Galaxy Publication

Lovastatin in the Context of Organ Transplantation: Comprehensive Review and Survey Findings

Abigail Owusu[1], Kany Bonnaire[1], Bisrat Hailemeskel[2]*

[1] Clinical & Administrative Pharmacy Sciences, College of Pharmacy, Howard University, Washington, DC 20059, USA.
[2] College of Pharmacy, Howard University, Washington, DC 20059 US, USA.

*E-mail ✉ bhailemeskel@howard.edu

ABSTRACT

Despite significant advances in heart transplant treatment, transplant rejection remains a significant challenge. Lovastatin, a statin medication with intriguing immunomodulatory effects, has received attention as a potential treatment for heart transplant rejection. All of the studies show that lovastatin can affect T-cell activation, reduce acute rejection events, and preserve graft function. These results provide encouraging directions for the use of lovastatin to improve patient outcomes and transplant success rates. This survey aimed to investigate opinions regarding the treatment of post-cardiac transplant rejection with lovastatin. Survey questions about lovastatin candidacy, perceived dangers of unapproved medications, and the significance of dyslipidaemia prophylaxis were asked of participants from a variety of backgrounds. The 39 people who responded were analysed, revealing demographic trends: most were female (59%) and between the ages of 18 and 24 years (82.1%), mainly from Maryland and Virginia. The majority had a 4-year degree as their highest level of education, and while 70.3% acknowledged lovastatin as a statin, opinions on its effectiveness varied, with notable opinions from 51.4% that it should be considered for the management of rejection. Demographic comparisons showed significant differences in opinions, including age groups differing in their suitability for lovastatin ($P = 0.003$) and awareness of unapproved medications ($P < 0.001$). Patient education and prevention of dyslipidemia are essential for transplant survival. Given the array of viewpoints, further research is warranted to clarify the safety and effectiveness of lovastatin in this context.

Keywords: Lovastatin, Transplant, Pharmacy, Students, Survey, Opinion

Introduction

Organ transplantation, which offers hope and a longer life expectancy to patients with end-stage organ failure, is one of the greatest medical discoveries. However, issues resulting from immunosuppressive treatment, which is mainly intended to prevent graft rejection, frequently impede the outcome of organ transplantation. Patient morbidity and transplant rejection are increased by these adverse effects, which include infections, cardiovascular events, and metabolic abnormalities [1].

Often recommended to treat hyperlipidaemia and prevent cardiovascular disease (CVD), lovastatin is a member of the statin medication class. Lovastatin competitively inhibits 3-hydroxy-3-methylglutaryl-coenzyme A (HMG-CoA) reductase, the enzyme that limits the rate at which cholesterol is made. By preventing the liver from producing cholesterol, lovastatin reduces the amount of low-density lipoprotein cholesterol (LDL-C) in the blood and, as a result, the risk of atherosclerosis and cardiovascular events [2].

A variety of patient demographics can benefit from lovastatin's ability to reduce LDL-C levels; randomised controlled trials (RCTs) have shown that lovastatin can reduce LDL-C levels by approximately 24–40% when taken as prescribed; it has also been shown to improve triglycerides, HDL-C, and high-density lipoprotein

cholesterol; and studies with long-term follow-up have demonstrated that lovastatin medication continues to reduce the risk of cardiovascular events and death [3].

Overall, lovastatin is well received and has a good safety profile. However, the most common adverse effects of lovastatin, like those of other statins, are hepatotoxicity, myopathy, and gastrointestinal issues. Adverse effect risk is dose-dependent and can be affected by concurrent medication use, age, and co-occurring medical problems. Myopathy, the most serious adverse effect of lovastatin, is characterised by muscle discomfort, weakness, or tenderness and requires prompt medical intervention. Hepatotoxicity is rare but can result in severe hepatic injury or elevated liver enzymes; most of the time, the gastrointestinal side effects are mild and transient and include diarrhoea, nausea, and abdominal pain.

Lovastatin in transplant – Review of studies

To examine factors including attitudes and beliefs regarding the use of statin medications in avoiding cardiovascular disease, a study was carried out in Sana'a, Yemen. Data for the study came from 428 healthcare professionals, including doctors and chemists, who worked in a variety of healthcare settings, including private clinics, public and private hospitals, and local chemists. The questionnaire was divided into the following sections: demographic information, clinical expertise about statin drugs, understanding of monitoring parameters, and assessments of barriers to following recommendations. The study found substantial knowledge gaps among participants, even though statins are often used in contemporary clinical practice. The most notable finding was that nearly 80.4% of healthcare providers could not identify which patient groups needed to have their risk for atherosclerotic cardiovascular disease (ASCVD) evaluated before beginning statin medication. Furthermore, there was a glaring lack of knowledge regarding the definitions of statin strength, the best time to take them, and their contraindications. More precisely, several respondents expressed ignorance of the best times to take statins, the recommended dosage levels for different patient groups, and the circumstances in which taking statins is not advised, such as when a woman is pregnant or nursing. These results underline the urgent need for focused educational interventions and extensive training initiatives meant to improve the understanding of healthcare professionals [4].

The present research aims to assess the literature on opinions regarding the usage of lovastatin in heart transplant environments. It also looks into survey respondents' knowledge and viewpoints on the subjects. To determine how these factors impact people's opinions and understanding of lovastatin medication, survey-based research approaches will take into account demographic parameters such as age, gender, residence state, type of work, years worked, and highest education attended. This section of the study searches for misunderstandings or gaps in knowledge on the usage of lovastatin among heart transplant recipients.

Materials and Methods

The survey was done as a part of the drug information, a 2-credit hour mandatory course for incoming pharmacy students at the Howard University College of Pharmacy. Participants completed a structured questionnaire that included questions about their age, gender, state of residence, employment history, income, and educational attainment.

Knowledge-based questions were incorporated into the questionnaire to gauge the participants' comprehension of lovastatin and its significance in managing dyslipidemia following heart transplantation. Opinion-based questions were also added to get viewpoints on FDA approval, patient awareness of non-approved medications, and the suitability of lovastatin for treating rejection from heart transplants.

Statistical methods such as Pearson correlation and chi-square tests were used to analyze the data and look for relationships between opinions on lovastatin and demographic factors. Comparative research was carried out utilizing demographic characteristics to detect any relationships with opinions regarding the use of lovastatin.

Results and Discussion

The survey was filled out by 39 people in total (**Table 1**). 59.0% of the responses came from female participants, who made up the bulk of the population. In terms of age distribution, young adults between the ages of 18 and 24 made up 82.1% of the respondents. Geographically, responses were widely distributed, with Maryland accounting for the largest percentage (25.6%), Virginia (17.9%), and Washington, DC (5.1%), but a sizable 51.3% of respondents came from other states, demonstrating the survey's wide geographic appeal.

Table 1. Demographic (age, gender, states; n = 39)

Demographic	Frequency	Percent
Gender		
Male	16	41.0%
Female	23	59.0%
Age (years)		
18-24	32	82.1%
25-34	0	0%
≥ 35	9	17.9%
State		
Washington, DC	2	5.1%
Maryland	10	25.6%
Virginia	7	17.9%
Other states	20	51.3%

Before enrolling in the pharmacy program, 87.2% of respondents had work experience (**Table 2**), with a large percentage (30.8%) earning less than $10,000 per year; 33.3% were working in pharmacy-related jobs, and 30.8% were working in healthcare but not directly in pharmacy; time spent at work varied, with 48.7% reporting 1-3 years of experience; educational qualifications varied, but 74.4% had earned a degree from a 4-year institution before enrolling in the program; and notably, missing data affected responses related to income (7.7%), type of work (15.4%), and years worked (10.3%).

Table 2. Demographic (work experience, income, etc.)

Demographic	Frequency	Percent
Have you worked or had a job before coming to Howard University's pharmacy program? (n = 39)		
Yes	34	87.2
No	5	12.8
Annual income from your Job if you have worked (n = 39)		
< $10,000	12	30.8
$10,000-$19,999	2	5.1
$20,000-$29,999	5	12.8
$30,000-$39,999	7	17.9
$40,000-$49,999	4	10.3
> $49,999	6	15.4
If you worked before coming to HU, what kind of work have you had? (n = 39)		
Non-pharmacy or non-healthcare related	8	20.5
Pharmacy related	13	33.3
Non-pharmacy but healthcare-related	12	30.8
If you had a job before attending HU, how many years did you work there? (n = 39)		
< 1 Year	3	7.7
1-3 Years	19	48.7
4-5 years	2	5.1
> 5 years	11	28.2
Before attending Howard Pharmacy School, the highest level of education (n = 39)		
Some college	4	10.3
2-year degree	3	7.7
4-year degree	29	74.4
Professional degree	3	7.7

Participants agreed, according to **Table 3**, which compiles answers to knowledge-based questions about prescription drugs and therapeutic procedures. Lovastatin's classification as a statin is accepted by almost 91.9% of respondents, with a noteworthy 70.3% strongly supporting this classification (Question #1). Indeed, a class of drugs known as statins is frequently used to reduce blood cholesterol levels. They function by blocking the HMG-CoA reductase enzyme, which is essential for the liver's synthesis of cholesterol. In particular, lovastatin lowers blood levels of "bad" LDL cholesterol and triglycerides while increasing "good" HDL cholesterol, hence lowering the risk of heart disease and improving cholesterol levels.

Question #2 asked about the significance of dyslipidaemia prevention for heart transplant survival, and 86.5% of respondents gave the right response. Additionally, a significant 83.8% of respondents think that following statin recommendations, especially while taking lovastatin, can improve survival rates after heart transplantation

(Question #3). "Prophylaxis of dyslipidaemia seems to be critical for cardiac transplant survival" is a statement that is in line with recent clinical findings and studies. Due mostly to immunosuppressive treatment, dyslipidaemia is frequently observed in heart transplant recipients and plays a major role in the development of cardiac allograft vasculopathy (CAV), which is a major cause of morbidity and death after transplantation. Controlling lipid levels in such individuals is undoubtedly crucial, as dyslipidemia has been associated with accelerated CAV and poor long-term outcomes. Numerous transplant recipients are impacted by CAV, according to studies, and there is a noticeable increase in intimal thickening that may result in graft failure. In contrast to normal atherosclerosis, this disease presents with more widespread and concentric lesions and is made worse by immunological reactions and inflammation. Furthermore, systemic inflammation is frequently seen in transplant recipients and is associated with the development of CAV. This inflammation is shown by higher levels of high-sensitivity C-reactive protein. A key component of post-transplant therapy is controlling these inflammatory processes in conjunction with rigorous cholesterol level control to increase survival rates and lower the incidence of CAV (American College of Cardiology). Therefore, it is clear that heart transplant recipients' longevity and quality of life depend on maintaining normal lipid levels and controlling cardiovascular risk factors, highlighting the need for dyslipidaemia prevention in these patients.

86.4% of respondents agree that lovastatin is useful in treating dyslipidaemia (Question #4). Strong evidence supports the use of statins as a crucial part of the post-transplant treatment regimen to improve patient outcomes and prolong survival, according to the results of the literature search. Consistent results from numerous trials supporting the preventive effects of statins against problems that impact transplant survival support this conclusion.

Finally, 86.5% of respondents agree that lowering statin dosages for preventative reasons is a good idea (Question #5). Statin dosages, such as lovastatin, may be lowered in heart transplant recipients to control dyslipidaemia and lower the possibility of drug interactions with immunosuppressive treatments. These drugs, such as calcineurin inhibitors, can raise blood statin levels, increasing the risk of adverse consequences like myopathy. While maintaining patient safety, the objective is to successfully manage cholesterol and avoid side effects such as cardiac allograft vasculopathy. For this patient group, routine monitoring of cholesterol levels and statin effectiveness is crucial.

Table 3. Knowledge-based questions

Knowledge-based questions	Correct answers	Number (%) of participants with correct answers
1. Lovastatin belongs to a class of drugs called statins.	True	34 (91.9%)
2. Dyslipidaemia prevention appears to be essential for heart transplant survival.	True	32 (82.0%)
3. Following a heart transplant, the chances of survival are increased if a statin, such as lovastatin, is taken as prescribed.	True	31 (79.4%)
4. Lovastatin is an efficient dyslipidemia drug.	True	32 (82.0%)
5. When taken prophylactically, the dosage of statins such as lovastatin may be lowered for heart transplant recipients.	True	32 (82.0%)

The outcomes of the opinion-based questions are summarised in **Table 4**. Answers to statements regarding the application of lovastatin to manage rejection from a heart transplant reveal a range of opinions (statement #1), with approximately 70.3% of participants believing that lovastatin could be considered for this purpose; 75.7% caution against the use of non-approved drugs and the risks linked to organ rejection (statement #2); opinions regarding FDA approval of lovastatin are divided, with 48.6% agreeing that it should be awaited before use (statement #4); however, there is strong support (94.5%) for additional FDA research on lovastatin, with nearly half strongly agreeing; and 86.5% of participants agreeing that patient awareness of non-approved drugs is important (Statement #5). This illustrates differing opinions regarding the use of lovastatin in post-transplant treatment, emphasising the significance of patient education and regulatory approval.

Table 4. Opinion-based questions

Statements	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree	Total
1. Since organ rejection is a significant problem with the available therapeutic options, I believe lovastatin should be	5.4%	24.3%	51.4%	18.9%	100.0%

considered as a contender for the management of heart transplant rejection.					
2. Since organ rejection might be fatal, I advise against using any medications that are not authorised.	--	24.3%	24.3%	51.4%	100.0%
3. Lovastatin ought to be employed till the FDA gives its permission.	18.9%	32.4%	35.1%	13.5%	100.0%
4. The FDA should proceed with research on lovastatin.	--	5.4%	45.9%	48.6%	100.0%
5. In my opinion, patients ought to be informed before taking any unapproved medication to treat their conditions.	--	13.5%	27.0%	59.5%	100.0%

Proposing lovastatin as a primary remedy for rejection following a transplant demands broad clinical research focussing on the immunomodulatory effects, if any, for transplant rejection is mainly treated with immunosuppressive drugs instead of cholesterol-lowering drugs, and although lovastatin is successful in managing cholesterol as well has shown positive aspects for lowering the rate of CA post-transplant, its effectiveness in particular for treating transplant rejection is not directly established.

According to the analysis, lovastatin is viewed favourably for the management of heart transplants; 42.9% of older persons (those aged 35 and over years) strongly support its consideration, while 60% of younger adults (18–24 years) somewhat agree and 13.3% strongly agree with its benefits. Most respondents agree that organ rejection is a serious condition and that using non-FDA-approved drugs to manage it could pose significant risks; the use of approved and well-researched immunosuppressants is crucial to ensure the safety and efficacy of treatment in transplant patients; 75% of older respondents strongly advise against the use of non-approved drugs due to the risks of organ rejection, compared to 43.3% of younger respondents; and there is strong agreement that patient awareness regarding non-approved drugs is important.

Although it isn't specifically approved by the FDA to prevent transplant rejection, lovastatin is already approved for controlling cholesterol levels. Unless novel applications are supported by additional research and subsequently approved by the FDA, they should only be used within their approved indications.

Opinions on the use of lovastatin and FDA approval differed greatly depending on the occupations of the respondents. Of those who did not work in pharmacy or healthcare, 25% somewhat agreed and another 25% somewhat disagreed that lovastatin should wait for FDA approval. The majority of pharmacy-related employees (58.3%) expressed some disagreement, suggesting a cautious approach to its use in the absence of FDA approval. The majority, however, favoured additional FDA study on lovastatin from both pharmacy-related (50%) and non-pharmacy healthcare-related (87.5%) sectors. All non-pharmacy healthcare-related professions agreed that lovastatin is a member of the statin class. Divergent opinions were also expressed about statin dose reduction for heart transplants and dyslipidaemia prophylaxis; respondents with a pharmacy background (66.7%) and those without a pharmacy background but in the healthcare industry (72.7%) disagreed significantly on dose reduction. This demonstrates a range of viewpoints shaped by work experience, including agreement on the necessity of lovastatin research and recognition of its statin classification.

Based on professional background, **Table 5**'s data reveals differing opinions on lovastatin and dyslipidaemia prophylaxis: 27.3% of respondents from non-pharmacy but healthcare professions strongly agreed with lovastatin usage, whereas 50% of respondents from non-pharmacy/non-healthcare fields strongly opposed. Seventy-five percent of pharmacy-related areas strongly believe that dyslipidaemia prevention is important. Among non-pharmacy/non-healthcare fields, scepticism about lovastatin was highest (58.3% somewhat disagreed), suggesting significant differences in opinions related to respondents' work experience (P-values of 0.042 and 0.045), underscoring the impact of professional background on attitudes towards medical treatments.

The chart shows how Howard University freshmen's views on lovastatin for managing heart transplant rejection and the importance of dyslipidaemia prevention for transplant survival are influenced by their job experience. It shows a clear trend: people with more than five years of employment are most likely to strongly disagree (100%) with the idea that lovastatin is an effective remedy for heart transplant rejection, yet they are also more likely to firmly believe (40–50%) that dyslipidaemia prophylaxis is crucial for survival, demonstrating an advanced knowledge of the complexities of therapy. Conversely, the majority of respondents with 1-3 years of work experience (60%) somewhat disagree with the applicability of lovastatin, but they are also somewhat in agreement with its potential advantages (83.3%) and the need for dyslipidaemia prevention (55.6%). According to these findings, those with more job experience are more likely to place a higher value on prophylaxis and be careful

when using unapproved medications like lovastatin, whereas people with less experience are more receptive to the advantages of such medications.

Opinions on the use of unapproved medications for organ rejection are also summarised in the table, which shows widespread agreement across educational backgrounds and a notable tendency towards caution. Just 6.1% of respondents strongly disagreed with the statement, highlighting the widespread reluctance to use unapproved drugs. Strong agreement was the most prevalent position, held by 72.7% of participants, regarding the risks of organ rejection and the need to stay away from unapproved medications. Notably, the largest concordance was found among those with professional degrees (42.4%). Diverse levels of worry are also highlighted by somewhat disagreeing (39.4%) and somewhat agreeing (36.4%) viewpoints, particularly among those with a 4-year degree. This suggests that the hazards of organ rejection and the critical assessment of drug approval status are widely acknowledged.

The information examines opinions regarding lovastatin consumption concerning post-cardiac transplant recommendations for various age groups. Key data indicate that there is little to no substantial disagreement with its use, mostly among people aged 35 and up. Of the younger group (18–24 years old), nine strongly agreed and 18 somewhat agreed that lovastatin had a positive effect on survival after transplantation. The younger age group generally exhibits a more positive attitude regarding following statin recommendations following heart transplants, indicating a general sense of optimism regarding lovastatin's potential to improve patient outcomes. The table also offers respondents' thoughts on numerous assertions linked to lovastatin consumption and cardiac transplant survival, grouped by their prior work experience, particularly in pharmacy or healthcare-related sectors. There is also agreement on the hazards of organ rejection, as evidenced by the statistics illustrating regional perspectives about the severity of organ rejection and the use of unapproved medications. Regarding the statement's seriousness, sentiments in Washington, DC, were evenly divided between slightly and strongly agreeing. With 77.8% strongly agreeing, Maryland demonstrated strong concurrence. With the highest degree of strong agreement (85.7%), Virginia demonstrated the region's general prudence. Significant percentages of people in other states agreed and disagreed, reflecting a wider spectrum of viewpoints. Although there are some regional variations in the degree of agreement, the general trend is to acknowledge the grave consequences of organ rejection and to be cautious when using unapproved medications.

Respondents' opinions on the prevention of dyslipidaemia in heart transplant survival are correlated with their prior work experience before enrolling in the pharmacy school. Respondents with more than five years of experience (30.3%) are the next most likely to acknowledge its significance, followed by those with one to three years of work experience (54.5%). Less than one year's experience and four to five years' experience make up lesser percentages (9.1% and 6.1%, respectively) of the overall recognition of the importance of dyslipidaemia prophylaxis. Depending on the level of previous work experience, this suggests a widespread understanding of the crucial role that dyslipidaemia care plays in heart transplant outcomes.

Table 5. Comparative analysis based on demographic factors ($P < 0.05$)

Demographic factors	Knowledge or opinion questions
Age	* Given that organ rejection is a significant problem with the available treatments, I believe lovastatin should be considered as a potential medication for heart transplant rejection.
	* Since organ rejection might be fatal, I advise against using any medications that are not authorised.
	* Patients should, in my opinion, be informed before taking any unapproved medication to treat their conditions.
	* Following a heart transplant, the chances of survival are increased if a statin, such as lovastatin, is taken as prescribed.
	* Chances of survival are higher if a statin like lovastatin is taken within guidelines after a cardiac transplant.
Residence state	* Since organ rejection might be fatal, I advise against using any medications that are not authorised.
	* Since organ rejection might be fatal, I advise against using any medications that are not authorised.
	* Since organ rejection might be fatal, I advise against using any medications that are not authorised.
Type of work	* Lovastatin should be used until it gets FDA approval.
	* Dyslipidaemia prevention appears to be essential for heart transplant survival..
	* Lovastatin should be used until it gets FDA approval.
	* The FDA should proceed with research on lovastatin.

	* Prophylaxis of dyslipidemia seems to be critical for cardiac transplant survival.
	* The dose of statins like lovastatin might be reduced for cardiac transplant when used prophylactically.
	* Prophylaxis of dyslipidemia seems to be critical for cardiac transplant survival.
	* Lovastatin belongs to a class of drugs called statins.
Years worked	* Lovastatin is an efficient dyslipidemia drug.
	* Prophylaxis of dyslipidemia seems to be critical for cardiac transplant survival.
	* Since organ rejection is a significant problem with the current treatment choices, I believe lovastatin should be considered as a contender for the management of heart transplant rejection.
Highest education attended	* Since organ rejection might be fatal, I advise against using any medications that are not authorised.

Survey limitations

The tiny sample size and the fact that this study only looked at pharmacy students at one university are its main limitations. Furthermore, self-reported data may be subject to accuracy and response bias issues, particularly when it comes to sensitive factors like demographic information like income and work experience. Lastly, selection bias limits the interpretability of the results by only selecting participants in a certain course. Absence of background information or context on the respondents' experiences.

Conclusion

A variety of perspectives on the potential use of lovastatin in the management of heart transplant rejection are presented in this survey. Even while many people support its consideration, opinions vary by age, professional background, and geographic location. Despite differences, there is a broad consensus about the importance of patient education and dyslipidaemia prevention. More research is needed to address these conflicting viewpoints and clarify the role of lovastatin in transplant therapy to improve patient outcomes in transplant medicine.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: None

References

1. Kasiske BL, Zeier MG, Chapman JR, Craig JC, Ekberg H, Garvey CA, et al. KDIGO clinical practice guideline for the care of kidney transplant recipients: A summary. Kidney Int. 2010;77(4):299-311. doi:10.1038/ki.2009.377
2. Duong H, Bajaj T. Lovastatin. [Updated 2023 Mar 20]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024.
3. Bradford RH, Shear CL, Chremos AN, Dujovne CA, Franklin FA, Grillo RB, et al. Expanded clinical evaluation of lovastatin (EXCEL) study results: Two-year efficacy and safety follow-up. Am J Cardiol. 1994;74(7):667-73. doi:10.1016/0002-9149(94)90307-7
4. Al-Ashwal FY, Sulaiman SAS, Sheikh Ghadzi SM, Kubas MA, Halboup A. Physicians and pharmacists' clinical knowledge of statin therapy and monitoring parameters, and the barriers to guideline implementation in clinical practice. PLoS One. 2023;18(1):e0280432. doi:10.1371/journal.pone.0280432