastasis (N1)</td>
<td>0.73</td>
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<tr>
<td>Resected nodes ( \geq 7 ) (median)</td>
<td>1.29</td>
</tr>
<tr>
<td>Microscopic tumor left (R1)</td>
<td>0.75</td>
</tr>
<tr>
<td>Differentiation moderate/good (compared with poor)§</td>
<td>1.76</td>
</tr>
</tbody>
</table>

* Variables with \( p<0.1 \) were subsequently entered in multivariable analysis, in which variables with \( p<0.05 \) were considered to be independently associated with development of isolated chylous ascites.
† \( p<0.1 \).
‡ \( p<0.05 \).
§ Variable confined to patients with adenocarcinoma.
ASA, American Society of Anesthesiologists; OR, odds ratio; PD, pancreatoduodenectomy; PPPD, pylorus-preserving pancreatoduodenectomy.

After establishing a diagnosis of CA, an expectative approach was followed in 16 patients; in 50 patients dietary therapy was started. Patients who received therapy had a significantly higher drain output on day of diagnosis compared with patients who underwent an expectative approach, i.e., 600 mL (median interquartile range...
[IQR, 400 to 963 mL] versus 275 mL (median IQR, 133 to 494 mL; p<0.001; Fig. 1). Forty-seven patients were started on an LCT-restricted diet; two of these patients underwent earlier (diagnostic) paracentesis. Another three patients were started on total parenteral nutrition (TPN) at the discretion of the treating surgeon, in one of these patients also after a (diagnostic) paracentesis. TPN was switched to an oral LCT-restricted diet after several days. Once therapy was started, isolated CA resolved after a median of 3.5 days (range 1 to 16 days). One of the two readmitted patients was readmitted a second time because of general malaise. A transanal puncture of an encapsulated CA collection in the rectovesical pouch was performed, and the patient quickly recovered.

Figure 1 Median volume of isolated chylous ascites (symbols) with interquartile range on the day of diagnosis (index), the day therapy is started (day 0), and days after, discerned by intervention (squares, straight line) and expectative management (triangle, dotted line).

There were no significant differences in the occurrence of additional surgical and general complications or ICU stay in patients with isolated CA compared with those without (data not shown). Overall hospital stay was significantly longer for patients with isolated CA: 15 days (median IQR, 12 to 18 days) versus 12 days (median IQR, 10 to 16 days) for patients without CA (p=0.002). Linear regression analysis of compli-
cations (isolated CA included) demonstrated that isolated CA was an independent
variable for prolonged hospital stay (p=0.004). When anastomotic leakage, either
pancreatic or biliary, was incorporated in the model, isolated CA failed to reach sig-
nificance in influencing overall hospital stay.

DISCUSSION

This study demonstrated that the overall incidence of isolated CA of any measurable
volume in patients who underwent PD is 11%. Female gender and a pathologic diag-
nosis of (focal) chronic pancreatitis were independently associated with development
of isolated CA. In the absence of anastomotic leakages, isolated CA was not related
to the occurrence of other surgical and nonsurgical complications after PD. Isolated
CA was an independent prognostic factor for prolonged hospital stay, but could be
successfully treated with dietary measures, resulting in a nonproducing drain after
a median of 3.5 days.

CA in abdominal surgery, recognized after provocation by enteral feeding, arises
from surgical trauma to the abdominal lymphatic plexus or develops through fistulas
between intestinal lymphatics, cisterna chyli, and the peritoneal cavity.8,27 Because
the cisterna chyli are located at the same level as the pancreatic head, anterior to the
first and second vertebrae, damage is likely to occur during a PD procedure. Extended
lymphadenectomy carries an increased risk of laceration to the cisterna chyli or tribu-
taries, and the occurrence of CA, but is not performed in our center because of the
lack of survival benefit, as has been confirmed by a recent metaanalysis.28 As a con-
sequence, we could not possibly detect an association between CA and the number of
(positive) lymph nodes resected, a recognized risk factor for chyle leakage in thoracic
surgery. Interestingly, the series analyzed in the metaanalysis also did not report on
CA as an encountered complication or an increased risk.

This study demonstrated female gender and (focal) chronic pancreatitis to be
independently associated with development of isolated CA. The association between
CA and chronic pancreatitis is of interest. It might be hypothesized that surround-
ing infiltration or inflammation in these patients requires more extensive surgery
risking leakage. Another hypothesis could be that a longstanding inflammatory pro-
cess causes congestion of lymph, with subsequent lymph duct enlargement, more
likely to be interrupted during operations. Although hypertriglyceridemia is an
established cause of acute pancreatitis, the opposite (pancreatitis-associated CA) has
been reported in only a few case reports and lacks evidence.29,30 The predisposition of
women to development of isolated CA is hard to explain on the basis of current infor-
mation, and the influence of unrecognized confounding variables cannot be ruled
out. The possibility that there is an interaction between CA development and anas-
tomotic leakage (pancreaticeo- or hepaticojejunostomy or both) is possible. Aggressive
pancreatic enzymes, released when leakage occurs, and bilirubin damage surround-
ing soft tissue, could interfere with the triglyceride content of drain output. In these
circumstances, to diagnose CA, based on TG level and appearance (milky), is very hard, if not impossible. In addition, the relevance of detecting CA, a relatively mild complication, in the presence of such leakages, considered the most major complications of pancreatic surgery, is low. Pancreaticojejunostomy or hepaticojejunostomy leakage requires mostly major interventions, which, in the concomitant presence of CA, complicate analysis of treatment effect.

Randomized controlled trials demonstrated that immediate postoperative enteral feeding through a jejunostomy tube is not beneficial in patients undergoing PD and is even associated with impaired respiratory mechanics and postoperative mobility. Theoretically, application of a feeding jejunostomy might lead to earlier provocation with enteral feeding and, as such, poses a risk for development of CA. Indeed, this study demonstrated a feeding jejunostomy to be associated with development of CA, but this factor was significant only in univariable analysis. This finding should be taken into account when implementing fast-track perioperative care programs, which are emerging and, in fact, propagate early enteral feeding. Studies are needed to detect whether or not implementing fast-track programs in pancreatic surgery poses a risk for development of isolated CA.

Conservative management is the mainstay in treatment of CA. Reoperations to repair injured lymphatic ducts were not necessary in this study, nor was application of a peritoneovenous shunt. All patients started on an LCT-restricted diet responded and did not run an increased risk of developing other complications. With an established diagnosis of isolated CA, three patients were started on TPN, but an LCT-restricted diet would probably have sufficed. Although Malik and colleagues recently advocated the use of TPN as primary measure for CA after PD, TPN should be used as second-line treatment for refractory cases of isolated CA; TPN is expensive, the dedicated central venous catheter harbors a risk of infection, and enteral feeding maintains the intestinal mucosa integrity, in contrast to TPN. A recent systematic review found that routine postoperative TPN was associated with a higher incidence of complications compared with enteral nutrition, specifically in patients undergoing a PD. Although some authors have proposed somatostatin as an adjunctive measure to treat CA, somatostatin in this study, started as prophylaxis to prevent pancreatic leakage, was not a factor associated with prevention of isolated CA development. The indication to perform paracentesis in three patients in this series was diagnostic rather than therapeutic, although it offered an immediate palliative effect. Nevertheless, dietary intervention should always follow in these patients.

The significance of leaving a prophylactic drain after pancreatic head resection is controversial. Routinely leaving a drain after resection allows monitoring and treatment of anastomotic leakage or postoperative hemorrhage. A recent study from Japan showed that short-term postoperative drainage, i.e., drain removal on postoperative day 4, was an independent factor in reducing infectious complications. Conlon and associates concluded that drainage should not be standard practice, even though the majority of their patients had pancreatic adenocarcinoma, which is less prone to anastomotic leakage because of the firm texture of the pancreas and dilated duct.
Abandoning drainage excludes the possibility of detecting CA in drain output, necessitating close monitoring of the patient, especially the day after starting enteral feeding. A low threshold to start an LCT-restricted diet is advised in case of complaints of abdominal fullness or distention after enteral feeding.

A drawback of this study is that serum TG level was not determined simultaneously with drain TG level. A TG level in drain output of more than 1.2 mmol/L was considered to confirm the diagnosis of isolated CA. But the TG level in lymph is possibly related to the nutritional status of the host. Malnourishment, not uncommon in pancreatic surgery patients, might result in lower TG levels both in serum and lymph and in underdiagnosis of CA, when 1 sticks to a cut-off TG level of 1.2 mmol/L in drain output. In addition, to establish a diagnosis of CA, TG content of drain output needs to exceed the serum TG level. It might be argued whether or not a drain output as low as less than 100 mL/day, despite a TG level greater than 1.2 mmol/L, should be regarded as CA or merely a chyliform type of effusion. Three of our expectatively treated patients indeed had outputs below 100 mL/day.

Clearly the lack of a uniform definition of isolated CA after PD complicates its assessment. To begin with, a clear definition should contain: a drain output with milky appearance and a TG-level >1.2mmol/L, in the absence of anastomotic leakage. Moreover, consideration should be given to the amount, required treatment and implications for hospital stay. Rather than to adopt the threshold of 600 mL/day from thoracic surgery reports to establish diagnosis, we chose a minimal production of 275 mL as diagnostic for CA, based on our finding that patients below this cut-off were managed adequately with an expectant approach. Drain output with high TG level, but below this production threshold, should be regarded as chyliform effusion. In addition, following the International Study Group for Pancreatic Surgery’s initiative to grade complications according to severity, a grading system is proposed in Table 3. Grade A implies biochemically present, but clinically not significant CA, so no or only a minor deviation of the clinical pathway follows; grade A might or might not be treated with an LCT diet, but CA production should be limited to several days and there should not be a prolonged hospital stay. Grade B is associated with longer duration of CA production requiring persistent drainage and results in a prolonged hospital stay. Grade C is reserved for patients scoring positive on 1 or more of the following items: duration of CA production greater than 2 weeks despite therapeutic measures, requirement of TPN or surgical intervention or both, and readmission related to CA development. Applying this definition and grading to our own series would result in an incidence of CA of 9% (54 of 609; grade A, 31 patients; grade B, 15 patients; grade C, 8 patients). So, clinically significant CA comprises 4% (grades B and C. 23 of 609). The proposed definition of the complication and grading system might be applicable to other abdominal operations, but tailored adaptations should be investigated for each specific intervention and implemented whenever necessary.

In summary, the estimated incidence of isolated CA after PD is 11%, but when applying a novel proposed definition and grading system, clinically significant CA occurs in 4% (grades B and C). Female gender and (focal) chronic pancreatitis are
independently associated with development of isolated CA, but no factors were identified that could readily anticipate CA. Isolated CA results in a prolonged hospital stay but is effectively controlled by dietary measures in the majority of patients. Based on this experience, our group proposes a dedicated definition and grading system of CA after pancreateoduodenectomy.

Table 3  Proposed Grading System for Isolated Chylous Ascites after Pancreateoduodenectomy According to Severity.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Grade A</th>
<th>Grade B</th>
<th>Grade C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical conditions</td>
<td>Well</td>
<td>Often well</td>
<td>Ill appearing</td>
</tr>
<tr>
<td>Signs of infection</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Ultrasound/CT (if obtained)</td>
<td>Negative</td>
<td>Negative/positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Duration of CA production</td>
<td>&lt; 7 days</td>
<td>7-14 days</td>
<td>&gt; 14 days</td>
</tr>
<tr>
<td>Dietary measure</td>
<td>Yes/No*</td>
<td>Yes*</td>
<td>Yes†</td>
</tr>
<tr>
<td>Persistent drainage</td>
<td>No</td>
<td>Usually yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Surgical intervention</td>
<td>No</td>
<td>No</td>
<td>Yes/No‡</td>
</tr>
<tr>
<td>Prolongation of hospital stay§</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Readmission‡</td>
<td>No</td>
<td>No</td>
<td>Yes/No§</td>
</tr>
</tbody>
</table>

* Low-chain-triglyceride–restricted diet.
† Total parenteral nutrition.
‡ Paracentesis, direct surgical repair, peritoneovenous shunt.
§ Because of chylous ascites development.

CA, chylous ascites.
REFERENCE LIST


(22) Malik HZ, Crouzier J, Murray I, Carter R. Chyle leakage and early enteral feeding following pancreateoduodenectomy.