Chapter 1

Introduction

Cardiac output (CO) is one of the key measurements of cardiac function. The importance of reliable information about CO for research into cardiovascular function can hardly be overstated. In addition, reliable information about CO could improve anesthetic monitoring and aid the clinical assessment of critically ill patients and those with cardiac abnormalities. Standard methods for determination of CO (thermodilution, dye dilution, Fick method) are time-consuming and require specialized equipment; as such they are only practical within a research setting. In addition, the thermo-dilution method is invasive, requiring placement of catheters into the right atrium and pulmonary artery. Such procedures are not without risk, as several authors have reported[1, 2]. A method for measuring CO quickly, easily, and non-invasively is needed in order to be able to apply knowledge of CO in both the clinical setting and in research which requires the investigator's attention to other, concurrent measurements or procedures.

M-mode echocardiographic calculation of stroke volume can be performed in a clinical setting with relative ease and economy of time, from standard menu options available on diagnostic ultra-sound units with cardiac capability. However, values obtained by these calculations in horses have not been compared with direct

volume measurements or with other indirect methods[a]. It is reasonable to expect that they will not be highly accurate, as the formulas used are based on geometric assumptions about left ventricular shape which do not hold true for the equine heart[3, 4]. However, preliminary investigations have shown them to be reasonably repeatable within a given horse, and as such, they may be useful for the detection of relative changes in CO.

Statement of the Problem

Although many studies of CO in horses have relied on M-mode echocardiographic measurements to calculate CO, such application has never been validated in the horse. Assumptions about the reliability of M-mode measurements have been made but not tested.

The overall objective of this investigation was to determine whether CO values derived from M-mode echocardiographic measurements of left ventricular internal diameter in systole and diastole (LVIDs and LVIDd) were sufficiently reliable to be used as a substitute for the thermodilution method of measuring CO.

Accordingly, the specific aims of the project were:

1. To implement use of a pharmacological protocol for inducing a range of CO, and to determine whether data obtained via the use of such protocol could be used in a method comparison study.
2. To determine the nature and strength of the relationship between simultaneous thermodilution and echocardiographic determinations over a range of cardiac outputs.

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[a] Young, L.E. Personal Communication. Animal Health Trust, Newmarket, Suffold, U.K., 1997.

3. To determine whether CO_{TD} could be reliably predicted from Co_{echo}.

4. To determine the bias between the two measurement techniques, if any.

5. To determine the extent of agreement between the two methods.

Overview

This dissertation begins with a review of the literature on various methods for determination of CO, with special emphasis on the methods compared in this report. Pharmacological information on the drugs used in this experiment is also reviewed. Chapter 3 describes efforts to induce a range of cardiac outputs in standing horses with our selected pharmacological protocol and to determine those cardiac outputs from simultaneous M-mode echocardiography and thermodilution (TD). These efforts had to be abandoned due to difficulties with subject movement, so data was analyzed to determine whether the results obtained in standing horses could be compared with that from an identical procedure in anesthetized horses. In Chapter 4, the pharmacological protocol is evaluated in anesthetized horses, to determine whether it would produce an adequate range of cardiac outputs for study, and whether it would interfere with comparison of the methods in any way. Chapter 5 presents an analysis of the simultaneous M-mode echocardiographic and TD CO determinations (CO_{echo} and CO_{TD}) in which the relationship between CO_{echo} and CO_{TD} is specified, and the use of

CO_{echo} to predict CO_{TD} is evaluated. In Chapter 6, the question of whether CO_{echo} can be used as a satisfactory substitute for CO_{TD} is addressed by method comparison analysis using the methods of Bland and Altman. Sources of the variability in CO_{echo} are also evaluated. Chapter 7 then summarizes the general conclusions of these studies.

Bibliography

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