

3.04 The retrospective matched controls design: right heart catheterization (RHC) dataset

NHS-R workshop no. 4 | February 2019

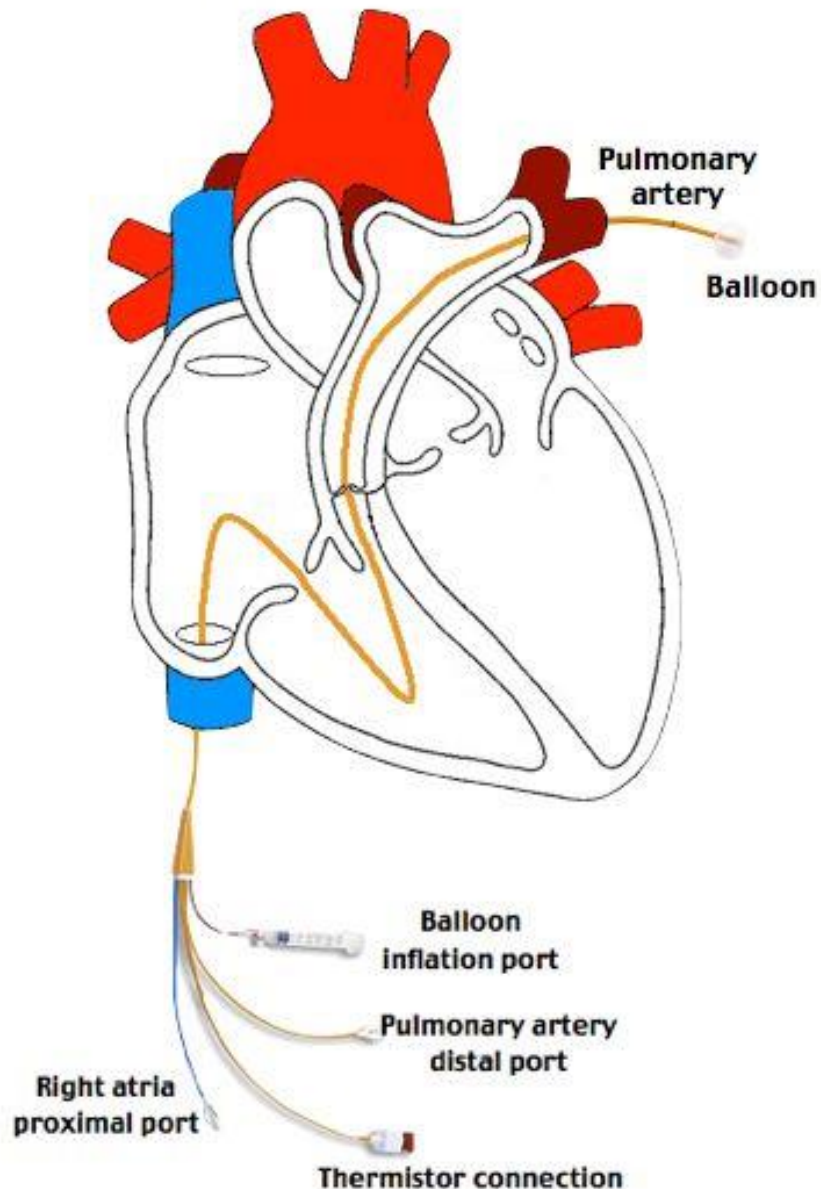


Midlands and Lancashire
Commissioning Support Unit

Swan-Ganz Catheter

(Pulmonary Artery Catheter)

Allows direct, simultaneous measurement of pressures in the **right atrium**, **right ventricle**, **pulmonary artery**, and **filling pressure** (wedge pressure) of the **left atrium**



Cardiac catheterization to measure blood flow was pioneered in the 1950s. The Swan-Ganz catheter (1970) extended its scope beyond simple diagnosis. Over the next three decades, RHC was accepted by the critical care community and was widely used in ICUs to direct therapy.

RHC dataset

Connors AF Jr, Speroff T, Dawson NV, *et al*. The Effectiveness of Right Heart Catheterization in the Initial Care of Critically Ill Patients. *JAMA*. 1996;276(11):889.

doi:10.1001/jama.1996.03540110043030

Right heart catheterization (RHC) dataset

Objective—to examine the association between the use of right heart catheterization (RHC) during the first 24 hours of care in the intensive care unit (ICU) and subsequent survival.

Design—Prospective cohort study.

Setting—Five US teaching hospitals between 1989 and 1994.

Subjects—A total of 5735 critically ill adult patients receiving care in an ICU for 1 of 9 prespecified disease categories.



What do you think about the
choice of study design

// While the benefit of RHC has not been demonstrated in a randomized controlled trial (RCT), the popularity of this procedure and the widespread belief that it is beneficial make the performance of an RCT difficult. Physicians cannot ethically participate in such a trial or encourage a patient to participate if convinced the procedure is truly beneficial.

Connors, 1996.



How would you decide on what variables to use for matching

// Before any analysis, a panel of 7 specialists in critical care (4 intensivists and 3 cardiologists) specified the variables that would relate significantly to the decision to use or not to use a right heart. These variables were then included in a multivariable logistic regression analysis. The logistic regression analysis was used to determine probability of RHC (from 0 to 1), the propensity score, for each patient in the data set.

Connors, 1996.



What variables do you think it would be important to match on

Variable Description	Variable Description	Variable Description
Patient ID	ADL	<i>Categories of comorbidities illness:</i>
Age	DASI (Duke Activity Status Index)	Acute MI, Peripheral Vascular Disease, Severe Cardiovascular Symptoms (NYHA-Class III), Very Severe Cardiovascular Symptoms (NYHA-Class IV)
Sex	DNR status on day 1	Congestive Heart Failure
Race	Cancer	Dementia, Stroke or Cerebral Infarct, Parkinson's Disease
Years of education	Support model estimate of the prob. of surviving 2 months	Psychiatric History, Active Psychosis or Severe Depression
Income	APACHE score	Chronic Pulmonary Disease, Severe Pulmonary Disease, Very Severe Pulmonary Disease
Medical insurance	Glasgow Coma Score	Chronic Renal Disease, Chronic Haemodialysis or Peritoneal Dialysis
Primary disease category	Weight	Cirrhosis, Hepatic Failure
Secondary disease category	Temperature	Upper GI Bleeding
<i>Categories of admission diagnosis:</i>	Mean blood pressure	Solid Tumour, Metastatic Disease, Chronic Leukaemia/Myeloma, Acute Leukaemia, Lymphoma
Respiratory Diagnosis	Respiratory rate	Immunosuppression, Organ Transplant, HIV Positivity, Diabetes Mellitus Without End Organ Damage, Diabetes Mellitus With End Organ Damage, Connective Tissue Disease
Cardiovascular Diagnosis	Heart rate	Transfer (> 24 Hours) from Another Hospital
Neurological Diagnosis	PaO2/FIO2 ratio	Definite Myocardial Infarction
Gastrointestinal Diagnosis	PaCo2	
Renal Diagnosis	PH	
Metabolic Diagnosis	WBC	
Hematologic Diagnosis	Hematocrit	Right Heart Catheterization (RHC)
Sepsis Diagnosis	Sodium	Death within 30 days
Trauma Diagnosis	Potassium	Study Admission Date
Orthopaedic Diagnosis	Creatinine	Date of Death
	Bilirubin	Date of Last Contact
	Albumin	Hospital Discharge Date
	Urine output	Death at any time during follow-up

Exercise 1: RHC dataset

RHC dataset

1. Load RHC dataset in R
`rhc <- readRDS("rhc.RDS")`
2. Load required packages
`library("tidyverse")`
`"zoo"`
`"Matching"`
`"tableone"`
`"survey"`
`"pROC"`

RHC dataset

1. Examine exposure (**swang1**) and outcome (**dth30**) variables
2. Identify numbers of cases (treated) and controls (untreated)
3. Compare unadjusted outcomes (i.e. crude death rates in cases v controls)
4. Examine some of the key patient characteristics (covariates) e.g. age, admission diagnosis, blood pressure etc.

Exercise 2: RHC dataset

RHC dataset

Experiment with different matching methods

Steps in matching methods

1. Define 'closeness' (distance measure for determining whether an individual is a good match for another)
2. Implement a matching method (for a given measure of closeness)
3. Assess quality of matched samples
4. ... iterate
5. Estimate the treatment effect (for a given matched sample)

Findings

The original analysis by Connors et al. used binary logistic model to develop a propensity score that was then used for matching RHC patients with non-RHC patients. A sensitivity analysis was also done. The results provided some evidence that patients receiving RHC had decreased survival time, and the sensitivity analysis indicated that any unmeasured confounder would have to be somewhat strong to explain away the results

Epilogue

Concerns were also expressed about the validity of the case matching—whether the patients were truly matched or whether there was an unrecorded factor that was influencing both the physicians' decision to place a right heart catheter and the patient's chance of survival. This is a methodological limitation of case-matching studies and can never be adequately answered with this study design.

“PAC-Man” study—first randomized controlled trial of the use of right heart catheterization in intensive care in the UK—subsequently showed no change in in-hospital mortality, suggesting it can be used safely.