




Clinical Efficacy and Safety of a Novel Antifungal, Fosmanogepix, in Patients with Candidemia Caused by *Candida auris*: Results from a Phase 2 Trial

Jose A. Vazquez,^a Peter G. Pappas,^b Kenneth Boffard,^c Fathima Paruk,^d Paul A. Bien,^e  Margaret Tawadrous,^f Eric Ople,^e Pamela Wedel,^e Iwona Oborska,^e Michael R. Hodges^e

^aMedical College of Georgia, Augusta University, Augusta, Georgia, USA

^bUniversity of Alabama at Birmingham, Birmingham, Alabama, USA

^cMilpark Hospital, University of the Witwatersrand, Johannesburg, South Africa

^dSteve Biko Academic Hospital, University of Pretoria, Pretoria, South Africa

^eAmplix Pharmaceuticals Inc., San Diego, California, USA

^fPfizer Inc., Groton, Connecticut, USA

ABSTRACT Fosmanogepix (FMGX), a novel antifungal available in intravenous (IV) and oral formulations, has broad-spectrum activity against pathogenic yeasts and molds, including fungi resistant to standard of care antifungals. This multicenter, open-label, single-arm study evaluated FMGX safety and efficacy for treatment of candidemia and/or invasive candidiasis caused by *Candida auris*. Eligible participants were ≥ 18 years, with established candidemia and/or invasive candidiasis caused by *C. auris*, (cultured within 120 h [for candidemia] or 168 h [for invasive candidiasis without candidemia] with accompanying clinical signs) and limited treatment options. Participants were treated with FMGX (≤ 42 days; loading dose: 1000 mg IV twice daily [Day 1], followed by 600 mg IV once daily [QD]). Switching to oral FMGX 800 mg QD was permitted from Day 4. Primary endpoint was treatment success (survival and clearance of *C. auris* from blood/tissue cultures without additional antifungals) at the end of the study treatment (EOST), assessed by an independent data review committee (DRC). Day 30 survival was a secondary endpoint. *In vitro* susceptibility of *Candida* isolates was assessed. Nine participants with candidemia (male:6, female:3; 21 to 76 years) in intensive care units in South Africa were enrolled; all received IV FMGX only. DRC-assessed treatment success at EOST and Day 30 survival were 89% (8/9). No treatment related adverse events or study drug discontinuations were reported. FMGX demonstrated potent *in vitro* activity against all *C. auris* isolates (MIC range: 0.008 to 0.015 $\mu\text{g/mL}$ [CLSI]; 0.004–0.03 $\mu\text{g/mL}$ [EUCAST]), with the lowest MICs compared to other antifungals tested. Thus, the results showed that FMGX was safe, well-tolerated, and efficacious in participants with candidemia caused by *C. auris*.

KEYWORDS intensive care unit, APX001, *Candida auris*, Gwt1 inhibitor, candidemia, fosmanogepix

Candida auris is a fungal pathogen that was first identified in 2009 and has since emerged as a global threat. *C. auris* isolates have been implicated in nosocomial outbreaks worldwide, with 5 distinct clades classified by region of independent emergence. Based on current profiling, these clades are referred to as Clade I (South Asian), Clade II (East Asian), Clade III (African), Clade IV (South American), and Clade V (Iranian) with different genetic determinants of resistance and resulting antifungal resistance profiles. Despite the classification of each clade based on the initial geographical region of detection, transmission in other areas has been reported, with multiple clades identified in Canada, Kenya, and the United States (1–7).

Copyright © 2023 Pfizer. This is an open-access article distributed under the terms of the [Creative Commons Attribution 4.0 International license](https://creativecommons.org/licenses/by/4.0/).

Address correspondence to Margaret Tawadrous, Margaret.Tawadrous@pfizer.com.

Trial Registration: NCT04148287.

The authors declare a conflict of interest. Jose A. Vazquez received grant support from Cidara, Scynexis and was a consultant for Cidara, Scynexis, F2G, Amplix. Michael R. Hodges, Eric Ople, Pamela Wedel were employees of Amplix (now a Pfizer Inc subsidiary). Michael R. Hodges was previously an employee of Pfizer and holds Pfizer stock. Paul A. Bien and Margaret Tawadrous are employees of Pfizer and hold Pfizer stock. Iwona Oborska was a consultant for Amplix, previously a Pfizer employee, and Pfizer shareholder. Fathima Paruk has served on the speaker bureaus for Thermofischer Scientific, Pfizer, Biomerieux, MSD and Dr Reddy's. Peter G. Pappas received grant support from Astellas, Gilead, Mayne, Cidara, Scynexis and provided advisory and consultancy services to Amplix, Mayne, Scynexis. Kenneth Boffard has no conflicts of interest to declare.

Received 20 October 2022

Returned for modification 11 December 2022

Accepted 13 March 2023

Published 6 April 2023

Invasive *C. auris* infections are associated with high mortality rates, with 60% of hospitalizations due to *C. auris* infections resulting in death (8). These rates are higher than the observed mortality rates for candidemia/invasive candidiasis, which are estimated to be 25% overall and 31%, respectively, for patients ≥ 65 years of age (9).

C. auris is well known for its multi-drug resistant characteristics, with most isolates resistant to fluconazole, an important first-line antifungal agent (3, 6, 10, 11). Furthermore, 41% of *C. auris* isolates from a global study were found to be resistant to 2 or more classes of antifungals (8). Indeed, echinocandins are now generally recognized as the drugs of choice for the treatment of *C. auris* infections (12). Increased rates of resistance, especially to the azoles, and high mortality rates demonstrate a significant unmet medical need for novel antifungal agents with activity against these *Candida* species.

Fosmanogepix (FMGX; PF-07842805, APX001, E1211) is the first member in the “gepex” class of antifungals, with a unique mechanism of action (MOA). FMGX is a prodrug that is rapidly converted *in vivo* by systemic phosphatases to the active moiety manogepix (MGX). MGX inhibits the conserved fungal glycosylphosphatidylinositol (GPI)-anchored wall transfer protein 1 (Gwt1) (13, 14). In yeasts, Gwt1 mediates cross-linking of cell wall mannoproteins to β -1,6-glucan. Inhibition of Gwt1 results in pleiotropic effects on the fungal cell including alterations in fungal adherence to surfaces, inhibition of biofilm and germ tube formation, and subsequently results in severe growth defects and yeast lethality (15). Broad-spectrum antifungal activity has been observed against pathogenic yeasts and molds, including activity against resistant strains (16–18).

Surveillance studies have demonstrated that MGX was the most mycologically active agent against over 400 diverse *C. auris* isolates, including strains which were multi-drug resistant (19, 20). Another study that focused on 200 *C. auris* strains collected between 2017 and 2020 in New York and New Jersey reported low MICs for MGX even against pan-resistant strains shown to be resistant to the 3 main classes of antifungal drugs (i.e., azoles, polyenes, and echinocandins) (21). When *in vitro* activity of MGX was evaluated against eight comparator agents against 122 wild type and non-wild type *C. auris* isolates, similar findings were reported, with MGX having the most potent antifungal activity against all *C. auris* strains (22). FMGX improved survival over anidulafungin, an echinocandin, in a disseminated *C. auris* infection model in immunocompromised mice (13). In a study assessing the efficacy of FMGX in reducing fungal burden and increasing survival of *C. auris* infected neutropenic mice, similar *in vivo* efficacy and improved survival was detected, even when treatment was delayed postinfection by 24 h (23). Additionally, with a wide tissue distribution, high oral bioavailability, and availability in both IV and oral formulations, FMGX provides drug characteristics that are favorable for treating invasive fungal infections, such as candidemia/invasive candidiasis caused by *C. auris* (24, 25).

In a Phase 2 study in 20 patients with invasive candidiasis, FMGX was safe, well-tolerated, and demonstrated a high treatment success rate of 80% at end of study treatment (EOST) and Day 30 survival of 85% (26). In the present Phase 2 study, we aimed to assess the efficacy and safety of FMGX in a similar population of patients with candidemia/invasive candidiasis caused by *C. auris*, with limited antifungal treatment options.

RESULTS

Disposition, demographics, and exposure. The study enrolled 9 participants from 2 sites in South Africa (15 participants were planned for enrollment). However, the study was terminated early due to the impact of the COVID-19 pandemic on patient enrollment. The intent-to-treat and safety populations each included all 9 enrolled participants with candidemia (henceforth, study population). Eight participants completed a full course of treatment, and one did not complete treatment due to death. Seven participants completed the study through the 4-week follow-up, with an additional death reported during the follow-up period.

Demographics and baseline characteristics for enrolled participants were consistent with the epidemiology of *C. auris* infections (Table 1). The study was conducted in intensive

TABLE 1 Demographics and baseline characteristics

Parameter	Fosmanogepix N = 9
Age, mean (SD) ^a [range] yrs ^b	49.8 (17.7) [21 to 76]
<65 yrs, n (%)	7 (77.8)
≥65 yrs, n (%)	2 (22.2)
Gender, n (%)	
Male	6 (66.7)
Female	3 (33.3)
Race, n (%)	
Black or African American	5 (55.6)
White	3 (33.3)
Asian	1 (11.1)
BMI ^c (kg/m ²), mean (SD)	28.11 (6.6)
APACHE ^d II score, mean (SD)	12.7 (6.4)
<10	3 (33.3)
10 to 19	4 (44.4)
20 to 30	2 (22.2)
ICU ^e , n (%)	9 (100.0)

^aSD, standard deviation.^byrs, years.^cBMI, body mass index.^dAPACHE, acute physiology and chronic health evaluation.^eICU, intensive care unit.

care units (ICUs). Underlying diseases leading to *C. auris* infection included fractures, burns, trauma, and nervous system disorders. All participants had *C. auris* infections at baseline with no coinfections with other *Candida* spp. All participants had candidemia only, with no evidence of invasive candidiasis at other sites. All 9 patients received at least 1 dose of an echinocandin antifungal (for ≤4 days) prior to start of FMGX treatment. No other class of antifungal was administered prior to FMGX treatment.

The mean (SD) duration of treatment with FMGX was 19 (5.83) days, ranging from 11 to 27 days; most participants (5/9 [55.6%]) received FMGX for >14 days but ≤28 days. All participants received FMGX via IV infusion; none were switched to the oral formulation. PK sampling was sparse and relatively few PK samples were collected, precluding a model-based compartmental analysis. However, a linear, two-compartment population PK model based on previous phase I studies provided an adequate fit for the MGX concentrations observed. The PK data collected indicated that all participants had systemic exposures to MGX (median [range] total drug plasma AUC over duration of therapy: 93 [64.4 to 182] mg·h/L), consistent with prior exposure data from Phase 1 and Phase 1b studies in healthy volunteers and in patients with acute myeloid leukemia. MGX AUC:MIC ratios were also determined (median [range] total drug plasma AUC:MIC ratio over duration of therapy: 7147 [5194 to 12112] mg · h/L). Attainment of the total-drug plasma AUC:MIC ratio ED₅₀ target was 100% for total-drug plasma AUC:MIC ratio evaluated on Day 7 and averaged over study treatment. FMGX exposures were minimal, as expected, given the rapid conversion by systemic phosphatases of parent (FMGX) to active moiety (MGX), as observed previously in Phase 1 and Phase 1b studies.

Efficacy. (i) Primary efficacy endpoint: Treatment success at EOSt. DRC-assessed treatment success at EOSt was 89% (8/9) in the study population (Table 2). One (11%) participant was a treatment failure at EOSt as death occurred during the FMGX treatment period. The participant initially presented with extensive burns (60% partial to full thickness) and acute renal failure 27 days prior to enrollment. The participant eventually developed Gram-negative sepsis and multi-organ failure on Day 10 of the study and died due to cardiac arrest on Day 11. This death was considered unrelated to

TABLE 2 Efficacy endpoints: treatment success and survival

Endpoint	Fosmanogepix N = 9
Response at EOST ^a	
Treatment Success ^b , n (%) [95% CI] ^d	8 (88.9) [51.8, 99.7]
Treatment Failure, n (%)	1 (11.1)
Reasons for failure at EOST	
Death, n (%)	1 (11.1)
Response at 2 wks after EOST	
Treatment Success Sustained, n (%) [95% CI] ^d	6 (66.7) [29.9, 92.5]
Clinical Relapse (Positive culture), n (%)	1 (11.1)
Death, n (%)	1 (11.1)
Response at 4 wks after EOST	
Treatment Success Sustained, n (%)	6 (66.7)
Survival at Day 30, n (%)	8 (88.9)

^aEOST, end of study treatment.

^bTreatment Success was defined as meeting all of the following criteria: 2 consecutive blood cultures negative for *Candida* spp. and/or for participants with a deep-seated site of infection, at least 1 negative tissue culture or aspirate/fluid culture; alive at EOST; and no concomitant use of any other systemic antifungals through EOST.

^cCI, confidence interval.

^d95% CIs were two-sided exact binomial CIs.

FMGX. All 4 patients who did not have all preexisting intravascular catheters removed prior to receiving the first dose of FMGX were assessed as treatment successes by the DRC, as were the majority (4/5) of the patients who had their intravascular catheters removed.

Secondary efficacy endpoints. (i) Time to first negative blood culture. All participants had positive *C. auris* blood cultures during the enrollment period. A positive blood culture was reported for 3 participants on Day 1 before starting FMGX treatment ($n = 3$). For these participants, the mean (SD) time to first negative blood culture was 8.7 (5.51) days.

In the study population, 6 (66.7%) participants demonstrated eradication of *C. auris* bloodstream infection at EOST, 2 were indeterminate due to missing blood cultures, 1 participant had a recurrence 2 days after stopping FMGX (based on a single positive blood culture but was asymptomatic) (Table 3). All subsequent blood cultures were negative and therefore later assessed as eradication by the investigator. There were no further recurrences during the 4-week follow-up period.

(ii) Mycology. All screened *C. auris* isolates recovered from blood cultures had low

TABLE 3 Mycological outcomes

Mycological outcome	Total (N = 9)	no. of Participants by Treatment Outcome	DRC assessed treatment outcome
EOST			
Eradication	6	6	Treatment Success
Indeterminate	2	1: no EOST culture taken	Treatment Success
		1: death on Day 11	Treatment Failure
Recurrence	1 ^a	1 ^a	EOST Treatment Success, followed by early relapse
Follow-up period (2 and 4 wks after EOST combined)			
Eradication	7	1 ^a	Recurrence at EOST, subsequently eradication (early relapse)
		6	Treatment Success sustained
Indeterminate	2	1 death on Day 11	Treatment Failure at EOST
		1 death on Day 36	Treatment Success at EOST, not sustained through follow-up
Recurrence	0		

^aPatient with investigator-assessed mycological recurrence at EOST visit was assessed as treatment success followed by early relapse by DRC, because the single *C. auris* in blood culture was sampled 2 days after stopping study drug, *de facto* in the early follow-up period. All subsequent blood cultures were negative and assessed as eradication by the investigator. EOST, end of study treatment.

TABLE 4 Activity of manogepix and comparators against *C. auris* baseline isolates (CLSI and EUCAST methods)^a

Participant	MIC (CLSI ^b /EUCAST ^c ; $\mu\text{g}/\text{mL}$)					
	Amphotericin	Anidulafungin	Micafungin	Fluconazole	Manogepix	Voriconazole
1	1/0.5	0.5/1	0.25/0.25	>128/>128	0.015/0.015	2/2
2	1/0.5	0.5/0.06	0.12/0.03	>128/128	0.015/0.008	2/0.5
3	1/0.5	1/2	0.25/2	128/>128	0.015/0.03	2/8
4	1/0.5	1/0.25	0.25/0.25	>128/128	0.015/0.004	2/0.5
5	1/0.5	1/0.06	0.25/0.12	>128/>128	0.008/0.008	1/1
6	1/0.5	1/0.06	0.25/0.5	>128/>128	0.015/0.008	2/1
7	1/0.5	0.5/0.12	0.25/0.25	>128/>128	0.015/0.008	2/1
8	1/0.5	0.5/0.03	0.25/0.06	>128/>128	0.008/0.004	2/4
9	1/0.5	1/0.06	0.25/0.12	>128/>128	0.015/0.008	2/1

^aMICs of isolates collected at baseline shown for all participants.

^bCLSI, Clinical & Laboratory Standards Institute.

^cEUCAST, European Committee on Antimicrobial Susceptibility Testing.

MIC values to MGX using both CLSI and EUCAST assay methods (0.008 to 0.015 $\mu\text{g}/\text{mL}$ [CLSI] and 0.004 to 0.03 $\mu\text{g}/\text{mL}$ [EUCAST]; Table 4). Among all antifungals evaluated, MGX had the lowest MIC values across all *C. auris* isolates. In the single case of relapse, the *C. auris* isolate did not have a high MIC value at baseline, nor did the value increase during FMGX treatment. For the study population, no shift in MGX susceptibility was observed in *C. auris* isolates collected during FMGX treatment. Similar to a previous study on *C. auris* isolates (22), the agreement between CLSI and EUCAST MICs for MGX were high (equal to or within 1 dilution for 8/9 isolates) while anidulafungin MICs were different (2 to 16-fold) between CLSI and EUCAST methods for all 9 isolates.

(iii) Secondary safety endpoints. All participants experienced a treatment-emergent adverse event (TEAE); however, none were considered treatment related (Table 5). The most common TEAEs were pyrexia (3 [33.3%]), constipation, multiple organ dysfunction syndrome, pneumonia, pruritus, hypertension, and hypotension (2 [22.2%] each). Two participants experienced 5 serious adverse events (SAEs); all were considered unrelated to treatment. No clinically significant safety concerns related to routine laboratory investigations were identified.

Two deaths, both unrelated to FMGX treatment, were reported during the study. One occurred on treatment (Day 11) due to a cardiac arrest in a patient with Gram-negative

TABLE 5 Treatment-emergent adverse events^a

Category	Fosmanogepix (N = 9)	
	Participants n (%)	Events n
All TEAEs	9 (100.0)	48
Study drug-related TEAEs	0	0
TEAEs ^b by Maximum Severity		
Mild (CTCAE Grade 1)	1 (11.1)	2
Moderate (CTCAE Grade 2)	2 (22.2)	5
Severe (CTCAE Grade 3)	4 (44.4)	5
Life-threatening (CTCAE Grade 4)	0 (0.0)	0
Death (CTCAE Grade 5)	2 (22.2)	2
Study drug related TEAEs	0 (0.0)	0
SAEs		
All SAEs	2 (22.2)	5
Study drug related TESAEs	0 (0.0)	0
TEAEs leading to discontinuation of study drug	1 (11.1)	1
Study drug related TEAEs	0 (0.0)	0

^aAE = adverse event; CTCAE: Common Terminology Criteria for Adverse Events; SAE = serious adverse event; TEAE = treatment-emergent adverse event; TESAE = treatment-emergent serious adverse event.

^bTEAEs were defined as AEs occurring on or after the first dose of the study drug. Both participants and events are by maximum severity per patient.

sepsis, and the second occurred after treatment completion (Day 36) in a patient who developed ventilator-associated pneumonia and multi-organ failure.

DISCUSSION

The goal of this Phase 2 study was to assess the safety and efficacy of FMGX in participants with *C. auris* candidemia and/or invasive candidiasis. The enrolled population was consistent with the disease epidemiology. All participants were in the ICU and were generally younger (median age of 45 years) and with fewer comorbidities than participants evaluated in prior candidemia and invasive candidiasis studies (27). A high rate of treatment success at EOST and survival at Day 30 (both 88.9%) was reported, along with a durable mycological response. No discontinuations or treatment related AEs were reported. Furthermore, both deaths were considered unrelated to study treatment. MGX was the most active compound tested against all *C. auris* study isolates with an MIC range of 0.008 to 0.015 $\mu\text{g}/\text{mL}$ (CLSI) and 0.004 to 0.03 $\mu\text{g}/\text{mL}$ (EUCAST). This is consistent with previous *in vitro* studies showing MGX to be the most potent antifungal tested against *C. auris* isolates (21, 22).

C. auris, a well-documented global threat, has caused several independent outbreaks in different geographical areas. Currently, 5 clades have been identified, based on genetic sequence and geographical origin (2, 7). Outbreaks with high fatality have occurred in health care settings in immunosuppressed patients. More importantly, rapid nosocomial spread from person-to-person has also been documented (28). Almost all identified strains are resistant to at least 2 classes of antifungals (azoles and polyenes), with some strains demonstrating multi-drug resistance (azole-polyene-candin) (29). Given these characteristics, *C. auris* is classified as an urgent global threat by the Centers for Disease Control and Prevention (CDC), with endemic hospital-associated infections being reported worldwide (30). There is a high unmet need for novel antifungals to treat candidemia/invasive candidiasis caused by drug resistant *C. auris*.

In the United States, the occurrence of infection caused by pan-resistant *C. auris* isolates was recently reported in several regions. These isolates were resistant to echinocandins, the antifungal class of choice for the treatment of most systemic candida infections (31). It is important to note that these patients all had prior epidemiological links to health care facilities but no prior echinocandin exposure (32).

In addition, outbreaks of *C. auris* infection are associated with increased length of hospital stay and health care costs, treatment failures, and death. In an analysis of an outbreak involving 34 patients at a large teaching hospital in the United Kingdom, prior antifungal prescription was strongly associated with increased risk of infection. In this case, the cost of infection control was estimated to be more than £1 million, notwithstanding costs related to lost opportunity, consumables, and screening costs. At the same health care facility, outbreak management costs continued to remain high the subsequent year due to an increased persistence of *C. auris* in the environment (33).

The incidence of *C. auris* infections have also increased during the COVID-19 pandemic, straining health care capacity, and increasing the risk of multidrug resistant nosocomial infections (34). Thus, there is an urgent need to improve treatment options for affected patients and control the spread of infection in health care facilities worldwide. Although no patients in this study received oral treatment, FMGX has high oral bioavailability and maintenance of plasma exposures when switching from IV or oral dosing. In addition, FMGX has a wide tissue distribution and provides exposures to the eye, gut, and brain, common sites of *Candida* dissemination (24).

This pilot study had some limitations. The sample size was small since the study was terminated early due to the ICU burden of the COVID-19 pandemic. However, no trial related visits or procedures were negatively impacted by the pandemic, and all protocol mandated study data were collected. All active sites from which participants were enrolled were in South Africa, and the *C. auris* isolates were likely from Clade III so these results may not be generalizable to all clades. However, Clade III isolates (found in South Africa) have also been detected in other countries, including Canada and the United States

(2, 35). In addition, study participants were at high risk of infection with *C. auris*. A high rate of treatment success at EOST was achieved despite an increased risk of adverse outcomes in participants admitted to intensive care units. However, although none of the study participants had deep-seated *C. auris* infections, in a delayed therapy animal infection model of *C. auris* invasive candidiasis, significant reductions in fungal burden were observed in both kidney and brain (consistent with a deep-seated infection) in all dosing cohorts of FMGX in the survival arm of the study (23).

In conclusion, FMGX was safe and well-tolerated and demonstrated activity in participants with candidemia caused by *C. auris*. Based on the results from this pilot study, as well as a previously completed Phase 2 study in patients with candidemia, FMGX has the potential to be a safe and effective treatment option for patients with candidemia/invasive candidiasis. Additional studies are planned to further assess the safety and efficacy of FMGX in patients with invasive fungal infections.

MATERIALS AND METHODS

This multicenter, open-label, non-comparative, single-arm study (NCT04148287), evaluated the safety and efficacy of FMGX for the treatment of candidemia and/or invasive candidiasis caused by *C. auris*. The study was planned at 4 sites in South Africa and one site in Panama. Participants were enrolled at 2 sites in South Africa, between 10 Dec 2019 and 23 Oct 2020, in accordance with International Conference on Harmonization Guidelines for Good Clinical Practice, applicable regulatory requirements, and the Declaration of Helsinki.

Eligible participants (males and females, ≥ 18 years of age) had an established diagnosis of candidemia and/or invasive candidiasis caused by *C. auris* from blood collected <120 h (for participants with candidemia) or from a normally sterile site <168 h (for participants with invasive candidiasis without candidemia) from the time of enrollment, and had limited or no treatment options due to either antifungal resistance, contraindication(s), intolerance, or lack of clinical response to standard of care antifungal therapy, as advocated by the relevant regional/country treatment guidelines (36, 37).

Mycological and clinical diagnoses criteria were: ≥ 1 positive culture from blood or other normally sterile site for *C. auris* (including possible co-infection with other *Candida* spp., except *C. krusei*), attributable clinical signs (fever [$>38^{\circ}\text{C}$], or hypothermia [$<36^{\circ}\text{C}$], or hypotension [SBP <90 mmHg or decrease of >30 mmHg]) within the permitted 120 h or 168 h enrollment period for candidemia or invasive candidiasis, respectively.

Exclusion criteria included severe or moderate hepatic impairment (total bilirubin $> 3\times$ upper limit of normal and alanine aminotransferase or aspartate aminotransferase $> 5\times$ upper limit of normal); concomitant use of strong CYP inhibitors; investigator-assessed life expectancy <7 days; diagnosis of *C. krusei* infection, deep-seated *Candida*-related infections requiring >42 days of treatment; and pregnancy or lactation. Participants with severe or moderate renal impairment were initially excluded, but became eligible later on, based on a protocol amendment.

Treatment. Participants were treated with FMGX within 12 h of study enrollment (Fig. 1). Participants received a 1000 mg FMGX loading dose (3-h IV infusion, twice daily [BID], 12 h apart). The maintenance dose was 600 mg IV, administered as a 3-h infusion once daily (QD). A switch to oral FMGX on Day 4 onwards (800 mg QD maintenance dose) was permitted at the discretion of the investigator if the participant was clinically stable and able to swallow tablets. FMGX was administered for 14 days after clearance of *Candida* from the bloodstream (2 consecutive negative blood cultures), and in accordance with clinical judgment as applicable for other infected sites, up to a maximum of 42 days. Participants were monitored for continued safety and efficacy at 2 weeks and 4 weeks after EOST.

Plasma samples for pharmacokinetic (PK) analysis of FMGX and MGX levels were collected at baseline (pre-dose), twice weekly during treatment, at EOST/early termination (ET), and 2 weeks after EOST. Adverse events (AEs) were recorded from the date of informed consent through study completion, and coded (using Medical Dictionary for Regulatory Activities [MedDRA] version 22.0).

The primary efficacy endpoint was the percentage of participants with DRC-assessed treatment success at EOST, defined as clearance of *C. auris* from the blood/infection site with no additional antifungal treatment and survival. Clearance was defined as 2 consecutive blood cultures negative for *Candida* spp., and/or ≥ 1 negative tissue culture or aspirate/fluid culture for deep-seated infections. For participants with a deep-seated infection involving visceral organs from which a tissue culture was not obtainable, resolution of the attributable clinical signs of infection that were recorded at baseline, and as applicable, radiological improvement associated with the site of infection, were required.

Secondary efficacy parameters included all-cause mortality through Day 30, and time to first negative blood culture. The DRC also assessed treatment success at 2 and 4 weeks after EOST. Investigator-assessed secondary parameters included percentage of participants with successful mycological outcomes, treatment success at EOST and 2 and 4 weeks after EOST, and the number of participants with TEAEs.

Data availability. Upon request, and subject to review, Pfizer will provide the data that support the findings of this study. Subject to certain criteria, conditions and exceptions, Pfizer may also provide access to

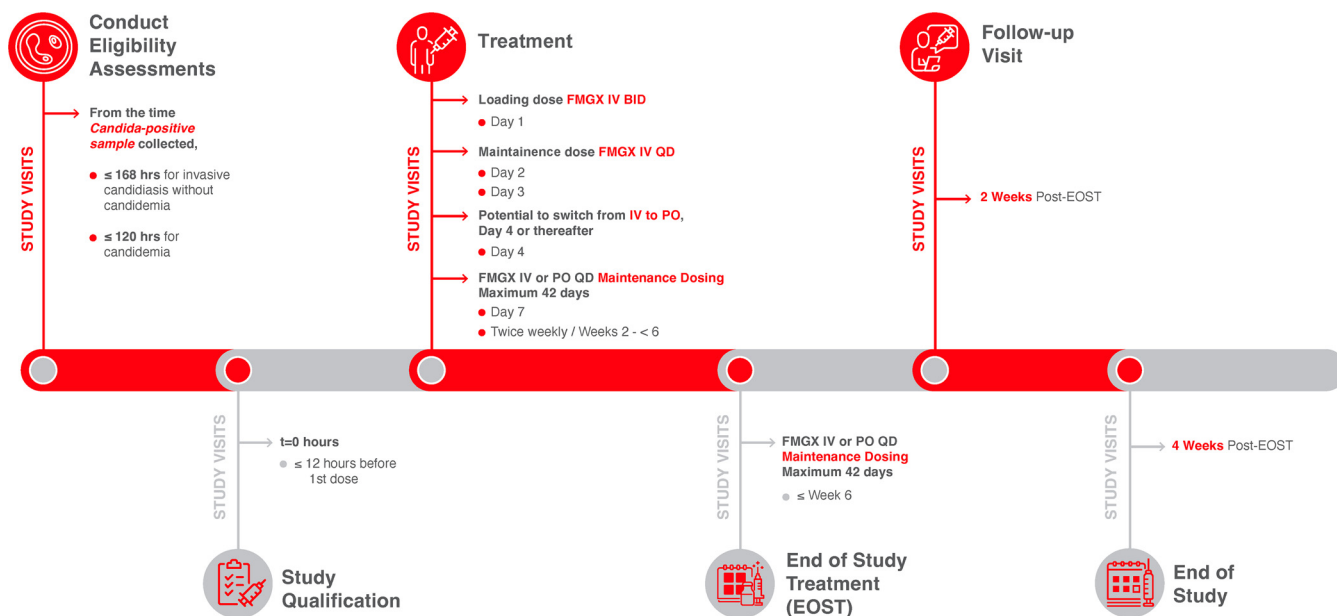


FIG 1 Study Design. For participants with invasive candidiasis, maintenance dosing was to continue until there was at least 1 negative tissue culture or aspirate/fluid. For participants with a deep-seated site of infection from which a tissue culture was not obtainable, maintenance dosing was to continue until after the resolution of the attributable clinical signs of infection recorded at baseline, and as applicable, radiological improvement associated with the site of infection. BID, twice daily; EOST, end of study treatment; FMGX, fosmanogepix; IV, intravenous; PO, orally; QD, once daily.

the related individual de-identified participant data. See <https://www.pfizer.com/science/clinical-trials/trial-data-and-results> for more information.

ACKNOWLEDGMENTS

We thank all investigators, staff, and patients for participating in study-related activities and procedures. Milli Kapoor (PhD, employee of Pfizer) assisted with *in vitro* data collection and analysis; Abhijeet Jakate (PhD, employee of Pfizer) assisted with confirmation of the PK data included. The authors acknowledge Michelle Merrigan (PhD) and Kripa Madnani (PhD, CMPP; employee of Pfizer Inc.) for providing medical writing assistance under the guidance of the authors. Sonia Philipose (PhD, CMPP) and Varkha Agrawal (PhD, CMPP), employees of Pfizer Inc., provided editorial assistance.

The study was funded by Amplyx, now a subsidiary of Pfizer Inc.

Jose Vazquez received grant support from Cidara, Scynexis and was a consultant for Cidara, Scynexis, F2G, Amplyx. Michel R Hodges, Eric Ople, Pamela Wedel were employees of Amplyx (now a Pfizer Inc subsidiary). Michel R Hodges was previously an employee of Pfizer and holds Pfizer stock. Paul A. Bien and Margaret Tawadrous are employees of Pfizer and hold Pfizer stock. Iwona Oborska was a consultant for Amplyx, previously a Pfizer employee, and Pfizer shareholder. Fathima Paruk has served on the speaker bureaus for Thermofischer Scientific, Pfizer, bioMérieux, MSD and Dr Reddy's. Peter Pappas received grant support from Astellas, Gilead, Mayne, Cidara, Scynexis and provided advisory and consultancy services to Amplyx, Mayne, Scynexis. Kenneth Boffard has no conflicts of interest to declare.

REFERENCES

- Ben-Ami R, Berman J, Novikov A, Bash E, Shachor-Meyouhas Y, Zakin S, Maor Y, Tarabia J, Schechner V, Adler A, Finn T. 2017. Multidrug-resistant *Candida haemulonii* and *C. auris*, Tel Aviv, Israel. *Emerg Infect Dis* 23:195–203. <https://doi.org/10.3201/eid2302.161486>.
- Chow NA, Muñoz JF, Gade L, Berkow EL, Li X, Welsh RM, Forsberg K, Lockhart SR, Adam R, Alanio A, Alastruey-Izquierdo A, Althawadi S, Araúz AB, Ben-Ami R, Bharat A, Calvo B, Desnos-Ollivier M, Escandón P, Gardam D, Gunturu R, Heath CH, Kurzai O, Martin R, Litvitseva AP, Cuomo CA. 2020. Tracing the evolutionary history and global expansion of *Candida auris* using population genomic analyses. *mBio* 11:e03364-19. <https://doi.org/10.1128/mBio.03364-19>.
- Magobo RE, Corcoran C, Seetharam S, Govender NP. 2014. *Candida auris*-associated candidemia, South Africa. *Emerg Infect Dis* 20:1250–1251. <https://doi.org/10.3201/eid2007.131765>.
- Satoh K, Makimura K, Hasumi Y, Nishiyama Y, Uchida K, Yamaguchi H. 2009. *Candida auris* sp. nov., a novel ascomycetous yeast isolated from the external ear canal of an inpatient in a Japanese hospital. *Microbiol Immunol* 53:41–44. <https://doi.org/10.1111/j.1348-0421.2008.00083.x>.
- Spivak ES, Hanson KE. 2018. *Candida auris*: an emerging fungal pathogen. *J Clin Microbiol* 56:e01588-17. <https://doi.org/10.1128/JCM.01588-17>.

6. Vallabhaneni S, Kallen A, Tsay S, Chow N, Welsh R, Kerins J, Kemble SK, Pacilli M, Black SR, Landon E, Ridgway J, Palmore TN, Zelzany A, Adams EH, Quinn M, Chaturvedi S, Greenko J, Fernandez R, Southwick K, Furuya EY, Calfee DP, Hamula C, Patel G, Barrett P, Lafaro P, Berkow EL, Moulton-Meissner H, Noble-Wang J, Fagan RP, Jackson BR, Lockhart SR, Litvintseva AP, Chiller TM. 2017. Investigation of the first seven reported cases of *Candida auris*, a globally emerging invasive, multidrug-resistant fungus-United States, May 2013–August 2016. *Am J Transplant* 17:296–299. <https://doi.org/10.1111/ajt.14121>.
7. Spruijtenburg B, Badali H, Abastabar M, Mirhendi H, Khodavaissy S, Sharifsooraki J, Armaki MT, de Groot T, Meis JF. 2022. Confirmation of fifth *Candida auris* clade by whole genome sequencing. *Emerg Microbes Infect* 11:2405–2411. <https://doi.org/10.1080/22221751.2022.2125349>.
8. Lockhart SR, Etienne KA, Vallabhaneni S, Farooqi J, Chowdhary A, Govender NP, Colombo AL, Calvo B, Cuomo CA, Desjardins CA, Berkow EL, Castanheira M, Magobo RE, Jabeen K, Asghar RJ, Meis JF, Jackson B, Chiller T, Litvintseva AP. 2017. Simultaneous emergence of multidrug-resistant *Candida auris* on 3 continents confirmed by whole-genome sequencing and epidemiological analyses. *Clin Infect Dis* 64:134–140. <https://doi.org/10.1093/cid/ciw691>.
9. Tsay SV, Mu Y, Williams S, Epsom E, Nadle J, Bamberg WM, Barter DM, Johnston HL, Farley MM, Harb S, Thomas S, Bonner LA, Harrison LH, Hollick R, Marceaux K, Mody RK, Pattee B, Davis SS, Phipps EC, Tesini BL, Gellert AB, Zhang AY, Schaffner W, Hillis S, Ndi D, Graber CR, Jackson BR, Chiller T, Magill S, Vallabhaneni S. 2020. Burden of *Candidemia* in the United States, 2017. *Clin Infect Dis* 71:e449–e453. <https://doi.org/10.1093/cid/ciaa193>.
10. Chowdhary A, Kumar VA, Sharma C, Prakash A, Agarwal K, Babu R, Dinesh KR, Karim S, Singh SK, Hagen F, Meis JF. 2014. Multidrug-resistant endemic clonal strain of *Candida auris* in India. *Eur J Clin Microbiol Infect Dis* 33: 919–926. <https://doi.org/10.1007/s10096-013-2027-1>.
11. Schelenz S, Hagen F, Rhodes JL, Abdolrasouli A, Chowdhary A, Hall A, Ryan L, Shackleton J, Trimlett R, Meis JF, Armstrong-James D, Fisher MC. 2016. First hospital outbreak of the globally emerging *Candida auris* in a European hospital. *Antimicrob Resist Infect Control* 5:35. <https://doi.org/10.1186/s13756-016-0132-5>.
12. Kordalewska M, Lee A, Park S, Berrio I, Chowdhary A, Zhao Y, Perlin DS. 2018. Understanding echinocandin resistance in the emerging pathogen *Candida auris*. *Antimicrob Agents Chemother* 62:e00238–18. <https://doi.org/10.1128/AAC.00238-18>.
13. Miyazaki M, Horii T, Hata K, Watanabe NA, Nakamoto K, Tanaka K, Shirotori S, Murai N, Inoue S, Matsukura M, Abe S, Yoshimatsu K, Asada M. 2011. *In vitro* activity of E1210, a novel antifungal, against clinically important yeasts and molds. *Antimicrob Agents Chemother* 55:4652–4658. <https://doi.org/10.1128/AAC.00291-11>.
14. Watanabe NA, Miyazaki M, Horii T, Sagane K, Tsukahara K, Hata K. 2012. E1210, a new broad-spectrum antifungal, suppresses *Candida albicans* hyphal growth through inhibition of glycosylphosphatidylinositol biosynthesis. *Antimicrob Agents Chemother* 56:960–971. <https://doi.org/10.1128/AAC.00731-11>.
15. McLellan CA, Whitesell L, King OD, Lancaster AK, Mazitschek R, Lindquist S. 2012. Inhibiting GPI anchor biosynthesis in fungi stresses the endoplasmic reticulum and enhances immunogenicity. *ACS Chem Biol* 7:1520–1528. <https://doi.org/10.1021/cb300235m>.
16. Hager CL, Larkin EL, Long L, Abidi FZ, Shaw KJ, Ghannoum MA. 2018. *In vitro* and *in vivo* evaluation of the antifungal activity of APX001A/APX001 against *Candida auris*. *Antimicrob Agents Chemother* 62:e02319–17. <https://doi.org/10.1128/AAC.02319-17>.
17. Shaw KJ, Schell WA, Covell J, Duboc G, Giamberardino C, Kapoor M, Moloney M, Soltow QA, Tenor JL, Toffaletti DL, Trzoss M, Webb P, Perfect JR. 2018. *In vitro* and *in vivo* evaluation of APX001A/APX001 and other Gwt1 inhibitors against *Cryptococcus*. *Antimicrob Agents Chemother* 62:e00523–18. <https://doi.org/10.1128/AAC.00523-18>.
18. Zhao M, Lepak AJ, VanScoy B, Bader JC, Marchillo K, Vanhecker J, Ambrose PG, Andes DR. 2018. *In vivo* pharmacokinetics and pharmacodynamics of APX001 against *Candida* spp. in a neutropenic disseminated candidiasis mouse model. *Antimicrob Agents Chemother* 62:e02542–17. <https://doi.org/10.1128/AAC.02542-17>.
19. Berkow EL, Lockhart SR. 2018. Activity of novel antifungal compound APX001A against a large collection of *Candida auris*. *J Antimicrob Chemother* 73:3060–3062. <https://doi.org/10.1093/jac/dky302>.
20. Maphanga TG, Naicker SD, Kwenda S, Muñoz JF, Schalkwyk EV, Wadula J, Nana T, Ismail A, Coetzee J, Govind C, Mtshali PS, Mpmembe RS, Govender NP, for GERM-S. 2021. *In vitro* antifungal resistance of *Candida auris* isolates from bloodstream infections, South Africa. *Antimicrob Agents Chemother* 65:e0051721. <https://doi.org/10.1128/AAC.00517-21>.
21. Zhu Y, Kilburn S, Kapoor M, Chaturvedi S, Shaw KJ, Chaturvedi V. 2020. *In vitro* activity of manogepix against multidrug-resistant and panresistant *Candida auris* from the New York outbreak. *Antimicrob Agents Chemother* 64:e01124–20. <https://doi.org/10.1128/AAC.01124-20>.
22. Arendrup MC, Chowdhary A, Jørgensen KM, Meletiadis J. 2020. Manogepix (APX001A) *in vitro* activity against *Candida auris*: head-to-head comparison of EUCAST and CLSI MICs. *Antimicrob Agents Chemother* 64:e00656–20. <https://doi.org/10.1128/AAC.00656-20>.
23. Wiederhold NP, Najvar LK, Shaw KJ, Jaramillo R, Patterson H, Olivo M, Catano G, Patterson TF. 2019. Efficacy of delayed therapy with fosmanogepix (APX001) in a murine model of *Candida auris* invasive candidiasis. *Antimicrob Agents Chemother* 63:e01120–19. <https://doi.org/10.1128/AAC.01120-19>.
24. Mansbach R, Shaw KJ, Hodges MR, Coleman S, Fitzsimmons ME. 2017. Absorption, distribution, and excretion of (14)C-APX001 after single-dose administration to rats and monkeys. *Open Forum Infect Dis* 4:S472. <https://doi.org/10.1093/ofid/ofx163.1209>.
25. Shaw KJ, Ibrahim AS. 2020. Fosmanogepix: a review of the first-in-class broad spectrum agent for the treatment of invasive fungal infections. *J Fungi* (Basel) 6:239. <https://doi.org/10.3390/jof6040239>.
26. Pappas P, Kullberg BJ, Vazquez JA, Oren I, Rahav G, Aoun M, Bulpa P, Ben-Ami R, Ferrer R, McCarty TP, Thompson GR, III, Barbat S, Wedel P, Oborska I, Schlamm HT, Hodges M. 2020. Clinical safety and efficacy of novel antifungal, fosmanogepix, in the treatment of candidemia: results from a phase 2 proof of concept trial. *Open Forum Infect Dis* 7:S203–S204. <https://doi.org/10.1093/ofid/ofaa439.457>.
27. U.S. National Library of Medicine. 2017. Open-label study to evaluate the efficacy and safety of oral ibrexafungerp (SCY-078) in patients with candidiasis caused by *Candida auris* (CARES) (CARES). <https://clinicaltrials.gov/ct2/show/record/NCT03363841>. Accessed 25 January 2023.
28. Friedman DZP, Schwartz IS. 2019. Emerging fungal infections: new patients, new patterns, and new pathogens. *J Fungi* 5:67. <https://doi.org/10.3390/jof5030067>.
29. Al-Obaid I, Asadzadeh M, Ahmad S, Alobaid K, Alfouzan W, Bafna R, Emara M, Joseph L. 2022. Fatal breakthrough candidemia in an immunocompromised patient in Kuwait due to *Candida auris* exhibiting reduced susceptibility to echinocandins and carrying a novel mutation in hotspot-1 of FKS1. *J Fungi* 8:267. <https://doi.org/10.3390/jof8030267>.
30. U.S. Department of Health and Human Services. 2019. Antibiotic resistance threats in the United States. <https://www.cdc.gov/drugresistance/pdf/threats-report/2019-ar-threats-report-508.pdf>. Accessed 14 March 2022.
31. Pappas PG, Kauffman CA, Andes DR, Clancy CJ, Marr KA, Ostrosky-Zeichner L, Reboli AC, Schuster MG, Vazquez JA, Walsh TJ, Zaoutis TE, Sobel JD. 2016. Clinical practice guideline for the management of candidiasis: 2016 update by the infectious diseases society of America. *Clin Infect Dis* 62:e1–e50. <https://doi.org/10.1093/cid/civ933>.
32. Lyman M, Forsberg K, Reuben J, Dang T, Free R, Seagle EE, Sexton DJ, Soda E, Jones H, Hawkins D, Anderson A, Bassett J, Lockhart SR, Merengwa E, lyengar P, Jackson BR, Chiller T. 2021. Notes from the field: transmission of pan-resistant and echinocandin-resistant *Candida auris* in health care facilities – Texas and the District of Columbia, January–April 2021. *MMWR Morb Mortal Wkly Rep* 70:1022–1023. <https://doi.org/10.15585/mmwr.mm7029a2>.
33. Taori SK, Khonyongwa K, Hayden I, Ad Athukorala GD, Letters A, Fife A, Desai N, Borman AM. 2019. *Candida auris* outbreak: mortality, interventions and cost of sustaining control. *J Infect* 79:601–611. <https://doi.org/10.1016/j.jinf.2019.09.007>.
34. Hanson BM, Dinh AQ, Tran TT, Arenas S, Pronty D, Gershengorn HB, Ferreira T, Arias CA, Shukla BS. 2021. *Candida auris* invasive infections during a COVID-19 case surge. *Antimicrob Agents Chemother* 65:e0114621. <https://doi.org/10.1128/AAC.01146-21>.
35. De Luca DG, Alexander DC, Dingle TC, Dufresne PJ, Hoang LM, Kus JV, Schwartz IS, Mulvey MR, Bharat A. 2021. Four genomic clades of *Candida auris* identified in Canada, 2012–2019. *Medical Mycology* 60:myab079. <https://doi.org/10.1093/mmy/myab079>.
36. Govender NP, Avenant T, Brink A, Chibabhai V, Cleghorn J, Du Toit B, Govind C, Lewis E, Lowman W, Mahlangu H, Maslo C, Messina A, Mer M, Pieton K, Seetharam S, Srirottan C, Swart K, van Schalkwyk E. 2019. Federation of infectious diseases societies of Southern Africa guideline: recommendations for the detection, management and prevention of healthcare-associated *Candida auris* colonisation and disease in South Africa. *S Afr J Infect Dis* 34:163. <https://doi.org/10.4102/sajid.v34i1.163>.
37. Hodges MR, Ople E, Shaw KJ, Mansbach R, van Marle S, van Hoogdalem E, Wedel P, Kramer W. 2017. First-in-human study to assess safety, tolerability and pharmacokinetics of APX001 administered by intravenous infusion to healthy subjects. *Open Forum Infect Dis* 4:S526–S526. <https://doi.org/10.1093/ofid/ofx163.1370>.