Retreatment of Persons in Whom Prior Therapy Failed

This section provides guidance on the retreatment of persons with chronic HCV infection in whom prior therapy failed. The level of the evidence available to inform the best regimen for each patient and the strength of the recommendation vary and are rated accordingly (see Methods Table 2). In addition, specific recommendations are given when treatment differs for a particular group (e.g., those infected with different viral genotypes). Recommended regimens are those that are favored for most patients in that group based on optimal efficacy, favorable tolerability and toxicity profiles, complexity, and shorter treatment duration.

Alternative regimens are those that are effective but, relative to recommended regimens, have potential disadvantages, limitations for use in certain patient populations, or less supporting data. In certain situations, an alternative regimen may be optimal for a specific patient.

Specific considerations for pediatric patients; persons with HIV/HCV coinfection; decompensated cirrhosis (moderate or severe hepatic impairment; Child-Turcotte-Pugh [CTP] class B or C); HCV infection post liver transplantation; and severe renal impairment, end-stage renal disease (ESRD), or HCV infection post kidney transplantation are addressed in other sections of the guidance.

Recommended and alternative regimens are listed in order of level of evidence. When several regimens are at the same recommendation level, they are listed in alphabetical order. Regimen choice should be determined based on patient-specific data, including drug interactions. Persons receiving antiviral therapy require careful pretreatment assessment for comorbidities that may influence treatment response. All patients require careful monitoring during treatment, particularly for anemia if ribavirin is included in the regimen (See Monitoring section).

Scope and Need for Direct Acting Antiviral (DAA) Failure Retreatment

Despite the enormous success of DAA therapy, a small percent of patients who fail to achieve SVR with DAA treatment will require retreatment. To simplify and consolidate the guidance, this section no longer contains retreatment recommendations for interferon or interferon plus first-generation protease inhibitor failures because the cure rates with modern DAA regimens in these populations are comparable to treatment-naïve patients. In addition, pangenotypic regimens without the addition of ribavirin have shown high efficacy for patients with prior failure across all genotypes except genotype 3. Therefore, recommendations are categorized by regimen failure.

Prior DAA exposure may result in the selection of resistance-associated substitutions (RASs), particularly in NS5A, which could theoretically compromise the retreatment regimen. To date, however, a negative impact of NS5A RASs on the efficacy of retreatment regimens consisting of 3 DAAs with unique mechanisms of action (e.g., sofosbuvir/velpatasvir/voxilaprevir or sofosbuvir plus glecaprevir/pibrentasvir) has not been demonstrated in clinical trials. Persons experiencing multiple DAA regimen failures with complex RAS patterns in NS3 and/or NS5A represent a unique and understudied population where RASs may impact treatment response. For a full discussion, see HCV Resistance Primer section.

The following pages include guidance for management of treatment-experienced patients in the following categories:

- Sofosbuvir-based and elbasvir/grazoprevir treatment failures, including:
  - Sofosbuvir/ribavirin ± interferon
  - Sofosbuvir/ledipasvir

- Sofosbuvir/velpatasvir
- Elbasvir/grazoprevir

- Glecaprevir/pibrentasvir treatment failures
- Multiple DAA regimen failures, including:
  - Sofosbuvir/velpatasvir/voxilaprevir
  - Sofosbuvir plus glecaprevir/pibrentasvir

Last update: October 24, 2022

Sofosbuvir-Based and Elbasvir/Grazoprevir Treatment Failures

In general, persons who have experienced treatment failure with a sofosbuvir-based regimen should be retreated with 12 weeks of sofosbuvir/velpatasvir/voxilaprevir. The main exception is persons with genotype 3 and cirrhosis, in whom addition of ribavirin to sofosbuvir/velpatasvir/voxilaprevir for 12 weeks is recommended. Sixteen weeks of glecaprevir/pibrentasvir is an alternative regimen.

Elbasvir/grazoprevir treatment failure patients should also be retreated with 12 weeks of sofosbuvir/velpatasvir/voxilaprevir. However, glecaprevir/pibrentasvir for 16 weeks is not recommended as an alternative for this group of patients.

Recommended and alternative regimens listed by evidence level and alphabetically for:

Sofosbuvir-Based Treatment Failures, With or Without Compensated Cirrhosis[a]

RECOMMENDED	DURATION	RATING
Daily fixed-dose combination of sofosbuvir (400 mg)/velpatasvir (100 mg)/voxilaprevir (100 mg)[b]	12 weeks	I, A
ALTERNATIVE	**DURATION**	**RATING**
Daily fixed-dose combination of glecaprevir (300 mg)/pibrentasvir (120 mg) except for NS3/4 protease inhibitor inclusive combination DAA regimen failures[c] • **Not** recommended for genotype 3 infection with sofosbuvir/NS5A inhibitor experience.	16 weeks	I, A

Recommended and alternative regimens listed by evidence level and alphabetically for:

Sofosbuvir-Based Treatment Failures, With or Without Compensated Cirrhosis[a]

[a] For decompensated cirrhosis, please refer to the appropriate section.
[b] Genotype 3: Add weight-based ribavirin if cirrhosis is present and there are no contraindications.
[c] This regimen is not recommended for patients with prior exposure to an NS5A inhibitor plus NS3/4 PI regimens (e.g., elbasvir/grazoprevir).

Recommended Regimen

Sofosbuvir/Velpatasvir/Voxilaprevir

The placebo-controlled, phase 3 POLARIS-1 trial evaluated a 12-week course of the daily fixed-dose combination of sofosbuvir (400 mg)/velpatasvir (100 mg)/voxilaprevir (100mg) in 263 persons with a prior NS5A inhibitor-containing DAA regimen failure. The majority (55%) had experienced a sofosbuvir/ledipasvir failure (Bourliere, 2017). Virologic failure was rare (2%; 3/145) among those retreated with sofosbuvir/velpatasvir/voxilaprevir. All 3 individuals whose retreatment failed had cirrhosis; 2 persons had genotype 1a and 1 had genotype 4d. The treatment-failure patients with genotype 1a also had baseline RASs at Q80K, Z30T, and Y93H.

In the same study, a small number of persons who had a prior treatment failure with sofosbuvir/velpatasvir were retreated with sofosbuvir/velpatasvir/voxilaprevir. Two patients experienced virologic failure. Both had cirrhosis, genotype 3, and the Y93H RAS in the NS5A region at baseline. Because of the higher failure rates in the subgroup of genotype 3 patients with cirrhosis, the regimen of sofosbuvir/velpatasvir/voxilaprevir plus ribavirin for 12 weeks is recommended. If ribavirin cannot be used, extension to 24 weeks can be considered. Several real-world cohort reports also identified lower response rates after sofosbuvir/velpatasvir/voxilaprevir retreatment for 12 weeks in persons with genotype 3 and cirrhosis, lending further support to the need for regimen modification (Papaluca, 2021); (Llaneras, 2019). Serious adverse events were similar in the placebo and treatment arms; a single patient discontinued therapy due to an adverse event. Headache, diarrhea, and nausea were more common in those participants receiving sofosbuvir/velpatasvir/voxilaprevir compared to placebo.

Results from deferred treatment of the placebo arm in POLARIS-1 further support the high efficacy of 12 weeks of sofosbuvir/velpatasvir/voxilaprevir for retreatment of persons with a prior sofosbuvir/NS5A inhibitor treatment failure (Bourliere, 2018). Overall SVR in the deferred treatment group was 97% (n=147), including 96% SVR (n=76) in those with prior sofosbuvir/NS5A inhibitor experience (n=76).

The phase 3, open-label, randomized clinical trial POLARIS-4 compared a 12-week course of the daily fixed-dose combination of sofosbuvir/velpatasvir/voxilaprevir to 12 weeks of sofosbuvir/velpatasvir in NS5A inhibitor-naive, DAA-experienced patients (Bourliere, 2017). Eleven percent had prior exposure to simeprevir/sofosbuvir. Cirrhosis was common, 46% in both arms. SVR12 rates were higher for sofosbuvir/velpatasvir/voxilaprevir (98%; 178/182) compared to sofosbuvir/velpatasvir (90%; 136/151). This study supports sofosbuvir/velpatasvir/voxilaprevir as a recommended regimen for patients with a prior treatment failure with a sofosbuvir-containing regimen, regardless of the presence of compensated cirrhosis.

Data from both clinical trials (Bourliere, 2018); (Bourliere, 2017) and real-world cohorts (Da, 2020); (Belperio, 2019); (Degasperi, 2019); (Llaneras, 2019) that evaluated the efficacy and safety of sofosbuvir/velpatasvir/voxilaprevir among DAA-experienced persons support the use of this regimen for persons with a prior DAA treatment failure. A more recent real-world evaluation of 144 patients from the UK who were retreated with sofosbuvir/velpatasvir/voxilaprevir following virologic failure with first-line DAA treatment regimens found an overall retreatment SVR12 of 90 percent (Smith, 2021b). Interestingly, pre-retreatment RASs were not associated with SVR when HCV genotype was taken into account. Patients

with genotype 3, persons with cirrhosis, and those who had sofosbuvir/velpatasvir failure had significantly lower re-treatment response with sofosbuvir/velpatasvir/voxilaprevir. Possibly alternative or longer re-treatment regimens should be considered in such persons.

In resource-limited countries where sofosbuvir/velpatasvir/voxilaprevir in not available, innovative retreatment regimens using first-generation DAAs often proved successful (i.e., after a failure to NS5a/SOF in HCV genotype 1, switching to sofosbuvir when reused in combination with a new DAA class such as a protease inhibitor) (Dietz, 2021).

Alternative Regimen

Glecaprevir/Pibrentasvir

In parts 1 and 2 of the MAGELLAN-1 trial, 42 patients with genotype 1 who had previously been treated with either an NS5A inhibitor or an NS3/4A protease inhibitor were retreated with glecaprevir/pibrentasvir (Poordad, 2018); (Poordad, 2017). Twenty-four percent of the study participants had cirrhosis; 79% had genotype 1a. In the subgroup of persons previously treated with an NS5A inhibitor (ledipasvir or daclatasvir) and not concomitantly treated with a NS3/4A protease inhibitor, the daily fixed-dose combination of glecaprevir (300 mg)/pibrentasvir (120 mg) for 16 weeks achieved an SVR of 94% (16/17). The single patient who did not respond to therapy had an on-treatment virologic failure.

A phase 3b open-label study further supports the efficacy of 16 weeks of glecaprevir/pibrentasvir for retreatment of individuals with genotype 1 infection and a history of sofosbuvir/NS5A inhibitor treatment failure (Lok, 2019). The study randomized sofosbuvir/NS5A inhibitor-experienced, genotype 1 patients without cirrhosis to 12 weeks (n=78) or 16 weeks (n=49) of glecaprevir/pibrentasvir. Participants with cirrhosis were randomized to 12 weeks (n=21) or 16 weeks (n=29) of glecaprevir/pibrentasvir plus weight-based ribavirin. Enrollment in the 12-week plus ribavirin arm for participants with cirrhosis was halted early due 2 viral breakthroughs on therapy and 1 case of early relapse. SVR was numerically higher in the 16-week study arms (94% and 97% without and with cirrhosis, respectively) compared to the 12-week arms (90% and 86% without and with cirrhosis, respectively). No clear impact of ribavirin was detected in the study and the majority of virologic failures were among those with genotype 1a treated for 12 weeks without ribavirin. No virologic failures were seen in genotype 1b patients. These data further support glecaprevir/pibrentasvir for 16 weeks as an efficacious retreatment approach for sofosbuvir/NS5A inhibitor experienced patients.

Glecaprevir/Pibrentasvir for Genotype 3 Sofosbuvir/Ribavirin Treatment Failures

The SURVEYOR-II, part 3 trial evaluated the safety and efficacy of a 12-week or 16-week course of the daily fixed-dose combination of glecaprevir (300 mg)/pibrentasvir (120 mg) among treatment-naive or interferon-experienced (standard or peginterferon ± ribavirin, or sofosbuvir plus ribavirin ± peginterferon), genotype 3 patients without cirrhosis or with compensated cirrhosis. Among the 34 treatment-experienced participants with prior exposure to sofosbuvir who were treated for 16 weeks, regardless of cirrhosis status, SVR12 was 97% (33/34). The lone virologic failure was due to relapse in a patient with cirrhosis. No NS5A RASs were present prior to treatment; however, the L31F and Y93H substitutions were present at retreatment failure (Wyles, 2018). Sixteen weeks of glecaprevir/pibrentasvir is an alternative regimen for genotype 3 patients with prior exposure to sofosbuvir plus ribavirin given the high SVR and lack of need for the addition of ribavirin. This regimen was not evaluated for genotype 3 patients who experienced a prior treatment failure with a regimen containing both sofosbuvir and an NS5A inhibitor. Given the lack of data this regimen is not recommended for genotype 3 infection with prior sofosbuvir/NS5A inhibitor experience.

Last update: October 24, 2022

Glecaprevir/Pibrentasvir Treatment Failures

Recommended regimens listed by evidence level and alphabetically for:

Glecaprevir/Pibrentasvir Treatment Failures (All Genotypes), With or Without Compensated Cirrhosis[a]

RECOMMENDED	DURATION	RATING
Daily fixed-dose combination of glecaprevir (300 mg)/pibrentasvir (120 mg) plus daily sofosbuvir (400 mg) and weight-based ribavirin	16 weeks	IIa, B
Daily fixed-dose combination of sofosbuvir (400 mg)/velpatasvir (100 mg)/voxilaprevir (100 mg)	12 weeks	IIa, B
For patients with compensated cirrhosis, addition of weight-based ribavirin is recommended.	12 weeks	IIa, C

[a] For decompensated cirrhosis, please refer to the appropriate section.

Recommended Regimens

Glecaprevir/Pibrentasvir Plus Sofosbuvir and Ribavirin

For the small number of persons in whom treatment with the daily fixed-dose combination of glecaprevir (300 mg)/pibrentasvir (120 mg) fails, the addition of ribavirin and sofosbuvir is an attractive retreatment option. MAGELLAN-3 evaluated the safety and efficacy of glecaprevir/pibrentasvir in combination with sofosbuvir (400 mg) and weight-based ribavirin as a 12- or 16-week retreatment regimen for individuals who experienced virologic failure to glecaprevir/pibrentasvir (Wyles, 2019). Importantly, many study participants had received other regimens before their nonresponse to glecaprevir/pibrentasvir. Noncirrhotic, glecaprevir/pibrentasvir nonresponders with genotype 1, 2, 4, 5, or 6 who were naive to protease and NS5A inhibitors received 12 weeks glecaprevir/pibrentasvir plus sofosbuvir and weight-based ribavirin. Participants with genotype 3, and/or compensated cirrhosis, and/or protease or NS5A inhibitor experience (prior to their initial glecaprevir/pibrentasvir treatment) received 16 weeks of therapy with the same regimen. Overall, 96% (22/23) of these patients achieved SVR12 with a single relapse in a cirrhotic patient with genotype 1a. This individual had prior treatment failures with multiple other regimens and had multiple complex NS3 and NS5A RASs, including NS5A, Q30K, and Y93H prior to treatment. This study provides the rationale to recommend the combination of glecaprevir/pibrentasvir plus sofosbuvir and ribavirin for 16 weeks for persons without cirrhosis or with compensated cirrhosis who experienced treatment failure with initial glecaprevir/pibrentasvir treatment.

Sofosbuvir/Velpatasvir/Voxilaprevir

A prospective, nonrandomized observational study evaluated the efficacy of retreatment with 12 weeks of the daily fixed-dose combination of sofosbuvir (400 mg)/velpatasvir (100 mg)/voxilaprevir (100 mg) among patients who experienced treatment failure with initial glecaprevir/pibrentasvir therapy (Pearlman, 2019). SVR12 was 94% (29/31). The cohort had higher proportions of patients with factors traditionally associated with virologic failure, including black race, cirrhosis, and genotype 3. Two patients relapsed at week 4 following the completion of therapy. One patient had genotype 3 infection, was noncirrhotic, and had an A30K mutation at baseline and at relapse. The other patient had genotype 1a infection,

compensated cirrhosis, a Y93 variant detected at baseline, and L31M and Y93 variants at relapse. The addition of ribavirin was not evaluated in this study. For patients with cirrhosis, however, it may be helpful to add ribavirin based on prior studies of DAA failures.

Last update: October 24, 2022

Multiple DAA Treatment Failures (All Genotypes), Including Sofosbuvir/Velpatasvir/Voxilaprevir or Sofosbuvir Plus Glecaprevir/Pibrentasvir

Recommended regimens listed by evidence level and alphabetically for:

Sofosbuvir/Velpatasvir/Voxilaprevir Treatment Failures, With or Without Compensated Cirrhosis[a]

RECOMMENDED	DURATION	RATING
Daily fixed-dose combination of glecaprevir (300 mg)/pibrentasvir (120 mg) plus daily sofosbuvir (400 mg) and weight-based ribavirin	16 weeks[b]	IIa, B
Daily fixed-dose combination of sofosbuvir (400 mg)/velpatasvir (100 mg)/voxilaprevir (100 mg) plus weight-based ribavirin	24 weeks	IIa, B

[a] For decompensated cirrhosis, please refer to the appropriate section.
[b] Extension of treatment to 24 weeks should be considered in extremely difficult cases (e.g., genotype 3 with cirrhosis) or failure following sofosbuvir plus glecaprevir/pibrentasvir.

Recommended Regimens

Glecaprevir/Pibrentasvir Plus Sofosbuvir and Ribavirin

There are limited data, mostly retrospective case series, on the re-treatment of DAA non-responders. Pibrentasvir has improved in vitro activity compared to other NS5A inhibitors against most NS5A RASs (Ng, 2017b). A small study demonstrated the efficacy (22/23 patients) of glecaprevir/pibrentasvir plus sofosbuvir and ribavirin for heavily DAA-experienced patients (including those with genotype 3 and/or cirrhosis), although no sofosbuvir/velpatasvir/voxilaprevir failures were included (Wyles, 2019).

Failure to respond to sofosbuvir/velpatasvir/voxilaprevir is especially problematic. Dietz et al. described 40 such patients, 70% of whom had cirrhosis, and most not associated with specific RAS patterns following their sofosbuvir/velpatasvir/voxilaprevir treatment. The investigators attempted re-treatment with a host of different rescue treatments, varying from 12-24 weeks, and reported an overall 81% SVR rate. Therefore, such innovative rescue treatments with “multiple targeted therapies” may be effective in most patients, but there remain individuals in need of

newer options (Dietz, 2021b).

There is 1 case report examining retreatment of patients in whom therapy with sofosbuvir/velpatasvir/voxilaprevir failed. In this study, a quad regimen of sofosbuvir, glecaprevir/pibrentasvir, and ribavirin for 24 weeks was successful (Bernhard, 2020). Another case report describes an individual (genotype 1a, cirrhosis) who failed multiple regimens (including 24 weeks of sofosbuvir/velpatasvir/voxilaprevir and 24 weeks of glecaprevir/pibrentasvir plus sofosbuvir and ribavirin) who was then treated variously with multiple DAA regimens for 52 weeks, who finally achieved an SVR (Trudeau, 2022). This case suggests that on-treatment protracted HCV RNA-negativity beyond 24 weeks might be necessary to allow for immune reconstitution and viral clearance for these most difficult-to-treat patients.

Sixteen weeks of glecaprevir/pibrentasvir plus sofosbuvir and ribavirin is recommended based on the improved resistance profile of pibrentasvir and high response rate seen with this duration of therapy among genotype 3 patients in the MAGELLAN-3 trial (Wyles, 2019). Extension to 24 weeks or longer with this regimen could be considered; while there are case report data using this duration (Bernhard, 2020); (Fierer, 2020), no clinical trial data are available to support such an approach.

Sofosbuvir/Velpatasvir/Voxilaprevir Plus Ribavirin

Although there are no published studies examining retreatment of patients in whom therapy with sofosbuvir/velpatasvir/voxilaprevir failed, in the POLARIS-1 study—which studied sofosbuvir/velpatasvir/voxilaprevir treatment among patients who had a prior DAA therapy failure—treatment failure with this triple antiviral regimen was seen more commonly in persons with cirrhosis (7% cirrhosis vs 1% without cirrhosis), and those with genotype 3 or 4 (5% genotype 3, 9% genotype 4 vs 0% genotype 1) (Bourliere, 2017). Baseline RASs did not affect SVR nor did failure select for additional RAS variants. The recommendation to treat with longer therapy in conjunction with ribavirin when retreating with the same DAA regimen (sofosbuvir/velpatasvir/voxilaprevir) is based on extrapolation from prior studies showing benefit with this strategy in different populations (Gane, 2017).

Last update: October 24, 2022

Related References

Belperio PS, Shahoumian TA, Loomis TP, Backus LI. Real-world effectiveness of sofosbuvir/velpatasvir/voxilaprevir in 573 direct-acting antiviral experienced hepatitis C patients. J Viral Hepat. 2019;26(8):980-990.

Bernhard B, Stickel F. Successful fourth line treatment of a relapse patient with chronic hepatitis C virus infection genotype 3a using sofosbuvir, glecaprevir/pibrentasvir, and ribavirin: a case report. Z Gastroenterol. 2020;58(5):451-455.

Bourliere M, Gordon SC, Flamm SL, Cooper CL, Ramji A, Tong M, et al. Sofosbuvir, velpatasvir, and voxilaprevir for previously treated HCV infection. N Engl J Med. 2017;376(22):2134-2146.

Bourliere M, Gordon SC, Schiff ER, et al. Deferred treatment with sofosbuvir-velpatasvir-voxilaprevir for patients with chronic hepatitis C virus who were previously treated with an NS5A inhibitor: an open-label substudy of POLARIS-1. Lancet Gastroenterol Hepatol. 2018;3(9):559-565.

Da BL, Lourdusamy V, Kushner T, Dieterich D, Saberi B. Efficacy of sofosbuvir/velpatasvir/voxilaprevir in direct-acting antiviral experienced patients with hepatitis C virus. Eur J Gastroenterol Hepatol. 2020;:Epub ahead of print.

Degasperi E, Spinetti A, Lombardi A, et al. Real-life effectiveness and safety of sofosbuvir/velpatasvir/voxilaprevir in hepatitis C patients with previous DAA failure. J Hepatol. 2019;71(6):1106-1115.

Dietz J, Spengler U, B M, et al. Efficacy of retreatment after failed direct-acting antiviral therapy in patients with HCV genotype 1-3 infections. J Hepatol [Internet]. 2021;19(1):195-198. https://doi.org/10.1016/j.cgh.2019.10.051

J D, VC DMaio, De Salazar A, et al. Failure on voxilaprevir, velpatasvir, sofosbuvir and efficacy of rescue therapy. J Hepatol [Internet]. 2021;74(4):801-810. https://doi.org/10.1016/j.jhep.2020.11.017

Fierer DS, Wyles DL. Re-treatment of hepatitis C infection after multiple failures of direct-acting antiviral therapy. Open Forum Infect Dis. 2020;7(4):ofaa095.

Gane EJ, Shiffman ML, Etzkorn K, et al, et al. Sofosbuvir-velpatasvir with ribavirin for 24 weeks in hepatitis C virus patients previously treated with a direct-acting antiviral regimen. Hepatology. 2017;66(4):1083-1089.

Llaneras J, Riveiro-Barciela M, Lens S, et al. Effectiveness and safety of sofosbuvir/velpatasvir/voxilaprevir in patients with chronic hepatitis C previously treated with DAAs. J Hepatol. 2019;71(4):666-672.

Lok AS, Sulkowski MS, Kort JJ, et al. Efficacy of glecaprevir and pibrentasvir in patients with genotype 1 hepatitis C virus infection with treatment failure after NS5A inhibitor plus sofosbuvir therapy. Gastroenterology. 2020;157(6):1506-1517.e1.

Ng TI, Krishnan P, Pilot-Matias T, et al. In vitro antiviral activity and resistance profile of the next-generation hepatitis C virus NS5A inhibitor pibrentasvir. Antimicrob Agents Chemother. 2017;61(5):pii: e02558-16.

Papaluca T, Roberts SK, SI S, et al. Efficacy and Safety of Sofosbuvir/Velpatasvir/Voxilaprevir for Hepatitis C Virus (HCV) NS5A-Inhibitor Experienced Patients With Difficult to Cure Characteristics. Clin Infect Dis [Internet]. 2021;73(9):e3288-e3295. https://doi.org/10.1093/cid/ciaa1318

Pearlman B, Perrys M, Hinds A. Sofosbuvir/velpatasvir/voxilaprevir for previous treatment failures with glecaprevir/pibrentasvir in chronic hepatitis C infection. Am J Gastroenterol. San Francisco, CA; 2019;114(9):1550-1552.

Poordad F, Felizarta F, Asatryan A, et al. Glecaprevir and pibrentasvir for 12 weeks for hepatitis C virus genotype 1 infection and prior direct-acting antiviral treatment. Sulkowski MS, Reindollar RW, Landis CS, Gordon SC, Flamm SL, Fried MW, et al. Hepatology. 2017;66(2):389-397.

Poordad F, Pol S, Asatryan A, et al. Glecaprevir/pibrentasvir in patients with hepatitis C virus genotype 1 or 4 and past direct-acting antiviral treatment failure. Hepatology. 2018;67(4):1260.

Smith DA, Bradshaw D, Mbisa JL, et al. Real world SOF/VEL/VOX retreatment outcomes and viral resistance analysis for HCV patients with prior failure to DAA therapy. J Viral Hepat [Internet]. 2021;28(9):1256-1264. https://doi.org/10.1111/jvh.13549

Trudeau S, Mendiratta V, Dababneh Y, Hollingsworth J, Gordon SC. Letter to the Editor: Successful treatment of multidrug resistant hepatitis C after >12 months of continuous therapy with direct-acting antivirals. Hepatology. 2022;.

Wyles D, Poordad F, Wang S, Alric L, Felizarta F, Kwo PY, et al. Glecaprevir/pibrentasvir for hepatitis C virus genotype 3 patients with cirrhosis and/or prior treatment experience: a partially randomized phase 3 clinical trial: viral hepatitis. Hepatology. 2018;67(2):514-523.

Wyles D, Weiland O, Yao B, et al. Retreatment of patients who failed glecaprevir/pibrentasvir treatment for hepatitis C virus infection. J Hepatol. 2019;70(5):1019-1023.