The role of a multidisciplinary team in the management of portal hypertension

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Abstract

**Background**: Gastroesophageal variceal hemorrhage is the most severe complication of portal hypertension, with a high mortality rate. The current recommendations for gastroesophageal varices include pharmacological treatment, endoscopic treatment, transjugular intrahepatic portosystemic shunt (TIPS) placement, and splenectomy with devascularization surgery. Multidisciplinary team (MDT) comprises of a group of medical experts and specialists across a range of disciplines, providing personalized and targeted patient care tailored to each individual's condition, circumstances, and expectations.

**Methods**: Patients referred to the MDT clinic since its establishment in September 2014 were prospectively enrolled and followed-up for at least 12 months. Patient baseline characteristics, treatment methods, outcome and survival were compared to non-MDT patients retrieved from a prospectively maintained database with propensity score matching.

**Results**: Propensity-score matching (PSM) was carried out to balance available covariates, resulting in 58 MDT patients vs. 111 non-MDT patients. Overall survival and variceal rebleed was compared between the two groups. The rate of variceal rebleed was significantly higher in the non-MDT group, while no difference in overall survival was observed.

**Conclusions**: This study is the first to investigate the role of a multidisciplinary team in the management of gastroesophageal varices secondary to portal hypertension. Patients treated based on MDT clinic recommendations had a significantly lower risk for variceal rebleed.

**Keywords**: Portal hypertension, Multidisciplinary team, Individualized treatment
Multidisciplinary team (MDT) comprises of a group of medical experts and specialists across a range of disciplines, working together to deliver comprehensive patient care [6]. Regardless of guideline recommendations, MDT clinic provides personalized and targeted patient care tailored to each individual’s condition, circumstances, and expectations [7]. Relevant experts with different expertise are brought together to discuss and formulate a treatment plan. The present study is aimed at evaluating the value of MDT clinic in the management of gastroesophageal varices secondary to portal hypertension.

Methods
Multidisciplinary team for portal hypertension
The multidisciplinary team (MDT) for portal hypertension at our institution was first established in 2014. The team is comprised of 5 different clinical specialties, including gastroenterology, interventional radiology, general surgery, diagnostic radiology, diagnostic ultrasound, and consulting pathology. Through a multidisciplinary approach, all patients referred to the MDT clinic will receive a recommendation for individualized treatment based on the patient's disease status, laboratory and imaging studies, as well as personal preference. The MDT clinic is routinely scheduled every 2 weeks at a designated conference room. An example of case management by the MDT clinic is presented in Supplementary 1.

MDT patients
Patients referred to the MDT clinic since its establishment in September 2014 were eligible for study inclusion, in accordance with the following criteria: 1) patient with a confirmed diagnosis of gastroesophageal varices secondary to portal hypertension, evident by variceal bleeding or endoscopic examination, 2) diagnosis of portal hypertension was confirmed by imaging or pathological studies, 3) patients with complete documentation of the MDT clinic recommendations, including relevant biochemical, radiological, and procedural data. Exclusion criteria were as follows: 1) patients with acute active variceal hemorrhage, or clinically and hemodynamic unstable, 2) patients who failed to comply with recommended therapy, 3) patient with severe, life-threatening disease of another system, irrelevant to portal hypertension and its complications.

Non-MDT patients
Patient data were retrieved from a prospectively maintained database, with detailed documentation of general characteristics, treatments received, and follow-up for rebleed and mortality. Usage of the database was approved by the Ethics Committee at our institution (B2015-135R).

Treatment
Different treatment strategies include currently available options for the management of gastroesophageal varices secondary to portal hypertension, including endoscopic therapy, interventional radiology, and surgery. An informed consent was signed by all patients prior to any treatment procedures, acknowledging the purpose and associate risk.

Endoscopy
Endoscopic treatment for gastroesophageal varices was commenced after an overnight fast. First, the extent and characteristics of the varices were evaluated and classified according to Sarin’s classification with a standard esophagogastroduodenoscopy (Olympus GIF-XG240/260). After a thorough examination, each patient received appropriate personalized therapy as deemed fit by the operator. Endoscopic varices were treated with endoscopic band ligation (EBL) (6 Shooter, Universal Saeed, Multi-Band Ligator, Cook Medical or Speedband Superview Super 7, Multiple Band Ligators, Boston Scientific) or endoscopic injection sclerotherapy (EIS). Concurrent or isolated gastric varices were uniformly treated with cyanoacrylate injection, which begins with an injection of lauromacrogol (Tianyu Pharmaceutical, Zhejiang, China), followed by N-butyl-cyanoacrylate (Beijing Suncon Medical Adhesive Co. Ltd., Beijing, China), then again with a flush of lauromacrogol. The amount of lauromacrogol and cyanoacrylate injected directly correlated with the size of the varix. The operator aimed to eradicate the varices in one session, prompting multiple injection sites, when necessary. The needle sheath (Olympus NM-200 L-0423 injection needle) was held at the puncture site until the varix solidified, turned pale, and became less mobile. Patients were hospitalized for 1–2 days after the procedure barring any complications and were followed-up closely at a designated out-patient service clinic.

Interventional radiology
Interventional radiological treatment modalities for portal hypertension include transjugular intrahepatic portosystemic shunt (TIPS), percutaneous transhepatic variceal embolization (PTVE), total or partial splenic embolization (TSE or PSE), transarterial embolization (TAE) or a combination of the above-mentioned procedures.

The most frequently performed and well-accredited procedure for the treatment of portal hypertension is the TIPS procedure. In brief, the patient was placed in a supine position after an overnight fast. Access to the left branch of the intrahepatic portal vein was achieved with a 21G Chiba needle (Cook, USA) under ultrasound guidance or direct puncture. The right hepatic vein or hepatic segment of the inferior vena cava was chosen for TIPS needle insertion to the branch of the portal vein (typically left branch). An 8 mm × 40 mm balloon is used...
to dilate the shunt tract and an 8-10 mm × 60-100 mm Smart self-expanding stent (Cordis, USA) or a nitinol self-expanding stent (Bard, USA) was placed. PTVE can also be performed alongside the TIPS procedure in patients with large gastric varices. The catheter is extended to the gastric coronary vein for visualization of the gastric varices. N-butyl-cyanoacrylate (Beijing Suncon Medical Adhesive Co. Ltd., Beijing, China) is injected for embolization. Amount of tissue adhesive used ranged from 0.5-2 ml, depending on the size of the varix. Another procedure commonly performed in patients with hypersplenism is TSE or PSE, which entails the complete or partial embolization of the splenic artery with 300–500 Embosphere (Merit Medical, UT, USA). In patients with hepatic artery-portal vein arteriovenous fistula, TAE is achieved with injection of N-butyl-cyanoacrylate to embolize the fistula tract. All interventional radiological procedures are performed alone or in conjunction with other procedures, depending on the patient’s condition.

Surgery
The Hassab’s procedure begins with a 15 cm incision along the left rectus abdominus, followed by ligation of the splenogastric ligament, then the pancreatic tail is dissected for exposure of the spleen. A double layer surgical stich is used for splenic artery ligation, before removal of the spleen. The procedure is concluded with suture ligation of the left gastroepiploic artery, vascular branch along the gastric corpus and cardia, and a perihilar devascularization of the esophagus. Hemostasis was confirmed before abdominal closure.

Other clinical assessment
All patient from the MDT group received a computed tomography angiography (CTA) study of the portal system prior to treatment intervention. This allows for a thorough evaluation for any concurrent conditions such as hepatocellular carcinoma (HCC), portovenous thrombosis (PVT), or spontaneous portosystemic shunt (SPSS), which are common complications associated with portal hypertension. Some of the non-MDT patients also had available portosystemic CTA that were retrospectively reviewed. During the MDT clinic, radiology studies were carefully reviewed by the experts on Centricity Enterprise Web V3.0 (GE Healthcare, Illinois, USA). Some patients from both MDT and non-MDT groups underwent HVPG measurements to better assess disease severity. HVPG measurement was carried out in all MDT patients barring any contraindications. However, it is not a pre-requisite procedure before treatment.

Patient follow-up
Patients were prospectively followed for at least 12 months in order to document any incidence of variceal rebleed, evident by melena or hematemesis, confirmed by a subsequent endoscopic examination. Primary endpoints were defined as variceal rebleed or death. A thorough review of each subject’s patient history was conducted. Any missing information was obtained through a telephone interview or at the designated outpatient service clinic.

Propensity score matching
In order to better assess the role of MDT clinic is the management of patients with portal hypertension, a propensity score match (PSM) was carried out to compare MDT patients with non-MDT patients. The propensity score model of MDT was constructed by using the multivariable logistic regression model, which included age, gender, Child-Pugh classification, etiology of portal hypertension, previous treatment, treatment, portal venous thrombosis, hepatic cellular carcinoma and Sarin’s classification. Propensity scores were then matched with a maximal range of ±0.2 to obtain matched pairs of patients. Patients of MDT group were matched at 1:2 to non-MDT patients.

Statistical analysis
Continuous normally distributed variables are presented as mean ± standard deviation and group comparisons are tested using the Student t test. Ordinal and non-normally distributed variables are presented by median (Q1–Q3) and group comparisons are tested by using nonparametric Wilcoxon rank-sum test. Categorical variables are presented as absolute values (percentage) and group comparisons are tested by using Pearson $\chi^2$ tests or Fisher exact test.

For the primary endpoint (rebleeding), Kaplan-Meier curves show the cumulative event-free survival rates for each group and were compared by using the log-rank test. To assess the association between rebleeding and the different groups (MDT group vs. non-MDT group), a propensity score matched and an unmatched Cox proportional hazards models were constructed to calculate the hazard ratios (HR). The inverse probability of treatment weight (IPTW) was calculated on the basis of the propensity score. All hypothesis tests were two-sided, and values of < 0.05 were considered statistically significant. All data were analyzed with the R software, version 3.5.1.

Results
MDT patients
A total of 120 patients were referred to the MDT clinic from September 2014 through September 2017. Among which, 29 patients failed to comply with recommended treatment strategy due to personal or financial reasons, 2 patients had comorbid myelodysplastic syndrome (MDS), which preceded the treatment of portal hypertension. A total of 89 patients received treatment according to MDT recommendation, however, 3 were lost
|                              | Global Population (n = 528) | MDT (n = 86) | Non-MDT (n = 442) |
|------------------------------|-------------------------------|-------------|------------------|
| **General Characteristics**  |                               |             |                  |
| Gender                       |                               |             |                  |
| Male                         | 351 (66.5%)                   | 59 (68.6%)  | 292 (66.1%)      |
| Female                       | 177 (33.5%)                   | 27 (31.4%)  | 150 (33.9%)      |
| Age (years)                  | 53.51 ± 10.99                 | 52.91 ± 13.08 | 53.63 ± 10.55 |
| Child Pugh Score             | 6.70 ± 1.45                   | 6.59 ± 1.32 | 6.72 ± 1.47      |
| Child Pugh Classification    |                               |             |                  |
| Class A                      | 268 (50.8%)                   | 44 (51.2%)  | 224 (50.7%)      |
| Class B                      | 240 (45.5%)                   | 41 (47.7%)  | 199 (45%)        |
| Class C                      | 20 (3.8%)                     | 1 (1.2%)    | 19 (4.3%)        |
| MELD Score                   | 6.65 ± 4.29                   | 7.04 ± 4.59 | 6.57 ± 4.23      |
| HVPG (n = 135)               | 13.78 ± 7.33                  | 12.96 ± 7.10 | 15.04 ± 7.56 |
| **Etiology of Portal Hypertension** |                   |             |                  |
| HBV                          | 290 (54.9%)                   | 44 (51.2%)  | 246 (55.7%)      |
| HCV                          | 10 (1.9%)                     | 2 (2.3%)    | 8 (1.8%)         |
| Alcohol                      | 44 (8.4%)                     | 4 (4.7%)    | 40 (9%)          |
| PBC                          | 4 (0.8%)                      | 2 (2.3%)    | 2 (0.5%)         |
| AIH                          | 55 (10.4%)                    | 3 (3.5%)    | 52 (11.8%)       |
| Schistosomiasis              | 28 (5.3%)                     | 9 (10.5%)   | 19 (4.3%)        |
| Cryptogenic                  | 68 (12.9%)                    | 6 (7.0%)    | 62 (14%)         |
| NAFLD                        | 16 (3.0%)                     | 13 (15.1%)  | 3 (0.7%)         |
| Mixed                        | 12 (2.3%)                     | 3 (3.5%)    | 9 (2%)           |
| **Laboratory Parameters**    |                               |             |                  |
| Hemoglobin (g/L)             | 86.50 (72.00–104.00)          | 93.50 (76.25–117.75)  | 88.31 (71.00–102.00) |
| Platelet (x 10^9/L)          | 61.00 (43.00–83.25)           | 65 (39.25–114.75)  | 61.00 (44.00–80.00) |
| White blood cell (x 10^9/L)  | 2.74 (2.03–3.80)              | 2.83 (2.02–3.89)  | 2.73 (2.03–3.78) |
| Total Bilirubin (µmol/L)     | 14.55 (10.58–21.50)           | 14.25 (10.43–21.7) | 14.65 (10.63–21.48) |
| ALT (U/L)                    | 24.00 (16.85–36.00)           | 19.50 (15.00–27.00) | 25.00 (17.00–40.00) |
| AST (U/L)                    | 32.00 (24.00–44.00)           | 29.00 (21.25–38.75) | 33.00 (24.55–44.00) |
| Albumin (g/L)                | 34.00 (30.00–38.00)           | 36.00 (32.00–40.00) | 34.00 (30.00–38.00) |
| Serum Creatinine (µmol/L)    | 67.00 (57.00–79.00)           | 67.00 (58.00–77.75) | 67.00 (57.00–79.53) |
| Prothrombin Time (s)         | 14.10 (13.10–15.40)           | 13.80 (12.93–15.25) | 14.10 (13.20–15.40) |
| International Normalized Ratio (INR) | 1.22 (1.14–1.33)         | 1.23 (1.14–1.35)  | 1.22 (1.13–1.33)  |
| Received Previous Treatment  | 132 (64.5%)                   | 37 (43.0%)   | 95 (21.5%)       |
| **Concurrent Conditions**    |                               |             |                  |
| Portal Venous Thrombosis     |                               |             |                  |
| Absent                       | 431 (81.6%)                   | 53 (61.6%)  | 351 (79.4%)      |
| Present                      | 97 (18.4%)                    | 33 (38.4%)  | 91 (20.6%)       |
| Hepatic Cellular Carcinoma   |                               |             |                  |
| Absent                       | 490 (92.8%)                   | 77 (89.5%)  | 413 (93.4%)      |
| Present                      | 38 (7.2%)                     | 9 (10.5%)   | 29 (6.6%)        |
| Ascites                      | 253 (47.9%)                   | 45 (52.3%)  | 208 (47.1%)      |
to follow-up. A final of 86 patients were included in the present study analysis. Of the 86 subjects, 59 (68.6%) were male, 27 (31.4%) were female, with an average age of 52.91 ± 13.08 years old. 49 (57%) patients were admitted for initial treatment of gastroesophageal varices, while 37 (43%) patients had received previous treatment, including 25 cases of previous endoscopic therapy, 8 cases of previous splenectomy, and 3 cases of PSE, and 1 case of PTVE. The cause of portal hypertension for most patients were mainly due to cirrhosis with varying etiologies. The most common cause was viral hepatitis (53.5%), including both hepatitis B virus and hepatitis C virus. Other etiologies included drug or alcohol-induced (4.7%), autoimmune hepatitis or primary biliary cirrhosis (5.8%), schistosomiasis (10.5%), others (22.1%) or mixed etiology (3.5%). The average Child-Pugh score in the MDT group was 6.59 ± 1.32. With most patients classified as Child-Pugh Class A (51.2%), followed by Child-Pugh Class B (47.7%) and Child-Pugh Class C (1.2%). Endoscopic examination revealed esophageal varices (EV) in 16 patients (18.6%), gastroesophageal varices (GOV) type 1 in 23 patients (26.7%), GOV type 2 in 30 patients (34.9%), and isolated gastric varices (IGV) type 1 in 17 patients (19.8%). There are no IGV type 2 in this cohort. Concurrent conditions such as HCC was observed in 9 (10.5%) patients, while PVT was observed in 33 (38.4%) patients. After MDT discussion, 12 (14%) patients received drug therapy, 28 (32.6%) patients received endoscopic treatment, 7 (8.1%) patients received surgery, 37 (43.0%) patients received interventional radiology, and 2 (2.3%) patients received combined treatment. Detailed patient characteristics are shown in Table 1.

### Non-MDT patients

Patient data were retrieved from a prospectively maintained database. Prior to the establishment of MDT clinic, patients received at different outpatient clinic underwent standardized care. A total of 462 patients with gastroesophageal varices secondary to portal hypertension treated from August 2008 through August 2014 were retrospectively reviewed. Twenty patients were lost to follow-up within 12 months. A total of 442 patients were ultimately included for statistical analysis. Among which, 292 (66.1%) were male and 150 (33.9%) were female, with an average age of 53.63 ± 10.55. Three hundred forty-seven (78.5%) patients were admitted for initial treatment of gastroesophageal varices, while 95 (21.5%) patients had received previous treatment. The most common etiology for portal hypertension was cirrhosis secondary to viral hepatitis (57.5%). While drug or alcohol-induced cirrhosis accounted for 9.0%, autoimmune hepatitis or PBC for 12.2%, schistosomiasis for 4.3%, others for 14.9%, and mixed etiology for 2.0%. The average Child-Pugh score was 6.72 ± 1.47, with 224 (50.7%) patients classified as Child-Pugh Class A, 199 (45%) classified as Child-Pugh Class B, and 19 (4.3%)

### Table 1 Baseline characteristics of the general population, MDT group and non-MDT group (Continued)

|                        | Global Population (n = 528) | MDT (n = 86) | Non-MDT (n = 442) |
|------------------------|-----------------------------|--------------|-------------------|
| Mild                   | 232 (43.9%)                 | 40 (46.5%)   | 192 (43.5%)       |
| Severe                 | 43 (8.1%)                   | 1 (1.2%)     | 42 (9.5%)         |
| **Endoscopic Examination** |                           |              |                   |
| Gastroesophageal Classification |                   |              |                   |
| EV                     | 149 (28.2%)                 | 16 (18.6%)   | 133 (30.1%)       |
| GOV Type 1             | 298 (56.4%)                 | 23 (26.7%)   | 275 (62.2%)       |
| GOV Type 2             | 48 (9.1%)                   | 30 (34.9%)   | 18 (4.1%)         |
| IGV Type 1             | 33 (6.3%)                   | 17 (19.8%)   | 16 (3.6%)         |
| **Treatment Received** |                             |              |                   |
| Pharmacological Treatment | 20 (3.8%)                 | 12 (14%)     | 8 (1.8%)          |
| Endoscopy              | 403 (76.3%)                 | 28 (32.6%)   | 375 (84.8%)       |
| Surgery                | 55 (10.4%)                  | 7 (8.1%)     | 48 (10.9%)        |
| Interventional Radiology | 45 (8.5%)                  | 37 (43%)     | 8 (1.8%)          |
| Combined Therapy       | 5 (0.9%)                    | 2 (2.3%)     | 3 (0.7%)          |
| **Follow-up**          |                             |              |                   |
| Variceal Rebleed       | 156 (29.5%)                 | 7 (8.1%)     | 149 (33.7%)       |
| Time to Rebleed        | 521.40 (299.75–989.70)      | 382.50 (289.50–508.25) | 579.30 (301.35–1062.60) |
| Mortality              | 86 (16.3%)                  | 9 (10.5%)    | 77 (17.4%)        |
| Time to Death          | 728.25 (420.68–1198.58)     | 382.50 (289.50–508.25) | 843.15 (467.40–1368.00) |
classified as Child-Pugh Class C. Endoscopic examination showed 133 (30.1%) cases of EV, 275 (62.2%) cases of GOV type 1, and 18 (4.1%) cases of GOV type 2. No IGV type 2 was noted. Concurrent HCC was observed in 29 (6.6%) patients, while PVT was observed in 91 (20.6%) patients. Standardized care dictated 8 (1.8%) cases of pharmacological treatment, 375 (84.8%) cases of endoscopic therapy, 48 (10.9%) cases of surgery, 8 cases (1.8%) cases of interventional radiology, and 3 (0.7%) cases of combined treatment. Detailed patient characteristics are shown in Table 1.

### Table 2 Baseline characteristics of the MDT and non-MDT groups, before and after PSM

| General Characteristics | Global Population (n = 528) | MDT (n = 86) | Non-MDT (n = 442) | Propensity Score Matching (n = 169) | MDT (n = 58) | Non-MDT (n = 111) |
|-------------------------|-----------------------------|--------------|-------------------|------------------------------------|--------------|-------------------|
| **MDT** | **Non-MDT** | **MDT** | **Non-MDT** | **MDT** | **Non-MDT** | **MDT** | **Non-MDT** |
| **Gender** | Male | 59 (68.6%) | 292 (66.1%) | 0.74 | 39 (67.2%) | 88 (79.3%) | 0.275 |
| | Female | 27 (31.4%) | 150 (33.9%) | 19 (32.8%) | 23 (20.7%) |
| **Age (years)** | 52.91 ± 13.08 | 53.63 ± 10.55 | 0.579 | 51.76 ± 12.39 | 50.68 ± 11.73 | 0.089 |
| **Child Pugh Classification** | | | | | | |
| Class A | 44 (51.2%) | 224 (50.7%) | 0.371 | 28 (48.3%) | 55 (49.5%) | 0.761 |
| Class B | 41 (47.7%) | 199 (45%) | 29 (50.0%) | 52 (46.8%) |
| Class C | 1 (1.2%) | 19 (4.3%) | 1 (1.7%) | 4 (3.6%) |
| **MELD Score** | 7.04 ± 4.59 | 6.57 ± 4.23 | 0.359 | 7.51 ± 4.09 | 7.22 ± 3.78 | 0.64 |
| **Etiology of Portal Hypertension** | | | | | | |
| Viral Hepatitis | 46 (53.5%) | 254 (57.5%) | 0.027 | 35 (60.3%) | 60 (54.1%) | 0.894 |
| Alcohol | 4 (4.7%) | 40 (9%) | 2 (3.4%) | 8 (7.2%) |
| AIH/PBC | 5 (5.8%) | 54 (12.2%) | 4 (6.9%) | 7 (6.3%) |
| Schistosomiasis | 9 (10.5%) | 19 (4.3%) | 6 (10.3%) | 10 (9.0%) |
| Others | 19 (22.1%) | 66 (14.9%) | 10 (17.2%) | 23 (20.7%) |
| Mixed | 3 (3.5%) | 9 (2%) | 1 (1.7%) | 3 (2.7%) |
| **Received Previous Treatment** | 37 (43%) | 95 (21.5%) | < 0.001 | 30 (51.7%) | 53 (47.7%) | 0.742 |
| **Concurrent Conditions** | | | | | | |
| Portal Venous Thrombosis | | | | | | 0.841 |
| Absent | 53 (61.6%) | 351 (79.4%) | 0.005 | 52 (89.7%) | 102 (91.9%) |
| Present | 33 (38.4%) | 91 (20.6%) | 6 (10.3%) | 9 (8.1%) |
| Hepatic Cellular Carcinoma | | | | | | 0.886 |
| Absent | 77 (89.5%) | 413 (93.4%) | 0.292 | 50 (86.2%) | 98 (88.3%) |
| Present | 9 (10.5%) | 29 (6.6%) | 8 (13.8%) | 13 (11.7%) |
| **Endoscopic Examination** | | | | | | |
| Gastroesophageal Classification | | | | | | |
| EV | 16 (18.6%) | 133 (30.1%) | < 0.001 | 14 (24.1%) | 35 (31.5%) | 0.158 |
| GOV Type 1 | 23 (26.7%) | 275 (62.2%) | 19 (32.8%) | 46 (41.4%) |
| GOV Type 2 | 30 (34.9%) | 18 (4.1%) | 16 (27.6%) | 16 (14.4%) |
| IGV Type 1 | 17 (19.8%) | 16 (3.6%) | 9 (15.5%) | 14 (12.6%) |
| Treatment Received | | | | | | |
| Pharmacological Treatment | 12 (14%) | 8 (1.8%) | < 0.001 | 8 (13.8%) | 8 (7.2%) | 0.004 |
| Endoscopy | 28 (32.6%) | 375 (84.8%) | 26 (44.8%) | 68 (61.3%) |
| Surgery | 7 (8.1%) | 48 (10.9%) | 7 (12.1%) | 24 (21.6%) |
| Interventional Radiology | 37 (43%) | 8 (1.8%) | 15 (25.9%) | 8 (7.2%) |
| Combined Therapy | 2 (2.3%) | 3 (0.7%) | 2 (3.4%) | 3 (2.7%) |
Propensity score matching
The following variables were selected for propensity score matching (PSM): age, gender, previous treatment, treatment type, etiology of portal hypertension, concurrent hepatocellular carcinoma (HCC), concurrent portal venous thrombosis (PVT), Child-Pugh score, and Sarin’s classification. Before PSM, no significant statistical difference between age, gender, Child-Pugh score, and concurrent HCC was observed between MDT and non-MDT patients. However, statistical difference was noted in previous treatment,

Table 3 Difference in rate of variceal rebleed between MDT and non-MDT groups

|                  | Before PSM | After PSM |
|------------------|------------|-----------|
|                  | MDT        | non-MDT   | MDT        | non-MDT   |
| 1-month actuarial survival | 0.976 (0.943–1) | 0.907 (0.881–0.935) | 0.982 (0.949–1) | 0.955 (0.917–0.994) |
| 2-month actuarial survival | 0.976 (0.943–1) | 0.885 (0.855–0.915) | 0.965 (0.918–1) | 0.91 (0.858–0.965) |
| 3-month actuarial survival | 0.976 (0.943–1) | 0.825 (0.79–0.861) | 0.965 (0.918–1) | 0.874 (0.814–0.938) |
| 6-month actuarial survival | 0.923 (0.858–0.992) | 0.765 (0.726–0.806) | 0.965 (0.918–1) | 0.818 (0.749–0.894) |
| 1-year actuarial survival | 0.976 (0.943–1) | 0.907 (0.881–0.935) | 0.939 (0.873–1) | 0.75 (0.672–0.836) |
treatment method, etiology of portal hypertension, presence of PVT, and type of gastroesophageal varices (Table 2). PSM was carried out to balance almost all available covariates, resulting in 58 MDT patients vs. 111 non-MDT patients. Based on the priori established primary endpoints, overall survival and variceal rebleed was compared between the two groups. The rate of variceal rebleed was significantly higher in the non-MDT group, while no difference in overall survival was observed (Fig. 1). The actuarial rate of no variceal rebleed at 1-month, 2-months, 3-months, 6-months, and 1-year for the non-MDT group, was 95.5, 91.0, 87.4, 81.8, and 75.0%, while that of the MDT group was 98.2, 96.5, 96.5, 96.5, and 93.9%, respectively (Table 3). The Kaplan-Meier analysis indicated that MDT
group patients have a lower rate of variceal rebleed within 1 year. Cox proportional hazard regression analysis revealed that patients treated based on MDT clinic recommendation had a lower risk of variceal rebleed (hazard ratio 0.203, 95% CI 0.062–0.670, p < 0.01), while IPTW coincided similar results (hazard ratio 0.106, 95% CI 0.026–0.436, p < 0.01).

A subsequent subgroup analysis with Kaplan-Meir analysis was performed on different treatment modalities after PSM (Fig. 2). The risk of rebleed was statistically different between MDT and non-MDT patient, who underwent endoscopic treatment for gastroesophageal varices (p < 0.05). No difference was noted between the two groups in patients who received pharmacological treatment, surgery, interventional radiology or combined therapy. However, a trend is illustrated in the surgery and interventional radiology groups, nearly breaching statistical significance.

Discussion

According to the Baveno Consensus, primary prophylaxis for gastroesophageal varices include use of non-selective beta-blockers (NSBB) or endoscopic band ligation (EBL), while cyanoacrylate injection should be considered in patients with concurrent or isolated gastric varices. The TIPS procedure may be recommended for patients at high risk of treatment failure [4]. Although the guideline recommendations are based of highly credible clinical studies with promising evidential strength, clinical encounters may not always be straightforward. Patients often have comorbid conditions, which requires well-rounded consideration and prioritization, especially in a complicated disease such a portal hypertension [8, 9].

To our knowledge, the present study is the first to assess the utility of MDT in the management of gastroesophageal varices secondary to portal hypertension. While many other specialties, especially oncology, have successfully adopted MDT as routine practice for disease management [10, 11]. Since the establishment of MDT clinic at our facility, we have included experts from gastroenterology, interventional radiology, general surgery, diagnostic radiology, diagnostic ultrasound, and consulting pathology to form a joint disease management team, with two scheduled discussion panels every month. Prior to the establishment of MDT, patients with gastroesophageal varices are managed with standardized care in different subspecialties.

The two study cohorts were compared with propensity score matching. Representative indexes were selected as matching indices. However, treatment modalities were not comparable between the two groups. This can be explained by the development and advancements in interventional radiology in recent years. For instance, the TIPS procedure was not routinely implemented in the past, due to technical challenges and high incidence of hepatic encephalopathy [12]. However, in recent years, availability of self-expandable and drug-eluted stents has remarkably decreased procedure associated complications [13, 14]. Another explanation is that some patients were diverted from endoscopic treatment due to high HVPG measurements [15]. Studies have also shown that splenectomy and devascularization surgery were associated with post-operative portal venous thrombosis, making it a less favorable choice for the treatment of portal hypertension [16]. Therefore, an imbalance in treatment method was noted between non-MDT and MDT patients due to evolving medical techniques and a shift in clinical preference over the past decade (Fig. 3). Comparison between two groups showed no difference in overall survival.
However, the rate of variceal bleeding was significantly higher in non-MDT patients before and after PSM. Further subgroup analysis showed the different rebleeding rates amongst patients who received different treatment methods, however study results warrants a larger sample size and longer follow-up.

There are several limitations to our study. First, the sample size for the study is relatively small and the follow-up time is short in the MDT group. A 12 months period may be insufficient to assess the difference in overall mortality between MDT and non-MDT groups. Due to the retrospective nature of the study, not all patients received HVPG measurements, which can accurately reflect disease severity and provide a more reliable matching index for PSM. Lastly, there are many confounding factors that could not be balanced, including different treatment methods for gastroesophageal varices.

Conclusion
This study is the first to investigate the role of a multidisciplinary team in the management of gastroesophageal varices secondary to portal hypertension. Patients treated based on MDT clinic recommendations had a significantly lower risk for variceal rebleed. MDT-driven disease management is a relatively new concept introduced to clinical practice, especially in the non-oncological arena. Although it is heavily reliant on available resources [17], a multidisciplinary approach allows patient to receive the most well-rounded individualized therapy with consideration beyond medicine. The role of MDT practice has shown promising potential and we look forward to its application to other disease entities.

Supplementary information
Supplementary information accompanies this paper at https://doi.org/10.1186/s12876-020-01203-4.

Additional file 1: Supplementary 1. MDT Clinic – Case Management. This supplementary file demonstrates an example of case management carried out by a multidisciplinary team specialized in the diagnosis and treatment of portal hypertension.

Abbreviations
CTA: Computed tomography angiography; EBL: Endoscopic band ligation; GOV: Gastroesophageal varices; HCC: Hepatocellular carcinoma; IGV: Isolated gastric varices; MDT: Multidisciplinary Team; NSBB: Non-selective beta blockers; PBC: Primary biliary cirrhosis; PSE: Partial splenic embolization; PSM: Propensity matching score; PTV: Percutaneous transhepatic variceal embolization; PVT: Portal venous therapy; PSQ: Portosystemic shunt; TAE: Transarterial embolization; TIPS: TRANSJUGULAR intrahepatic portosystemic shunt; TSE: Total splenic embolization

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Authors’ contributions
All authors have read and approve of the final version of the manuscript and agree for publication at BMC Gastroenterology. Conceptualization, JW; Data curation, YT, LM, CFL, YW, CL and JZ; Formal analysis, ML and CFT; Funding acquisition, JW; Investigation, TL, DH and JY; Project administration, ZY, GH and DH; Resources, ZY, PX, GH and JY; Supervision, SC and JW; Validation, ML; Writing – original draft, YT, LM, TL; Writing – review & editing, YW.

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Availability of data and materials
Data will be made available upon request to the corresponding author.

Ethics approval and consent to participate
The study has been approved by the Ethics Committee at Zhongshan Hospital, Fudan University (B2015-135R). A written consent was signed by all participants included in the study.

Consent for publication
A written consent has been obtained from authors of this study whom may be identifiable in the pictures presented in the supplementary file.

Competing interests
The authors declare that they have no competing interests.

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References
1. Seo YS. Prevention and management of gastroesophageal varices. Clin Mol Hepatol. 2018;24:20–42.
2. Bosch J, Garcia-Pagan JC. Prevention of variceal rebleeding. Lancet. 2003; 361:952–4.
3. Garcia-Tsao G. Current Management of the Complications of cirrhosis and portal hypertension: Variceal hemorrhage, ascites, and spontaneous bacterial peritonitis. Dig Dis. 2016;34:382–6.
4. de Franchis R. Expanding consensus in portal hypertension: report of the Baveno VI consensus workshop: stratifying risk and individualizing care for portal hypertension. J Hepatol. 2015;63:743–52.
5. Zhang YF, Ji H, Lu HW, et al. Postoperative survival analysis and prognostic nomogram model for patients with portal hypertension. World J Gastroenterol. 2018;24:4499–509.
6. Mitchell GJ, Tieman JJ, Shelby-James TM. Multidisciplinary care planning and teamwork in primary care. Med J Aust. 2008;188:561–4.
7. Taylor C, Munro AJ, Glynne-Jones R, et al. Multidisciplinary team working in cancer: what is the evidence? BMJ. 2010;340:c951.
8. Garcia-Pagan JC, Barrufet M, Cardenas A, et al. Management of gastric varices. Clin Gastroenterol Hepatol. 2014;12:2819–28.e1 quiz e51–2.
9. Ahn SY, Park SY, Tak WY, et al. Prospective validation of Baveno V definitions and criteria for failure to control bleeding in portal hypertension. Hepatology. 2015;61:1033–40.
10. Sangiovanni A, Triolo M, Iavarone M, et al. Multimodality treatment of hepatocellular carcinoma: how field practice complies with international recommendations. Liver Int. 2018;38:1624–34.

11. Forrest LM, McMillan DC, McArdle CS, et al. An evaluation of the impact of a multidisciplinary team, in a single Centre, on treatment and survival in patients with inoperable non-small cell lung cancer. Br J Cancer. 2005;93:977–8.

12. Bettinger D, Schultheiss M, Boettler T, et al. Procedural and shunt-related complications and mortality of the transjugular intrahepatic portosystemic shunt (TIPS). Aliment Pharmacol Ther. 2016;44:1051–61.

13. Lo G, Liang H, Chen W, et al. A prospective, randomized controlled trial of transjugular intrahepatic portosystemic shunt versus cyanoacrylate injection in the prevention of gastric variceal rebleeding. Endoscopy. 2007;39:679.

14. Lv Yong, Zuo Luo, Zhu Xuan et al. Identifying optimal candidates for early TIPS among patients with cirrhosis and acute variceal bleeding: a multicentre observational study. Gut. 2019;68:1297–310.

15. Mura VL. Cirrhosis and portal hypertension: the importance of risk stratification, the role of hepatic venous pressure gradient measurement. World J Hepatol. 2015;7:688.

16. Tsamalaidze L, Stauffer JA, Brigham T, et al. Postsplenectomy thrombosis of splenic, mesenteric, and portal vein (PST-SMPv): a single institutional series, comprehensive systematic review of a literature and suggested classification. Am J Surg. 2018;216:1192–204.

17. Chinai N, Bintcliffe F, Armstrong EM, et al. Does every patient need to be discussed at a multidisciplinary team meeting? Clin Radiol. 2013;68:780–4.

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