Comparison Of One Minute Versus Five Minute Sampling Rate Of Physiologic Data

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Citation

Abstract

This study aims to evaluate possible differences in the values obtained by automated detection of hypertension, bradycardia and arterial blood oxygen desaturation between one minute and five minute automated recordings of physiologic data. The mean arterial pressure (MAP), heart rate (HR) derived from the radial pulse, and the arterial O2 saturation read by pulse oximeter (SpO2) were sampled continually in 20 patients undergoing general anesthesia. Anesthesia was induced and maintained using the same technique in all patients. Each parameter was automatically downloaded at one and five minute intervals to separate electronic spreadsheets. Hypertension was defined as MAP greater than 120 mmHg; bradycardia as HR lower than 50 bpm, and hypoxia as SpO2 < 95%. From the data presented we conclude that the five minute recording rate does not recognize the same number of clinical events as one minute recordings. This source of error must be considered when designing systems for computerized record keeping of anesthesia charts and when interpreting the data stored in electronic databases.

INTRODUCTION

Based on clinical convention and not science, the guidelines of the American Society of Anesthesiologists suggest that certain data should be recorded every 5 minutes on the handwritten anesthesia record. Data acquired by computerized systems is often recorded at one minute intervals [1][2], and even in presence of artifacts automated records have been reported to be more accurate than manual data charting [3][4]. However, the recording interval that best identifies clinically significant episodes is still obscure [2]. The aim of this investigation was to test the accuracy of two data sample rates against the recognition of three clinically significant episodes such as hypertension, bradycardia and hypoxia.

MATERIALS AND METHODS

Twenty patients scheduled for elective surgery requiring general anesthesia and endotracheal intubation were admitted to the study. Anesthesia was induced in the same fashion in all patients. Fentanyl 5 µg/kg was given initially, followed 1 min later by thiopental 3-5 mg/kg. Vecuronium bromide 0.1 mg/kg was administered at the end of the second minute, and endotracheal intubation was performed at the end of the fourth minute. Anesthesia was maintained using a series 5A circle absorber system and an OAV 7800 anesthesia ventilator (Ohmeda, West Yorkshire, England) to deliver O2, NO2, and isoflurane. Gas was sampled between the endotracheal tube and the Y-connector with an M1025B gas analyzer (Hewlett Packard, Palo Alto, California) to measure inspired and end-tidal O2 fraction, nitrous oxide, CO2 and isoflurane. Pulse oximetry and plethysmography were evaluated using an M1025B monitor (Hewlett Packard, Palo Alto, California). Before induction, the radial artery was cannulated for continuous measurement with an M1165A monitor (Hewlett Packard, Palo Alto, California) of arterial pressure and pulse rate.

The following parameters were studied: mean arterial pressure (MAP), heart rate derived from arterial pressure (HR) and oxygen saturation (SpO2). The monitor calculated beat-per-beat values for arterial pressure and heart rate and displayed the mean values over the previous two seconds on the screen. For pulse oximetry, the saturation value was calculated at each beat, and the monitor was programmed to display the mean value over the last 5 seconds

Data and analog wave forms were automatically downloaded from the monitor to a personal computer (Vectra QS7165, Hewlett Packard, Palo Alto, California) via an 8-channel RS-232C interface (M1810A, Hewlett Packard, Palo Alto, California). The computer sampled data from the monitors at

10 second intervals, displayed the data trends and wave forms on its video and generated the anesthesia record.

Every 30 seconds, the parameter mean values over the previous 1 min interval were recorded to a spreadsheet file (Excel, Microsoft Corp., Redmond, WA.). The spreadsheet also recorded the instantaneous value of the parameters read at the end of the 5 min recording period.

After recording the parameters for each patient, the wave forms of arterial blood pressure, and SpO2 were examined to check for artifacts in order to exclude charts with significant artifacts from the study.

Hypertension was defined as the presence of an MAP greater than 120 mmHg lasting more than 2 minutes. Bradycardia was defined as the presence of HR lower than 50 bpm lasting more than two minutes. Hypoxia was defined as the presence of SpO2 lower than 95% lasting more than 30 seconds. We tested the number of episodes of hypertension, bradycardia and hypoxia in two groups of data: the first group of data recorded at a rate of one per minute and the second recorded every five minutes. The differences in the mean number of clinically significant events in each group were then compared by the unpaired Student's t tests using the IMSL STAT LIB DTWOMV statistical package.

The study design had prior approval by the local Ethics Committee.

RESULTS

Automated records were free of significant artifacts during the periods studied; therefore none of the recorded data was excluded from the study.

The summary data recorded for MAP is reported in Table 1. The differences observed were quite remarkable in some patients and reached statistical significance between the two groups. Hypertensive events lasted 290 +/- 250 sec. (mean +/- Standard Deviation SD).

Table 1: Hypertension episodes (MAP > 120 mmHg) observed in 20 patients with two different sampling rate.

The summary data recorded for SpO2 is reported in Table 2. The differences observed were quite remarkable in some patients and reached statistical significance between the two groups. Hypoxemic events lasted 185 +/- 140 sec. (mean +/- SD).

Table 2: Oxygen desaturation episodes (SpO2 < 95%)

observed in 20 patients with two different sampling rate.

The summary data recorded for HR is reported in Table 3. Again, the differences observed were quite remarkable in some patients, but they were not statistically significant between the two groups. The bradycardia events lasted 125 +/- 66 sec. (mean +/- SD).

Table 3: Mean number of bradycardia episodes (HR > 50 b.p.m.) observed in 20 patients with two different sampling rate.

DISCUSSION

In order to faithfully reproduce the profile of rapidly changing physiologic data, they should probably be recorded at a rate greater than one per minute. However, large amounts of information are costly and unwieldy to handle, and thus it is preferable to record summary values that best represent the events occurring over the sampling interval. Based on the maximum rate of change of a parameter and the smallest variation we wish to detect, we can calculate how frequently data should be acquired and recorded [3].

This study demonstrates that there are significant differences between the single indices commonly used to summarize the clinical events occurring during anesthesia. The consequences of selecting an individual index may vary from loss of information to erroneous decisions based on the collected data. This concept was emphasized in a study that investigates the timing of the peak pressor response following endotracheal intubation, where the authors concluded that only continuous, beat-per-beat monitoring can reliably detect the hypertensive response to endotracheal intubation and that 1 min sampled data may miss important hypertensive episodes [5].

We limited this study to MAP, HR and SpO2. This does not imply that rapid changes do not occur in other physiologic parameters during surgery. Moreover, the type of data recorded influences whether these events are identified or missed. If the values are stored in a database, for quality assurance or as a basis for analyzing individual incidents, it is imperative that data accurately reflect the underlying events.

There are additional factors which can influence the validity of the recorded data [6]. The digital values are derived from analogue signals. The monitor we used adopts an averaging process to code the digital value, and consequently the extent of averaging will determine the degree of dependence of the

data recorded. To minimize this effect, we chose the shortest possible averaging interval available on the monitor.

The quality of data archived by automated recording of physiologic parameters has been questioned in the literature [3] [5] [7]. Though data recorded by computerized anesthesia records has been shown to be more precise than manually charted records, we must not conclude that automated charting inevitably provides an exact profile of the underlying physiologic parameters. Sampling rates of one per minute can detect many important clinical events and complications, but higher rates may be required to accurately depict certain clinical situations. For example, downloading data at intervals of at least 12 seconds provides reliable trends for cardio-respiratory parameters [8].

In conclusion, our findings indicate that saving physiologic data at one and at five minute intervals yields different information on the physiologic parameters considered.

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