



Original Article

The Impact of Addictions Management Following Cardiac Surgery on People Who Inject Drugs and Have Infective Endocarditis

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ABSTRACT

Background: Managing reinfection in patients who inject drugs and have undergone cardiac surgery could reduce mortality. A significant gap exists in the management of addiction in this population and it is rarely addressed during index hospitalization for surgical intervention. This study sought to determine if management of addiction changed rates of readmission for reinfection.

Methods: This study was a retrospective chart review and analysis. Patients who underwent cardiac surgery for infective endocarditis due to injection drug use underwent a full chart review to determine if they

Global rates of injection drug use have reached an estimated 15.6 million users worldwide.¹ The incidence of infective endocarditis (IE) due to injecting drugs has grown, with approximately 1.7–6.2 cases per 100,000 patients.² Patients in this cohort tend to be young and healthy with no underlying cardiac disease. Despite this, IE in this population has alarmingly high mortality rates of up to 40%.³ Additionally, a large proportion of these patients (60%–70%) require surgical intervention to manage severe infections.⁴ The critical risk requiring surgery is generally driven by sepsis or congestive heart failure, which is thought to be due in large part to ongoing drug use and noncompliance with medical treatment. As surgical management in this cohort of patients continues to be an area of disparity among medical professionals today, it is agreed that the disease process responsible is reinfection driven by addiction.⁵

Preventing reinfection in these patients has the potential to improve long-term survival.⁶ A significant gap in the management of addiction in this population exists, and it is rarely addressed during index hospitalization for surgical

RÉSUMÉ

Contexte : La prise en charge de la réinfection chez les patients qui s'injectent des drogues et ont subi une intervention chirurgicale cardiaque pourrait réduire la mortalité. Il existe des lacunes importantes dans la gestion de la dépendance dans cette population, et celle-ci est rarement abordée lors de la première hospitalisation pour l'intervention chirurgicale. Cette étude a cherché à déterminer si la gestion de la dépendance peut changer les taux de réadmission pour réinfection.

Méthodologie : Cette étude consistait en une analyse rétrospective de dossiers de patients. Les patients ayant subi une intervention chirurgicale

intervention. To date, a clear management strategy has not been identified. Kimmel et al. found that patients who received MOUD (medication for opioid use disorder) following hospitalization experienced reduced mortality (hazard ratio [HR] 0.3, confidence interval [CI] 0.10–0.89).⁷ Ray et al. concluded that medication-assisted therapy (MAT) and psychosocial intervention may reduce readmission rates in a small sample of patients.⁸ Currently, several strategies are being studied, including MAT or opioid-assisted therapy (OAT), consultation with the addictions medicine, consultation with the social work, and community follow-up.^{7–9}

The purpose of this study was to determine the extent of use, as well as the impact, of these addiction management strategies at a single institution for patients who have undergone cardiac surgery for IE due to injection drug use. Specifically, we sought to determine if MAT and/or OAT, consultation with the Addictions Medicine Service and the Social Work Service, and community follow-up impacted rates of reinfection and mortality.

Methods

Study design

This study is a retrospective chart review and analysis using International Classification of Diseases, 10th revision

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received management of their addiction (addictions medicine consultation, social work consultation, medication- and/or opioid-assisted treatment, and community follow-up) following their surgical intervention.

Results: A total of 41 patients were identified who met the inclusion criteria. For addictions management, 43.2% of patients received an addictions medicine consultation, 67.6% received a social work consultation, 40.5% received medication- and/or opioid-assisted treatment, and 56.8% received community follow-up. Overall mortality of these patients was 21.6%, and 56.8% of patients were readmitted with reinfection. Multivariate logistic regression showed that patients who received intervention were 1.6 times more likely to be readmitted with reinfection (odds ratio 1.65, 95% confidence interval 0.29-9.41, $P = 0.5736$). Female patients had a significantly higher odds of reinfection, when adjusted for gender (odds ratio 9.95, 95% confidence interval 1.42-69.72, $P = 0.021$).

Conclusions: We demonstrated a nonstandardized approach to consultation and varying approaches to management of addiction. Patients who received intervention for addiction were more likely to be readmitted for reinfection, but this difference was not significant. Future efforts can include promotion of formalized addictions consultation services for high-risk patients.

(ICD-10) codes for IE (codes I33.0 and I33.9) and injection drug use (opioid use disorder; code F11.1). Patients were identified using the ICD-10 codes and then underwent a full chart review to determine that the patients met the inclusion criteria. Chart reviews were done using electronic medical records in Nova Scotia, Canada (OneContent [Hyland Software Inc., Westlake, OH] and SHARE [Secure Health Access Record; Nova Scotia's Electronic Health Record]).

Setting

The Queen Elizabeth II Health Sciences Centre (QEII HSC) in Halifax, Nova Scotia, is the only facility providing tertiary and quaternary cardiovascular care (including cardiac surgery) to the province. The facility serves a network of 36 peripheral hospitals with a population of 979,499.¹⁰ The healthcare system is public and does not have a parallel private system, making complete data capture possible if patients were treated in the province.

Patients

The inclusion criteria were that patients be aged 16 years and older and have undergone cardiac surgery (valvular intervention) at the QEII HSC with IE due to injection drug use, from 2005 to 2018. These patients had to have undergone surgical intervention for valvular disease and have a confirmed history of injection drug use (patient had to confirm use of injection drugs to be included in the study). Patients were excluded from the study if they had presented

cardiaque pour une endocardite infectieuse due à l'usage de drogues injectables ont fait l'objet d'un examen complet de leur dossier afin de déterminer s'ils avaient reçu une prise en charge de leur dépendance (consultation en médecine des dépendances, consultation en travail social, traitement médicamenteux associant ou non des opioïdes et suivi communautaire) après l'intervention chirurgicale.

Résultats : Au total, 41 patients répondaient aux critères d'inclusion. En ce qui concerne la gestion des dépendances, 43,2 % des patients avaient effectué une consultation en médecine des dépendances, 67,6 %, en travail social, 40,5 % avaient reçu un traitement médicamenteux associant ou non des opioïdes et 56,8 % avaient fait l'objet d'un suivi communautaire. Le taux de mortalité globale chez ces patients était de 21,6 %, et 56,8 % des patients avaient subi une réinfection ayant nécessité une nouvelle hospitalisation. Une analyse de régression logistique multivariée a montré que les patients ayant reçu une intervention avaient une probabilité 1,6 fois supérieure de subir une nouvelle hospitalisation en raison d'une réinfection (rapport de cotes de 1,65, intervalle de confiance à 95 % de 0,29 à 9,41, $p = 0,5736$). Après ajustement en fonction du sexe, les femmes avaient une probabilité sensiblement plus élevée de réinfection (rapport de cotes de 9,95, intervalle de confiance à 95 % de 1,42 à 69,72, $p = 0,021$).

Conclusions : Nous avons présenté une approche non normalisée de la consultation et des diverses approches de la gestion de la dépendance. Les patients ayant reçu une intervention pour la dépendance étaient plus susceptibles de subir une nouvelle hospitalisation en raison d'une réinfection, sans que cette différence soit significative. Les efforts futurs peuvent inclure la promotion de services officiels de consultation sur les dépendances pour les patients à risque élevé.

with IE due to a reason other than injection drug use, or if they did not require surgical intervention.

Chart review

Baseline demographics, mortality, and readmission for reinfection were documented. Charts were then reviewed in detail to determine whether patients received intervention for their addiction during their index hospitalization for surgical intervention. These interventions included any of the following: consultation with the Addictions Medicine Service (included a formal consult to the Addictions Medicine Service, a consultation to the Mental Health and Addictions Service, with the consultation focusing on Addictions Medicine Service intervention, or a consultation to a small team of identified medical professionals at the Halifax Infirmary who were informally managing patients requiring Addictions Medicine Service intervention), consultation with the Social Work Service (formal consultation or involvement in progress notes), community follow-up (identified as planned medical visits for addictions, follow-up notes for addiction management, and progress notes from Addiction Medicine Service specialists), and MAT or OAT (identified as prescriptions for methadone or buprenorphine on discharge).

Patients who were identified by the inclusion criteria were considered to be "reinfected" using this extensive chart review. Patients were considered "reinfected" if they were readmitted to any hospital in Nova Scotia for management of IE, as defined based on the modified Duke criteria. This included

Table 1. Baseline demographics and information on interventions

Demographic	All (n = 37)	No intervention (n = 8)	Any intervention (n = 29)	<i>P</i>
Age, y, mean (SD)	35.97 (9.48)	37.5 (7.27)	35.55 (10.08)	0.6138
Gender				0.2323
Female	12 (32.43)	1 (12.5)	11 (37.93)	—
Male	25 (67.57)	7 (87.5)	18 (62.07)	—
Intervention (%)				
Addictions Service consultation	16 (43.24)	—	16 (55.17)	—
Social Work Service consultation	25 (67.57)	—	25 (86.21)	—
MAT and/or OAT	15 (40.54)	—	15 (51.72)	—
Community follow-up	21 (56.76)	—	21 (72.41)	—
Any Intervention	29 (78.38)	—	29 (100)	—
Number of interventions				
0	8 (21.62)	—	0 (0)	—
1	6 (16.22)	—	6 (20.69)	—
2	6 (16.22)	—	6 (20.69)	—
3	9 (24.32)	—	9 (31.03)	—
4	8 (21.62)	—	8 (27.59)	—
Surgical consultation	19 (57.58)	4 (66.67)	15 (55.56)	1
Missing	4	2	2	—
Redo surgery	11 (29.73)	2 (25)	9 (31.03)	1
Number of redo surgeries				1
0	26 (70.27)	6 (75)	20 (68.97)	—
1	9 (24.32)	2 (25)	7 (24.14)	—
2	2 (5.41)	0 (0)	2 (6.9)	—
Readmission for infective endocarditis	21 (56.76)	3 (37.5)	18 (62.07)	—
Number of readmissions				
0	16 (43.24)	5 (62.5)	11 (37.93)	—
1	12 (32.43)	3 (37.5)	9 (31.03)	—
2	4 (10.81)	0 (0)	4 (13.79)	—
3	2 (5.41)	0 (0)	2 (6.9)	—
4	2 (5.41)	0 (0)	2 (6.9)	—
5	1 (2.7)	0 (0)	1 (3.45)	—
Mortality				
Including post-op deaths (n = 41)	12 (29.27)	—	—	—
Excluding post-op deaths (n = 37)	8 (21.62)	1 (12.5)	7 (24.14)	0.6555

Values are n (%), unless otherwise indicated.

MAT and/or OAT, medication- and/or opioid-assisted treatment; post-op, postoperative; SD, standard deviation.

medical or surgical management at any hospital in the province. Patients were identified as “reinfected” and included as such only if they had finished the prescribed management from their provider prior to being readmitted.

The category of redo (ie, a repeat) operation included reoperation for valvular disease secondary to IE. Other reasons for reoperation, including bleeding, structural valve deterioration not due to IE, and other cardiac disease, were not included.

Statistical analysis

Baseline characteristics for the study population were summarized as mean (standard deviation) for continuous variables, and frequency (percent) for categorical variables.

Comparisons between patients receiving the intervention and those not receiving the intervention were done using the Student *t* test for continuous variables, and Fisher’s exact test for categorical variables.

The variables used in the analysis included age, sex, and interventions, such as consultation with the Addiction Medicine Service and/or Mental Health Service, consultation with the Social Work Service, medical management with OAT/MAT, and community follow-up, surgical consultation, redo surgery, and readmission for reinfection.

The intervention was defined in 2 ways, as follows: (i) The patient receiving any of the 4 interventions for their addiction

(any consultation with the Addictions Medicine Service and/or Mental Health Service, Social Work Service involvement, medical management, and community follow-up) or receiving none (binary); and (ii) the number of these interventions the patient received for their addiction, ranging from 0 to 4 (continuous).

The binary outcome of reinfection was modelled with univariable and multivariable logistic regression using Firth’s penalized likelihood to reduce bias due to small sample size. The univariable models included either the binary or continuous intervention as the predictor, and the multivariable models were additionally adjusted for gender.

A 2-sided *P* value of < 0.05 was the threshold for statistical significance. All analyses were performed using SAS statistical software version 9.4 (SAS Institute, Cary, NC).

Results

Between 2005 and 2018, a total of 205 patients underwent valve replacement surgery with a history of IE at the QEII HSC. Of these, 41 patients were identified who used injection drugs and fit the inclusion criteria. The mean age of these patients was 35.97 years, and 67.6% of the patients were male. Because the primary outcome of interest for analysis was reinfection, we excluded patients who died during the index

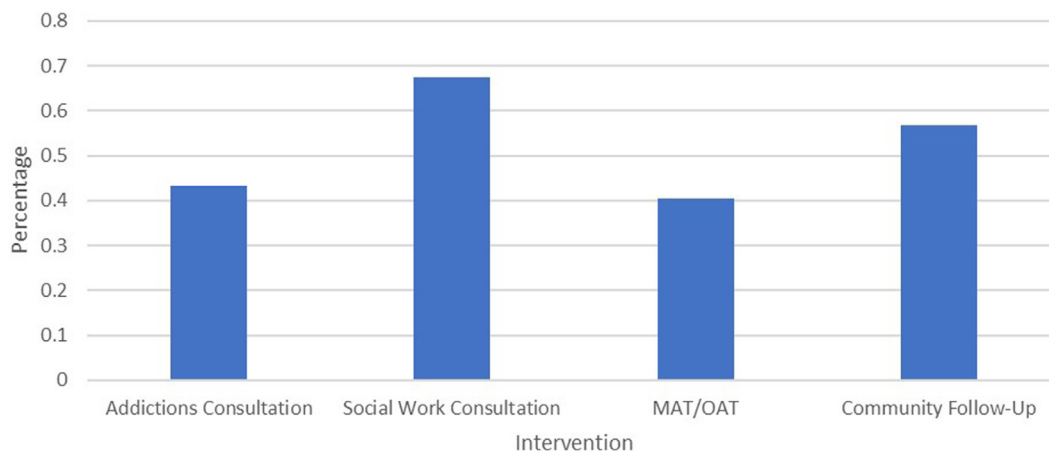


Figure 1. Postoperative management of addiction in infective endocarditis at a single institution. **Blue bars** represent the percentage of patients who received each intervention. MAT and/or OAT, medication- and/or opioid-assisted treatment.

hospitalization (first operation). Four patients died in the early postoperative period and were included in the calculation of the overall mortality rate but were excluded from analysis for recurrent infection. Baseline characteristics are outlined in Table 1. In terms of readmission for reinfection, 56.76% were readmitted, with readmissions ranging in number from 1 (32.43%) to 5 (2.7%). The overall mortality rate for all patients following their index surgery was 29.3%. Redo surgery took place in 29.7% of reinfected patients—a single redo operation in 24.3%, and 2 redo operations in 5.41%. Four patients (9.5%) passed away in the perioperative period (Table 1).

In terms of postoperative management of addiction, 43.2% of patients received an Addictions Medicine Service consultation, 67.6% received a Social Work Service consultation, 40.5% received MAT and/or OAT, and 56.8% received community follow-up (Fig. 1). A total of 78.4% of patients received an intervention. The number of interventions that patients received ranged from 0 to 4 for each of the interventions identified; 6 patients (16.2%) received 1 intervention, 6 patients (16.2%) received 2 interventions, 9 patients (24.3%) received 3 interventions, and 8 patients (21.6%) received a total of 4 interventions.

The univariate logistic regression analysis indicated that patients who had any intervention for their addiction had a 2.5-fold increase in odds of reinfection, compared to patients without any intervention (odds ratio [OR] 2.527, 95% CI 0.507-12.6, $P = 0.258$). Additionally, for each increase in the number of interventions a patient received, the odds of reinfection increased by 1.4 times (OR 1.441, 95% CI 0.901-2.303, $P = 0.1271$). Neither of these increases were significant (Table 2).

In the multivariable logistic regression analysis, each increase in the number of interventions a patient received resulted in the odds of reinfection increasing by 1.4 times (OR 1.35, 95% CI 0.802-2.273, $P = 0.258$) after adjusting for gender. An interesting finding is that female patients were found to have significantly higher odds of reinfection, compared to male patients (OR 9.743, 95% CI 1.395-68.035; Table 2).

Discussion

The results of this study indicate that patients who received any intervention for addiction at this institution had higher odds of reinfection—a complete contradiction to the study hypothesis. Although this finding is not significant, it represents a worrisome trend. High mortality and reinfection rates are once again redemonstrated in this cohort of patients. Further, we demonstrated that no standardized approach to addiction management is used for this patient population.

As this study is observational, we can only infer why patients who have been receiving interventions for their addiction at our facility have demonstrated higher rates of reinfection. A possible explanation is the practice of consultation at this institution. A common theme noted during the chart review was that patients who were considered “difficult” appeared to be more likely to receive consultation, in an effort to circumvent their behaviour. For example, notes found in the chart review identified patients as being “difficult” due to their desire to use drugs in the hospital, leaving the hospital against medical advice, and their lack of following prescribed practices. In this scenario, patients considered “difficult” could have received a higher number of consultations, compared to patients who did not demonstrate these behaviours, to provide assistance to the healthcare team.

Another likely contributing factor is the lack of formalized consultation with the Addictions Medicine Service at this institution over the study period. Patients represented in this

Table 2. Univariate and multivariate logistic regression analysis for readmission with reinfection

Univariable	OR (95% CI)	<i>P</i>
Any intervention (yes vs no)	2.527 (0.507, 12.6)	0.258
Number of Interventions, continuous	1.441 (0.901, 2.303)	0.1271
Multivariable, adjusting for gender		
Any intervention (yes vs no)	1.649 (0.289, 9.408)	0.5736
Gender (female vs male)	9.945 (1.419, 69.719)	0.0208
Number of Interventions, continuous	1.351 (0.802, 2.273)	0.258
Gender (female vs male)	9.743 (1.395, 68.035)	0.0217

CI, confidence interval; OR, odds ratio.

study were managed over a long time frame (2005-2018). During this period, the approach to managing addictions changed significantly. Although some patients were able to receive OAT and/or MAT and have consultation with the Social Work Service, formalized consultation with the Addictions Medicine Service was difficult, and we are unable to ascertain what this entailed in the early years of this study. The Addictions Medicine Service has evolved and now includes inpatient consultation, with outpatient management options. Until recently, these services were provided largely on a volunteer basis.

This model introduces the potential for large variations in the care being provided to patients. For example, integrally connected with the Addictions Medicine Service is the use of MAT and/or OAT.⁷ Healthcare professionals often have different levels of experience in prescribing these medications. Those lacking experience could potentially avoid prescribing them, especially for patients without adequate follow-up. Proper use in this population is therefore dependent on the ability to formally consult an Addictions Medicine Service, with ongoing outpatient community support. Likewise, community outreach programs promoting harm-reduction strategies are crucial for these patients.¹¹

Female patients were significantly more likely to be readmitted with reinfection. Fewer female patients were included in this study ($n = 12$; 32%) compared to their male counterparts ($n = 25$; 68%). At this time, why female patients would have higher rates of mortality at this institution is unclear. Previous reports indicate that male patients tend to have higher rates of opioid-use related death.¹²

A recent survey distributed to practicing cardiac surgeons in Canada found that 61.5% of respondents would not offer a repeat surgical procedure in patients with a history of injection drug use. Respondents cited a high likelihood of repeated infection as a reason they would not offer redo surgery. Less than half (49%) have a program or initiative in place that includes assessment for addiction as part of their management for IE in this population of patients.¹³ Therefore, a vital need is to improve the management of addiction for these high-risk patients to avoid the need for life-saving redo cardiac surgery.

Limitations

This study has several limitations. First, the population in this cohort is small, with a total of 41 patients included in a single institution, making generalization of the results difficult. Second, we were unable to track patients who have moved out of this province, owing to their having separate electronic health records. The record may not accurately reflect the current circumstances for the patient or the management they have received. Third, this study relies on accurate documentation to determine what management a patient received. Although thorough chart reviews were done, if patients received care through an informal setting or if it was not properly documented in the chart, it would not be included in this study.

Information on ongoing drug use at the time of readmission was not included in our analysis. Collection of this information is prone to inaccuracy. Determining whether ongoing drug use is occurring can be exceedingly difficult in this population, as patients can deny drug use, owing to

concerns about discrimination, and objective drug screens are not always performed. We also do not have information on why a patient did not receive surgical intervention. Documentation between outside hospitals and on-call surgeons is often done via a telephone call, and this information is not consistently charted.

Conclusion

The management of addiction is, in many ways, a new frontier for healthcare—perhaps more so in the Cardiac Surgery Service. This study highlights significant barriers in the management of addiction at a single institution. Ultimately, this research has had a positive impact. Through in-hospital presentation and advocacy, the authors helped highlight gaps in the care provided to this marginalized population. As a result, this institution has formalized an Addictions Medicine Consultation Service (established September 2023). An opportunity now exists to compare formal addictions management in this population of patients at this institution. Further research involving multiple provinces is ongoing, to provide insight into these gaps. Future efforts will be directed toward providing consistent care and improving the management of addiction to decrease reinfection rates.

Ethics Statement

This study was approved by the Nova Scotia Health Ethics Board.

Patient Consent

The authors confirm that patient consent was not applicable to this article. This was a retrospective chart analysis that did not require patient consent and was approved by the health board.

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Disclosures

The authors have no conflicts of interest to disclose.

References

1. Degenhardt L, Peacock A, Colledge S, et al. Global prevalence of injecting drug use and sociodemographic characteristics and prevalence of HIV, HBV, and HCV in people who inject drugs: a multistage systematic review. *Lancet Glob Health* 2017;5:e1192-207.
2. Weymann A, Borst T, Popov AF, et al. Surgical treatment of infective endocarditis in active intravenous drug users: a justified procedure? *J Cardiothorac Surg* 2014;9:1-8.
3. Chu VH, Park LP, Athan E, et al. Association between surgical indications, operative risk, and clinical outcome in infective endocarditis: a prospective study from the International Collaboration on Endocarditis. *Circulation* 2015;131:131-40.

4. Zubarevich A, Szczechowicz M, Osswald A, et al. Surgical treatment of infective endocarditis in intravenous drug abusers. *J Cardiothorac Surg* 2021;16:1-9.
5. Nguemini Tiako MJ, Mori M, Bin Mahmood SU, et al. Recidivism is the leading cause of death among intravenous drug users who underwent cardiac surgery for infective endocarditis. *Semin Thorac Cardiovasc Surg* 2019;31:40-5.
6. Tan C, Shojaei E, Wiener J, et al. Risk of new bloodstream infections and mortality among people who inject drugs with infective endocarditis. *JAMA Netw Open* 2020;3:1-13.
7. Kimmel SD, Walley AY, Li Y, et al. Association of treatment with medications for opioid use disorder with mortality after hospitalization for injection drug use-associated infective endocarditis. *JAMA Netw Open* 2020;3:1-12.
8. Ray V, Waite MR, Spexarth FC, et al. Addiction management in hospitalized patients with intravenous drug use-associated infective endocarditis. *Psychosomatics* 2020;61:678-87.
9. Kilwein TM, Brown S, Gaffaney M, Farrar J. Bridging the gap: Can group interventions assist addiction consult services in providing integrated, comprehensive healthcare for patients hospitalized for opioid-related infections? *J Clin Psychol Med Settings* 2021;28:262-6.
10. Statistics Canada. Population estimates, quarterly. Available at: <https://doi.org/10.25318/1710000901-eng>. Accessed June 30, 2023.
11. Thakarak K, Rokas KE, Lucas FL, et al. Mortality, morbidity, and cardiac surgery in injection drug use (IDU)-associated versus non-IDU infective endocarditis: the need to expand substance use disorder treatment and harm reduction services. *PLoS One* 2019;14:1-15.
12. Hoopsick RA, Homish GG, Leonard KE. Differences in opioid overdose mortality rates among middle-aged adults by race/ethnicity and sex, 1999-2018. *Public Health Rep* 2021;136:192-200.
13. Dready K, Greene A, Adams C. Intravenous drug use-associated infective endocarditis in Canada: a call for a standardized treatment strategy that includes in-hospital addiction medicine and harm reduction services. *Can J Addict* 2021;12:45-8.