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## The level of adherence to best-practice guidelines by interprofessional teams with and without acute care nurse practitioners in cardiac surgery: a study protocol --Manuscript Draft--

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<b>Article Type:</b>	Study Protocol
<b>Full Title:</b>	The level of adherence to best-practice guidelines by interprofessional teams with and without acute care nurse practitioners in cardiac surgery: a study protocol
<b>Short Title:</b>	Adherence to best-practice guidelines by interprofessional teams with and without nurse practitioners
<b>Corresponding Author:</b>	Li-Anne Audet, MSc McGill University Faculty of Medicine and Health Sciences Montreal, Quebec CANADA
<b>Keywords:</b>	Acute care nurse practitioner, best-practice guidelines, cardiac surgery, interprofessional teams, quality of care
<b>Abstract:</b>	<p><b>Background</b> Acute care nurse practitioners (ACNP) have been implemented in postoperative cardiac surgery settings and have shown to provide significant benefits to patients and organizations. To explain these associations, recent studies have suggested that ACNP increase the level of adherence to best-practice guidelines by interprofessional teams. However, it is unknown if interprofessional teams with ACNP are associated with higher levels of adherence to best-practice guidelines compared to interprofessional teams without ACNP. Furthermore, no extraction tool is available to measure the level of adherence to best-practice guidelines by interprofessional teams in postoperative cardiac surgery settings. This project aims to examine the level of adherence to best-practice guidelines of interprofessional teams with and without ACNP in a postoperative cardiac surgery setting in Québec, Canada.</p> <p><b>Methods</b> A retrospective observational study will be conducted of 300 patients hospitalized between January 1, 2019 and January 31, 2020 in a postoperative cardiac surgery unit in Québec, Canada. Data will be collected from patient health records and electronic databases. An extraction tool will be developed based on systematic review of the literature, and will include best-practice guidelines and confounding variables related to patient and interprofessional teams' characteristics. Content and criterion validation, and a pilot-test will be conducted for the development of the tool. A multivariate linear regression model will be developed and adjusted for several confounding variables, in order to examine the association between interprofessional teams with and without ACNP, and the level of adherence to best-practice guidelines.</p> <p><b>Discussion</b> This project represents the first study to examine the level of adherence to best-practice guidelines by interprofessional teams with and without ACNP in a postoperative cardiac surgery setting. The findings of this project will generate empirical data focusing on the contribution of ACNP within interprofessional teams, and ultimately enhance the delivery of high quality and evidence-based care for patients and families.</p>
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<b>Financial Disclosure</b>	This project is funded by the Réseau de recherche en intervention en sciences infirmières du Québec (RRISIQ). LAA holds doctoral scholarships from the Fonds de

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Additional data availability information:

1       **The level of adherence to best-practice guidelines by interprofessional teams**  
2       **with and without acute care nurse practitioners in cardiac surgery: a study**  
3       **protocol**

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39 **The level of adherence to best-practice guidelines by interprofessional teams**  
40 **with and without acute care nurse practitioners in cardiac surgery: a study**  
41 **protocol**

42 **Short title**

43 Adherence to best-practice guidelines by interprofessional teams with and without acute  
44 care nurse practitioners

45 **Abstract**

46 **Background**

47 Acute care nurse practitioners (ACNP) have been implemented in postoperative cardiac  
48 surgery settings and have shown to provide significant benefits to patients and  
49 organizations. To explain these associations, recent studies have suggested that ACNP  
50 increase the level of adherence to best-practice guidelines by interprofessional teams.  
51 However, it is unknown if interprofessional teams with ACNP are associated with higher  
52 levels of adherence to best-practice guidelines compared to interprofessional teams  
53 without ACNP. Furthermore, no extraction tool is available to measure the level of  
54 adherence to best-practice guidelines by interprofessional teams in postoperative  
55 cardiac surgery settings. This project aims to examine the level of adherence to best-  
56 practice guidelines of interprofessional teams with and without ACNP in a postoperative  
57 cardiac surgery setting in Québec, Canada.

58 **Methods**

59 A retrospective observational study will be conducted of 300 patients hospitalized  
60 between January 1, 2019 and January 31, 2020 in a postoperative cardiac surgery unit  
61 in Québec, Canada. Data will be collected from patient health records and electronic



62 databases. An extraction tool will be developed based on systematic review of the  
63 literature, and will include best-practice guidelines and confounding variables related to  
64 patient and interprofessional teams' characteristics. Content and criterion validation,  
65 and a pilot-test will be conducted for the development of the tool. A multivariate linear  
66 regression model will be developed and adjusted for ~~several~~ confounding variables, in  
67 order to examine the association between interprofessional teams with and without  
68 ACNP, and the level of adherence to best-practice guidelines.

## 69 **Discussion**

70 This project represents the first study to examine the level of adherence to best-practice  
71 guidelines by interprofessional teams with and without ACNP in a postoperative cardiac  
72 surgery setting. The findings of this project will generate empirical data focusing on the  
73 contribution of ACNP within interprofessional teams, and ultimately enhance the  
74 delivery of high quality and evidence-based care for patients and families.

## 75 **Keywords**

76 Acute care nurse practitioner, best-practice guidelines, cardiac surgery,  
77 interprofessional teams, quality of care

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## 85 **Background**

86 Cardiac surgeries are one of the leading types of surgical procedures performed  
87 internationally. In 2017, approximately 1 million patients throughout the world underwent  
88 a cardiac surgery (1). In 2018, the Society of Thoracic Surgeons (STS) reported  
89 287,872 cardiac surgeries and procedures performed in the United States (2). In  
90 Canada, 42,989 coronary artery bypass grafts (CABG) and 7,186 valve repairs were  
91 performed between 2013 and 2016 (3, 4).









92 In the postoperative phase after the surgery, many patients are at high risk of  
93 developing adverse events and postoperative complications such as myocardial  
94 infarction and wound infection (5). These complications are associated with higher risk  
95 of mortality and development of comorbidities (e.g., heart failure), as well as a decrease  
96 in the well-being and quality of life of patients and families (6). For healthcare  
97 organizations, adverse events and postoperative complications are associated with a  
98 longer length of stay at the hospital, higher rates of readmission in intensive care units,  
99 higher rates of surgical re exploration, and an increase in cost (7, 8).




100 To prevent the risk of adverse events and postoperative complications for  
101 patients and families, international healthcare organizations and research teams have  
102 developed best-practice guidelines (7, 9). Best-practice guidelines are defined as  
103 evidence-based practice of care, and aim to ensure the performance of  
104 interprofessional teams, enhancing the quality and safety of the care given to patients  
105 and families. In postoperative cardiac surgery settings, best-practice guidelines related  
106 to the pharmacotherapy, laboratory tests, clinical indicators, and lifestyle promotion

107 (e.g., diet, cardiac rehabilitation) have been developed and implemented in healthcare  
108 centres (2).

109 A consensus in the literature supports the importance of a high level of  
110 adherence by interprofessional teams to best-practice guidelines, in order to ensure  
111 their efficacy (7, 10). Adherence to best-practice guidelines is defined as the  
112 achievement of ~~the guideline recommendation~~, as well as the associated interventions  
113 ~~recommendations~~, performed by clinicians (11). In surgical settings (e.g., neurosurgery, orthopedic  
114 surgery) international research teams (12-15) have developed composite scores to  
115 examine the level of adherence to best-practice guidelines by interprofessional teams.  
116 Their findings suggested that a higher level of adherence is associated with a higher  
117 quality of care given to patients and families.

118 In postoperative cardiac surgery settings, recent studies (5, 16) identified a  
119 significant association between a high level of adherence to best-practice guidelines by  
120 interprofessional teams and a lower risk of postoperative complications and adverse  
121 events for patients. Other studies (5, 16, 17) have shown a significant association  
122 between a lower level of adherence to best-practice guidelines by interprofessional  
123 teams and a higher risk of postoperative complications and adverse events for patients.  
124 Larrazet et al. (2014) conducted a longitudinal study  from 144 patients who died after  
125 cardiac surgery. The authors identified a significant association between a lack of  
126 adherence to best-practice guidelines by interprofessional teams, and a higher risk of  
127 mortality, highlighting the importance of ~~the~~  high adherence to best-practice guidelines  
128 by interprofessional teams (17). 

129           Recent studies have examined the practice of nurse practitioners (NP) within  
130 primary and acute care settings, and suggested that their practice could increase the  
131 level of adherence to best-practice guidelines by interprofessional teams (18, 19). The  
132 NPs support of the practice of different care providers in the team with a focus on best  
133 evidence is believed to **undergird** providers' adherence to best-practice guidelines   
134 focused on pharmacotherapy, clinical indicators, and lifestyle promotion. NPs also  
135 enhance collaboration and communication among teams' members and ~~the~~ continuity of   
136 care, ~~contributing to the higher~~ adherence to best-practice guidelines by   
137 interprofessional teams (18, 20).




138           The NP is an advanced practice nursing role, based on a **graduate-level**   
139 education and in-depth nursing and medical expertise (21-23). In several acute care  
140 settings, including postoperative cardiac surgery, acute care nurse practitioners (ACNP)  
141 have been implemented in interprofessional teams and performed activities such as the  
142 clinical and psychosocial assessment of patients, the prescription and management of  
143 pharmacotherapy, laboratory tests and clinical interventions, lifestyle promotion,  
144 teaching of coping strategies, preparation for hospital discharge, and the management  
145 of consultations and external resources (24). International research teams (23, 25) have  
146 examined **their** practice in postoperative cardiac surgery settings. They identified   
147 significant associations between the ACNPs' practice and higher patient satisfaction, as  
148 well as between higher participation of patients to cardiac rehabilitation and lower length  
149 of stay at the hospital after the cardiac surgery. **However, other research teams** (21,   
150 26) did not identify significant associations between ACNP practice and patient and  
151 organizational outcomes within postoperative cardiac surgery settings, thus leading to


152 inconsistent findings in the current literature. To understand the inconsistent findings in  
153 the current literature, systematic reviews of randomized controlled trials (RCT) (21, 23)  
154 have been conducted. These systematic reviews have identified three important limits  
155 contributing to the inconsistent findings of the current literature.

156         Firstly, although several RCT of the current literature focus on the efficacy of  
157 ACNP for patients and healthcare organizations, less attention has been paid to the  
158 efficacy of these providers for interprofessional teams. The qualitative study of Reich et  
159 al. (2018) suggested that the implementation of ACNP within interprofessional teams  
160 increases the level of adherence of those teams to best-practice guidelines in  
161 postoperative cardiac surgery settings, and represents an underlying factor contributing  
162 to the efficacy of NP (19). However, these propositions have not been subjected to  
163 statistical validation, thus it is unknown if interprofessional teams with ACNP are  
164 associated with higher levels of adherence to best-practice guidelines, compared to  
165 interprofessional teams without ACNP. Moreover, until today, no validated extraction  
166 tool is available to measure the level of adherence to best-practice guidelines of  
167 interprofessional teams with and without ACNP in postoperative cardiac surgery  
168 settings.

169         Secondly, systematics reviews have highlighted the difficulty in adequality  
170 controlling confounding variables in the existing RCT (21, 23). Confounding variables  
171 represent important factors influencing the efficacy of ACNP on patient and  
172 organizational outcomes in postoperative cardiac surgery settings. Methodological limits  
173 of the existing RCT, such as the small sample size and high attrition rate, limit the  
174 capacity of research teams to develop robust multivariate statistical models adjusted for

175 confounding variables related to patient, interprofessional teams, and organizational  
176 characteristics (21, 23). Interestingly, retrospective observational studies have shown to  
177 be a relevant alternative to examine the association between ACNP and patient and  
178 organizational outcomes in postoperative cardiac surgery settings. Existing studies (27-  
179 30) have used retrospective observational studies to gather a large cohort of patients,  
180 limit attrition, and develop statistical models adjusted for many confounding variables.  
181 These studies (6, 27-29) have identified significant associations between ACNP within  
182 interprofessional teams, and lower risks of mortality and decreased costs in  
183 postoperative cardiac surgery settings.

184 Thirdly, the majority of the RCT focuses on ~~the practice of~~ ACNP within primary   
185 care settings (e.g., in-home care, rehabilitation clinic) after ~~the~~ cardiac surgery. Less  
186 attention has been paid to ~~the practice of~~ ACNP in acute care settings; however, within   
187 these settings, ACNP works in collaboration with cardiac surgeons, nursing teams,  
188 rehabilitation teams, social workers, and other members of ~~the~~ interprofessional teams  
189 to ensure ~~the patient~~ optimal recovery after ~~the~~ surgery, and prevents ~~the~~ risk of  
190 adverse events and postoperative complications. ~~Moreover,~~ for patients and families,  
191 the acute care hospitalization after ~~the~~ surgery represents a crucial phase of their  
192 postoperative recovery and is associated with several physical, psychosocial, and  
193 emotional stressors (30). Future studies are needed to ~~better document~~ the contribution   
194 of ACNP in interprofessional teams within acute care settings, and identify the benefits  
195 of their practice for patients, families, interprofessional teams, and healthcare  
196 organizations.

197  ~~Consequently~~, this project aims to examine the level of adherence to best-  
198 practice guidelines of interprofessional teams with and without ACNP in acute  
199 postoperative cardiac surgery settings in Québec, Canada.


## 200 **Study objectives and hypothesis**

201 The objectives of this study are as follows:

202 1. Develop and pilot-test an extraction tool to measure the level of adherence to  
203 best-practice guidelines of interprofessional teams within postoperative cardiac  
204 surgery setting.

205 2. Describe the patient and interprofessional teams' characteristics, as well as the  
206 level of adherence to best-practice guidelines, of patients under the care of  
207 interprofessional teams with and without ACNP.

208 3. Examine the association between interprofessional teams with ACNP and the  
209 level of adherence to best-practice guidelines, compared to interprofessional  
210 teams without ACNP, **after adjusting patient and interprofessional team**

211 **characteristics in postoperative cardiac surgery setting.** 

212 4. The hypothesis of this study is:

213 H1: This study will verify if interprofessional teams with ACNP are associated  
214 with a higher level of adherence to best-practice guidelines compared to  
215 interprofessional teams without ACNP, after controlling for the patient and  
216 interprofessional team characteristics.

## 217 **Methods and design**

### 218 **Study design**

219 A retrospective observational study (31, 32) will be conducted at a University healthcare  
220 centre (UHC) in Québec, Canada. Annually, this healthcare centre performs  
221 approximately 1,000 cardiac surgeries and procedures and has a postoperative cardiac  
222 surgery unit of 36 beds. De-identified data will be extracted from the UHC data  
223 warehouse and the patient health records to assemble the retrospective cohort of  
224 patients and conduct the data collection. Ethics approval was obtained from the McGill  
225 University Health Centre Research Ethics Board on September 15, 2021 (IPSSA  
226 chirurgie cardiaque/2022-8094). ~~This project uses the guidelines from *Strengthening the*  
227 *Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines*  
228 *for Reporting Observational Studies* (32) were used for this project (SA appendix).~~

### 229 **The hospitalization of patients after cardiac surgery**

230 After cardiac surgery, patients are admitted to the intensive care unit (ICU), and are  
231 under the care of ICU teams. At the time of data collection, the ICU teams in Québec,  
232 Canada do not include ACNP. On average, patients are hospitalized for 24 hours in the  
233 ICU before being transferred to the postoperative cardiac surgery unit. Patients  
234 readmitted to the ICU are under the care of ICU teams.


235 Upon admission to the postoperative cardiac surgery unit, patients are assigned  
236 to the care of interprofessional teams with or without ACNP. Team assignment depends  
237 on the current workload of each team, and the availability of the beds in the unit.  
238 Interprofessional teams with ACNPs are assigned 16 of the unit's beds (44%) and  
239 interprofessional teams without ACNP are assigned 20 of the unit's beds (56%).  
240 Patients are followed by their respective teams from their admission to the cardiac



241 surgery unit, until the hospital discharge or death. On average, the length of stay at the  
242 hospital after the surgery ranges from 9 to 11 days (33).


243 Interprofessional teams with and without ACNP include the following: cardiac  
244 surgeons and residents nursing teams, skin care and wound therapists,  
245 physiotherapists, nutritionists, respiratory therapists, social workers, and medical and  
246 other specialists. Interprofessional teams with and without ACNP ensure the daily  
247 follow-up of patients, the assessment of the patient's clinical and psychosocial condition,  
248 the management of pharmacotherapy, clinical intervention, laboratory tests, lifestyle  
249 promotion, and the preparation of patients upon hospital discharge.


### 250 **The practice of acute care nurse practitioners in postoperative cardiac surgery** 251 **unit**

252 Since 2017, seven ACNPs practice in postoperative cardiac surgery, based on a  
253 monthly rotation system. Two ACNP simultaneously practice within interprofessional  
254 teams and collaborate with other clinicians to ensure the daily follow-up of the patients  
255 after cardiac surgery. ACNP practice includes the assessment of the clinical and  
256 psychosocial condition of the patient and families, the management of the  
257 pharmacotherapy, clinical interventions, and laboratory tests. The ACNP also teaches  
258 coping strategies, lifestyle promotion, cardiac rehabilitation, preparation of the patients  
259 and families for the in-home recovery after discharge, and supports the cardiac surgeon  
260 in the patient hospital discharge (34). 

### 261 **Study population and sample**

262 A dynamic cohort of patients will be assembled from hospitalized patients at the  
263 postoperative cardiac surgery unit between January 1, 2019, and January 31, 2020.

264 This timeframe will avoid the recruitment of patients during the COVID-19 pandemic, a  
265 window of time during which the practice of ACNP within the unit was inconsistent.  
266 Patients will be selected, based on three inclusion criteria: 1) patient admitted for a  
267 diagnosis of CABG and/or valve repair (~~i.e., these surgeries were selected because~~  
268 ~~they are the most frequently performed internationally~~), 2) patient age is over 18 years  
269 old, and 3) patient has been hospitalized for at least 24 hours in the postoperative  
270 cardiac surgery unit. The minimum 24-hour criteria will allow our team to examine the  
271 hospitalization of the patient at the postoperative cardiac surgery unit, which is the   
272 setting where ACNPs practice in Québec (35). Patients will be identified from the  
273 electronic databases of the UHC and the diagnostic codes of the Canadian Institute for  
274 Health Information (36) (SB appendix).

275 A sample size calculation was conducted in G\*power (37). This project will  
276 include 15 variables, including one independent variable, one dependent variable, and   
277 13 confounding variables. To perform one multivariate linear regression model and  
278 detect an effect size of  $f^2=0.15$  with a power of 0.80 and a standard error of 5%, a  
279 minimum sample size of 183 patients was estimated.

280 A total of 300 patients will be selected, based on the sample size calculation and  
281 an over-estimation of at least 20%, to consider the risk of error from the presence of  
282 missing data and incomplete patient health records (38, 39). A systematic random  
283 selection of 150 patients under the care of interprofessional teams with ACNP will be  
284 conducted and matched with 150 patients under the care of interprofessional teams  
285 without ACNP. Three criteria (40-43) will be used to match each pair (1:1): 1) age (i.e., a

286 five-year gap will be tolerated) 2) sex, and 3) type of cardiac surgery (i.e., CABG, valve  
287 repair, or CABG/valve repair).

288 Patients will be followed from their admission to the ICU after the cardiac  
289 surgery, until the occurrence of the following events, whichever occurs first: 1)  
290 discharge from the hospital, 2) death, or 3) the cumulation of 14-days in hospital after  
291 the surgery. The 14-days' timeframe will allow our team to capture the acute phase of  
292 the patient hospitalization after the cardiac surgery (33). The total length of stay for  
293 patients hospitalized longer than 14-days will be measured.

#### 294 **Variables under study**

295 A systematic review of RCTs (24) and an extensive search in the literature and  
296 international healthcare organizations (e.g., American Heart Association, Society of  
297 Thoracic Surgeons) was conducted to retrieve best-practice guidelines for  
298 interprofessional teams in postoperative cardiac surgery settings, and confounding  
299 variables related to patient and interprofessional teams' characteristics. A total of 12  
300 best-practice guidelines and 13 confounding variables were identified and presented in  
301 Figure 1. The operationalization of each variable is presented in SC appendix.


302 *Independent variable: interprofessional teams with and without acute care nurse*  
303 *practitioner*

304 A dichotomous variable will be created to measure the inclusion of at least one ACNP  
305 within the interprofessional team. For patients under the care of an interprofessional  
306 team with ACNP, an additional descriptive variable will measure the number of days  
307 where the ACNP was implicated in the daily follow-up of the patient, on the entire  
308 hospitalization at the postoperative cardiac surgery unit.

309 *Dependant variable: the level of adherence to best-practice guidelines by*  
310 *interprofessional teams*

311 A composite score will be developed to measure the level of adherence to best-practice  
312 guidelines by interprofessional teams. An individual composite score will be calculated  
313 per patient per day of hospitalization at the postoperative cardiac surgery unit. A total of  
314 12 best-practice guidelines will be included in the composite score (Figure 1). Each  
315 best-practice guideline will be scored on two points based on the following: 1) the  
316 achievement of the guideline recommendation (e.g., prescription of beta blocker) and 2)  
317 the associated interventions performed by clinicians (e.g., follow-up of the blood  
318 pressure). All best-practice guidelines are divided into three categories: 1)  
319 pharmacotherapy (n=4), 2) laboratory tests (n=4), and 3) postoperative assessment  
320 (n=4).

321 Four best-practice guidelines are included in the category of pharmacotherapy.  
322 These guidelines are the prescription and monitoring of medications including: 1)  
323 anticoagulants, 2) beta blockers, 3) lipid-lowering agents, and 4) anti-platelets, during  
324 hospitalization and at hospital discharge of the patient. For each best-practice guideline,  
325 two additional descriptive variables will be collected, including the type of medication  
326 prescribed and the presence of a contraindication, which precludes the possibility of  
327 achieving the guideline recommendation (e.g., allergy).

328 Four best-practice guidelines on laboratory tests are included, recommending the  
329 prescription and monitoring of the following: 1) potassium (K+), 2) magnesium (Mg+), 3)  
330 serum glucose, and 4) **international normalized ratio (INR)** by interprofessional teams  
331 during the patient's hospitalization in the postoperative cardiac surgery unit. The 

332 achievement of each best-practice guideline recommendation will be confirmed if the  
333 laboratory result falls under the normal range supported by the current literature. The  
334 following three additional descriptive variables will be measured for each guideline: 1)  
335 number of prescriptions requested by interprofessional teams, 2) proportion of abnormal  
336 values below or above normal range, and 3) average of all values of laboratory tests.

337 Four best-practice guidelines are included in the category of the postoperative  
338 assessment performed by interprofessional teams. A daily assessment of the patient's  
339 level of pain, surgical wound(s), nutrition, and mobilization will be measured. For each  
340 best-practice guideline recommendation, the achievement of the guideline will be  
341 confirmed if at least one postoperative assessment per day is performed by the ACNP  
342 or other members of the interprofessional teams during the patient's hospitalization in  
343 the postoperative cardiac surgery unit. Two additional descriptive variables will be  
344 measured for each best-practice guideline, including: 1) the total number of  
345 postoperative assessments performed by interprofessional teams during the  
346 hospitalization, and 2) the type of associated interventions conducted by clinicians (e.g.,  
347 non-pharmacological, consultation, etc.).

348 *Confounding variables related to patient characteristics*

349 Eleven confounding variables related to patient characteristics will be measured. For  
350 each patient, sociodemographic characteristics (e.g., sex, age) will be measured. The  
351 total length of stay at the hospital will be measured, which includes the stay in the ICU  
352 and postoperative cardiac surgery unit. The type of cardiac surgery will be collected  
353 from a categorical variable with three categories: 1) CABG, 2) valve repair, and 3)  
354 CABG/valve repairs. Comorbidities will be measured and operationalized from the

355 Charlson Comorbidity Index (CCI) (44, 45). A total score of 24 points will be calculated  
356 for each patient based on the 17 clinical conditions included in the CCI (SD appendix).  
357 The length of stay in the postoperative cardiac surgery unit will be collected for each  
358 patient. The hospital 30-days readmission at the postoperative cardiac surgery unit after  
359 discharge will be measured for each patient from a dichotomous variable.

360 Four confounding variables related to the patient characteristics in the ICU  
361 setting will be measured. The total number of hours hospitalized in the ICU will be  
362 measured from the time (in hours) of admission to the ICU after the surgery and the  
363 time (in hours) of discharge of the patient. The postoperative prolonged mechanical  
364 ventilation will be measured from a dichotomous variable. A prolonged mechanical  
365 ventilation will be confirmed if the time under mechanical ventilation exceeds 24 hours.  
366 The failed extubation of the patient and reintubation after first extubation will be  
367 measured with a dichotomous variable. The number of episodes of ICU readmission  
368 after initial discharge will be measured for each patient.

369 *Confounding variables related to interprofessional teams' characteristics*

370 Two confounding variables related to interprofessional teams' characteristics will be  
371 measured. First, the cardiac surgeon who performed the surgery and ensured the  
372 follow-up of the patient's recovery will be noted. A confidential code will be created for  
373 each surgeon practising in the UHC. Second, a discrete variable will be created to  
374 measure the number of consultations conducted by clinicians from different expertises  
375 (e.g., nutrition, rehabilitation team) during the patient's hospitalization in the  
376 postoperative cardiac surgery unit. A categorical descriptive variable will be created to  
377 measure each clinicians expertise, including the following: 1) rehabilitation team (e.g.,

378 physical therapist, occupational therapist), 2) respiratory therapist, 3) social worker, 4)  
379 skin and wound care therapist, 5) nutritionist, and 6) speciality consultation (e.g.,  
380 internal medicine, nephrology).

### 381 **Data collection**

382 An extraction tool will be developed and pilot-tested, based on the best-practice  
383 guidelines and the confounding variables related to the patient and interprofessional  
384 team characteristics (Figure 1). One extraction will be completed per patient per day  
385 during the hospitalization in the postoperative cardiac surgery unit. The development of  
386 the extraction tool followed the Consensus-based Standards for the selection of health  
387 measurement instrument (COSMIN) guidelines (46) and will include three stages: the  
388 content validation; the criteria validation; and the pilot-test.



#### 389 *Data collection for the content validation*

390 Content validation will be performed following two steps (46). First, an expert committee  
391 will be recruited from clinicians, managers, and researchers who have expertise in  
392 postoperative cardiac surgery. The identification and recruitment of experts will be  
393 conducted by our research team and will include experts in Canada. A total of 10  
394 experts will be recruited, including at least the following five: 1) an ACNP who worked a  
395 minimum of one year within a postoperative cardiac surgery unit outside of our  
396 associated UHC, 2) a cardiac surgeon or fellow in cardiac surgery who worked at least  
397 two years in an acute care centre outside of our associated UHC, 3) a nurse manager  
398 who manages, at least one year, a postoperative cardiac surgery unit, within our  
399 associated UHC, 4) a healthcare professional who worked in the data warehouse of our

400 associated UHC for at least one year, and 5) a researcher in nursing or healthcare  
401 sciences with an expertise in measurement instruments and/or cardiac surgery.

402         Second, an electronic survey (47) will be created and composed of all items of  
403 the extraction tool (best-practice guidelines and confounding variables). For each item,  
404 experts will assess its relevance using a 5-points Likert scale (48, 49). Additional  
405 spaces for qualitative comments and suggestions will be included in the survey. Two  
406 rounds of revision are planned. After the first round, our team will update the extraction  
407 tool and revise any unclear items based on the experts' recommendations, and an  
408 updated version will be resubmitted to the expert committee.

409 *Data collection for the criterion validation*

410 The criterion validation of the extraction tool will follow three consecutive steps. Firstly,  
411 the best-practice guidelines of The Society of Thoracic Surgeons (STS) have been  
412 selected as the gold standard of comparison for this study. For many years, the STS  
413 has been a leading healthcare organization in the development and validation of best-  
414 practice guidelines and performance measures in the care of patients in cardiac surgery  
415 settings (10). In 2007, the STS developed and validated 21 performance measures for  
416 the delivery of high quality of care for patients who underwent CABG, valve repair, and  
417 CABG/valve repairs (50, 51). For this project, five performance measures were  
418 selected, including: 1) prolonged mechanical ventilation higher than 24 hours in the ICU;  
419 2) a 30-day readmission rate at the postoperative cardiac surgery unit after hospital  
420 discharge; and prescription of the 3) anti-platelet, 4) beta blocker, 5) and lipid-lowering  
421 agent, during the hospitalization at the postoperative cardiac surgery unit and at  
422 discharge. Each performance measure is operationalized as the proportion of patients



423 who achieved the outcome (e.g., proportion of patients who were under prolonged  
424 mechanical ventilation) over the total sample size (46, 47).

425 Secondly, 30 patient health records will be reviewed independently by two  
426 reviewers on two occasions. For the first round of revision, the patient's health record  
427 will be reviewed with the extraction tool. For the second round of revision, the records  
428 will be reviewed with the five performance measures from the STS.

#### 429 *Data collection for the pilot-test*

430 A pilot-test will be conducted to assess the feasibility of the tool, standardize data  
431 collection among reviewers, examine the quality and accessibility of the retrospective  
432 data, and update the tool if needed. Four iterative steps will be included in the pilot-test  
433 (52-55). First, two reviewers will conduct the pilot-test and data collection. Training  
434 sessions and documentation will be given to the reviewers.

435 Secondly, 30 patient health records from hospitalized patients in the  
436 postoperative cardiac surgery unit between January 1, 2019, and January 31, 2020, will  
437 be randomly selected. These patients will not be included in the retrospective cohort.  
438 Data will be collected by the two reviewers with the extraction tool. Inter-rater reliability  
439 will be assessed and a Cohen kappa higher than 0.60 will be targeted (55).

440 Thirdly, a triangulation of the available data will be performed to assess the  
441 quality and accessibility of the data. Multiple data sources will be screened between the  
442 electronic databases and patient health records. Items from the extraction tool with a  
443 high quantity of missing data or low quality of available data will be modified or  
444 removed.



445 Finally, frequent meetings among all research team members will be conducted  
446 to discuss divergences, reinforce convergences, and establish a consensus. The  
447 extraction tool will be updated after the pilot-test if needed (52).

448 During data collection from the retrospective cohort of patients, an additional 30  
449 patient health records will be reviewed by two independent reviewers to ensure the  
450 standardization of the data collection (49, 50). Inter-rater reliability will be assessed and  
451 a Cohen Kappa value higher than 0.60 will be targeted (55).

## 452 **Data analysis**

453 Statistical analysis will be conducted to meet objectives one, two and three. The unit of  
454 observation will be the patient-level and the unit of analysis will be the interprofessional  
455 team-level.


### 456 *Objective 1*

457 The content validation of the extraction tool will include two rounds of revisions, with  
458 additional rounds if needed (56, 57). For each round of revision, a Fleiss Kappa will be  
459 calculated and a value between 0.60 and 0.80 will be targeted (48, 49). The content  
460 validity index (CVI) of each individual item of the extraction tool will be calculated from  
461 the proportion of experts who rated a score of 4 or 5 on the Likert scale (58). A CVI of  
462 0.80 will be targeted for each item and items with a value below 0.80 will be removed or  
463 modified. Then, the proportion of items with a CVI value above 0.80 will be calculated to  
464 determine the overall CVI of the extraction tool. A value higher than 0.80 for the overall  
465 CVI of the extraction tool will be targeted (46). Qualitative comments and  
466 recommendations by experts will be analyzed by content analysis (59).

467 The criteria validation will be assessed using 30 patient health records. Five  
468 performance measures developed by the STS will serve as the gold standard for the  
469 comparison (10). First, the proportion of patients who achieved each performance  
470 measure over the total sample size (n=30) will be calculated, from the measures  
471 collected with the gold standard, as well as the measures collected with the extraction  
472 tool. Second, Spearman correlation will be calculated to assess the correlation between  
473 the proportions obtained from the measures of the gold standard, and the proportions  
474 obtained from the measures of the extraction tool. Values of Spearman correlation  
475 higher than 0.70 will be targeted (48, 49).

#### 476 *Objective 2*

477 Descriptive analysis will be performed to assess the level of adherence by  
478 interprofessional teams with and without ACNP, as well as the confounding variables for  
479 patients under the care of both teams (60). An analysis of missing data will be  
480 conducted to examine the quality and distribution of missing data within patient health  
481 records and electronic databases. Team meetings and consultations with clinicians and  
482 statisticians will be held to discuss and identify potential causes of missing data, as well  
483 as to conduct a statistical analysis to manage them (61).

484 A composite score will be developed to measure the level of adherence to best-  
485 practice guidelines by interprofessional teams with and without ACNP. A composite  
486 score per patient per day of hospitalization in postoperative cardiac surgery will be  
487 developed and based on four consecutive steps. 

488 Firstly, for each best-practice guideline, a score on a scale of two will be created  
489 and points will be attributed for: 1) the achievement of the best-practice guideline

490 recommendation, and 2) the associated intervention performed by clinicians. Points will  
491 be given based on the information contained in the patient health record and electronic  
492 databases. A missed intervention will be considered as a lack of adherence to best-  
493 practice guidelines, and no point will be given.

494 Secondly, all best-practice guidelines are divided into three categories: 1)  
495 pharmacotherapy, 2) laboratory tests, and 3) postoperative assessments. The sum of  
496 the individual score of each best-practice guideline will be calculated for each category.  
497 More specifically, each category includes four best-practice guidelines, and will be  
498 based on a total score ranging from zero to eight.

499 Thirdly, an overall composite score will be calculated from the sum of all the  
500 scores of the three categories, ranging from zero to 24. The overall composite score will  
501 be transformed into a value in percentage (0 to 100%) and an increase of the score will  
502 be associated with an increase of the level of adherence to best-practice guidelines by  
503 interprofessional teams. An overall score will be calculated per patient per each day  
504 hospitalized in the postoperative cardiac surgery unit.

505 Finally, an average composite score will be calculated from the average of all  
506 overall scores during the patient's hospitalization at the postoperative cardiac surgery  
507 unit. An average composite score will be calculated for all patients included in the  
508 retrospective cohort. A graphic illustration will be created from all average scores to  
509 visualize the tendency and distribution of the scores of the cohort.

### 510 *Objective 3*


511 Bivariate analysis will be conducted, and the statistical significance will be based on a  $p$ -  
512 value of 0.05 (60). The Bonferroni correction will be applied for the examination of each

513 confounding variable related to the patient and interprofessional teams' characteristics  
514 (62).

515 A multivariate linear regression model will be developed to examine the  
516 association between interprofessional teams with and without ACNP and the level of  
517 adherence to best-practice guidelines (63-65). An examination of the distribution of the  
518 data will be performed. In the case of an abnormal distribution of the data, a  
519 transformation will be conducted to adjust the statistical model based on the observed  
520 data. The independent variables will include the interprofessional teams with and  
521 without ACNP, as well confounding variables. A correlation matrix will be developed,  
522 and tolerance value lower than 0.2 and a variance inflation factor (VIF) value higher  
523 than 5 will be used to identify multicollinearity between independent variables (63-65).  
524 Independent variables with multicollinearity will be removed one at the time and a new  
525 regression will be calculated. The dependent variable of the regression model will be  
526 the average composite score (%) of the level of adherence to best-practice guidelines.  
527 Statistical significance will be based on a  $p$ -value of 0.05. Sensibility analysis will be  
528 conducted based on a selection of confounding variables related to the characteristics  
529 of the patient (e.g., length of stay, ICU readmission). The selection of these confounding  
530 variables will be based on the observed data and descriptive analysis. The residual  
531 analysis and the analysis of the  $R^2$  will be conducted to assess the goodness-of-fit of  
532 the multivariate linear regression model.

### 533 **Interpretation of the findings**

534 Consultations with clinicians and managers practising in postoperative cardiac surgery  
535 settings in Québec and Canada will be conducted to gain an in-depth understanding of

536 the findings. These consultations will allow our team to explore potential underlying  
537 factors and mechanisms which could influence the level of adherence to best-practice  
538 guidelines by interprofessional teams with and without ACNP. Field notes will be taken  
539 during these consultations and analyzed using content analysis (45). 



#### 540 **Ethical considerations**

541 Ethics approval was obtained prior to the beginning of the study. No identifying  
542 information will be collected during the content validation with the expert committee and  
543 the data collection within electronic databases and patient health records. A confidential  
544 pairing system will be created to match the patient identification with a random number  
545 (66). The database of the project will be kept in a secure server, protected by a  
546 confidential numeric code known only by the research team. During the dissemination of  
547 the findings, data will be shared in an aggregated form and the identity of the UHC, as  
548 well as the identity of the patients and clinicians, will remain confidential.

#### 549 **Discussion**

550 ACNPs hold an important place within interprofessional teams caring for patients and  
551 families following cardiac surgery. For patients and families, ACNPs contribute to the  
552 management of pharmacotherapy, clinical and psychosocial conditions, as well as  
553 lifestyle promotion and teaching of coping strategies. For interprofessional teams,  
554 ACNPs enhance ~~the~~ collaboration and communication among team members and  
555 reinforce continuity of care. Until now studies examined the efficacy of ACNP on patient  
556 and organization outcomes within postoperative cardiac surgery settings; however, less  
557 attention has been paid to underlying factors contributing to the effect of ACNPs on  
558 these outcomes. To the best of our knowledge, this study represents the first project to

559 examine the association between interprofessional teams with and without ACNP, and  
560 the level of adherence to best-practice guidelines in a postoperative cardiac surgery  
561 setting. As part of this project, a systematic review of randomized controlled trials was  
562 published to retrieve the current literature of the efficacy of ACNP and advanced  
563 practice nursing roles in postoperative cardiac surgery settings, and to examine their  
564 adherence to best-practice guidelines (40).

565 ~~Finally,~~ the findings of this study will further the understanding of the contribution  
566 of ACNP for interprofessional teams, clinicians and managers practising in  
567 postoperative cardiac surgery settings in Québec, Canada and **internationally**. This   
568 project will generate empirical data to support and document the practice of ACNPs  
569 within interprofessional teams. ~~Finally,~~ the extraction tool focusing on the level of  
570 adherence to best-practice guidelines by interprofessional teams in postoperative  
571 cardiac surgery will be available for the field of cardiac surgery research, and the  
572 scientific community more broadly. 

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#### 584 **Competing interest**

585 None to declare.

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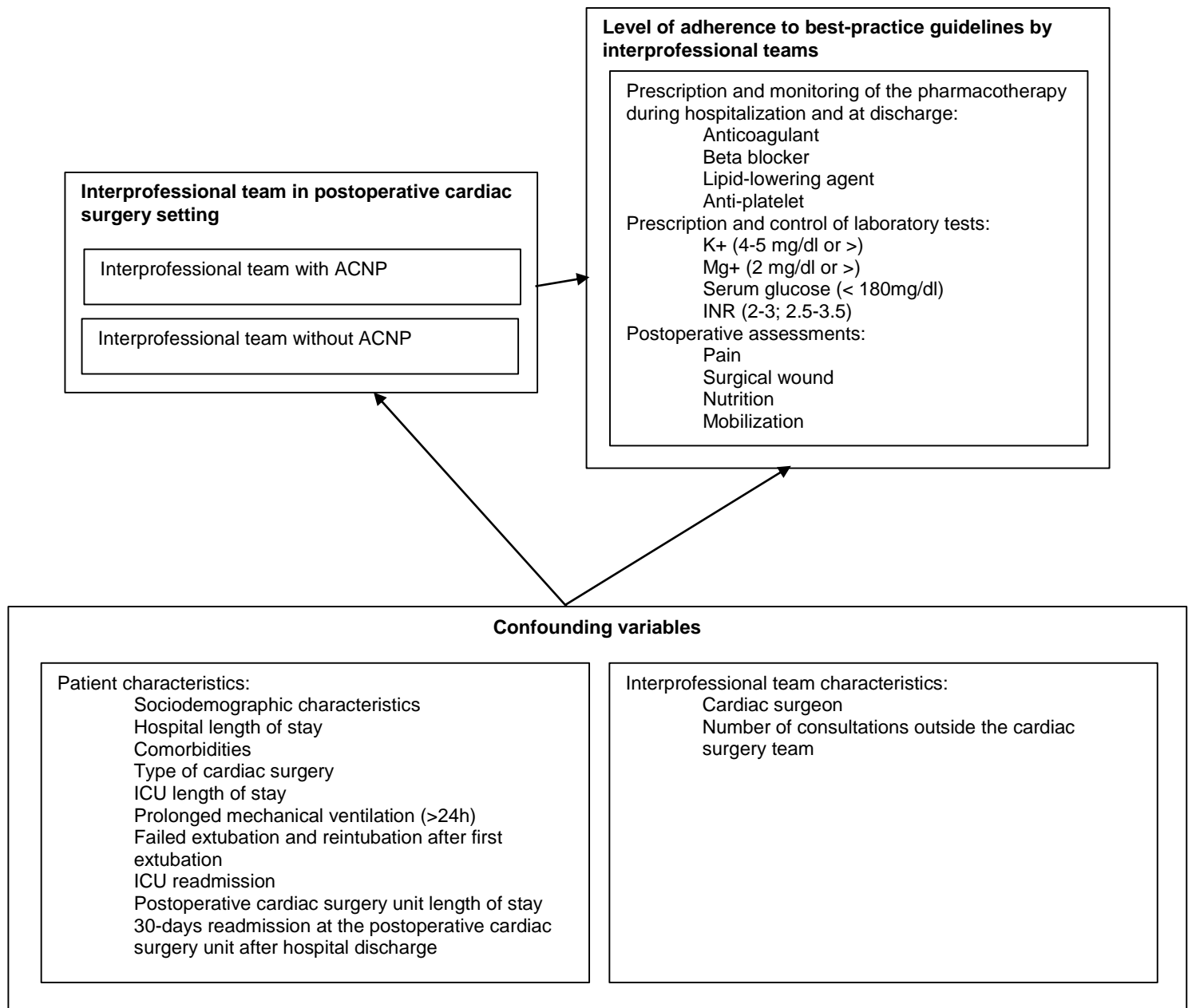
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**Figure 1. The confounding variables and the level of adherence to best-practice guidelines by interprofessional teams with and without acute care nurse practitioners in cardiac surgery**





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