Journal of
Health & Medical Informatics

Maeda, J Health Med Informat 2014, 5:3
DOI: 10.4172/2157-7420.1000157

Research Article Open Access

Medical Electronics Story

Kazuo Maeda*

Department of Obstetrics and Gynecology (Emeritus), Tottori University Medical School, Yonago, Japan

Abstract

Aims: To clarify past history of medical electronics to further promote the studies on medical engineering.

Methods: The hand-made medical electronic devices in obstetrics and gynecology were described with their circuits in vacuum tube age, transistor age, integrated circuit (IC) and large scale integration (LSI) ages then customized computer age have been experienced.

Results: EEGs were studied to clarify abnormal brain function of eclampsia. The ECG deteccted abnormal cardiac function before gynecologic operations. Fetal diagnosis shifted to fetal heart rate monitoring because of insufficient detection of fetal distress by fetal electro-and phonocardiograms. Simultaneous Doppler fetal movement records and fetal heart rate highly clarified the pathologic process of asphyxia by using actocardiogram. Maternal, fetal and neonatal medicine was highly improved by the electronics devices in every progress stage.

Conclusion and recommendation: The physicians and researchers must ask the supply of necessary complicated devices instead of their hand-making at present.

Introduction

This report will be a funny story, where medical electronic devices were hand-made by a young medical doctor around 1950 in Japan immediately after the Second World War, in the young Doctoral Course researcher, 24 years old K Maeda, in Kyushu University, Faculty of Medicine, who selected his doctoral thesis to study the electroencephalogram (EEG) of convulsive eclampsia disease, which was an important heavy disease in Obstetrics department [1], despite there was no commercial EEG machine in Japan, nor the possibility to import it from foreign country due to the poverty of Japan after the war, thus the EEG machine must be produced by the researcher himself. Fortunately it was a fashion to make it by his friends in psychiatric and pharmacologic departments in the medical school. The author enjoyed the productive works with his friends. The electronic element was vacuum tube at first, and changed to transistor, then integrated circuits and so on, in later ages.

Methods and Results

Vacuum tube age

The EEG amplifier was composed of vacuum tubes, which were selected in the guide book on the character of vacuum tubes: they were 6F5-6SL7-6SL7-6SN7-6V6 in the construction of EEG amplifier inserting 60 Hz removing filter to prevent AC hazard. The 6F5 tube was selected by its very low input noise, 6SL7 by its high gain in twin triodes. Two 50 volts and a 6 volts rechargeable batteries were the power supply. Two channel straight amplifiers were provided to record two channel EEGs at frontal and occipital regions (Figure 1). Amplifier action was checked by a magic eye tube, which twincled by the 10 Hz alfa EEG waves, which was the tuning monitor in the radio, utilized instead of oscilloscope. The shield cage, which covered patients to protect from AC hazard, was also built by Maeda by using aluminum plates. The EEG was recorded by Yokogawa electromagnetic recorder and light-sensitive paper, which was developed in the dark room. Recorded EEGs are displayed in the (Figure 2) and they were reported in the first meeting of Japan Society of EEG [1]. A broken Siemens ECG machine was found in Obstetrics and Gynecology department Kyushu University hospital, of which DC drive vacuum tube filaments were broken. Maeda repaired the machine with two amplifiers, one constructed by 1.5V DC filament vacuum tube (Figure 3), another one of 6V cathode heater tubes. They were hand-made and used for preoperative patient examination. The time constant of amplifier was 2.0 sec to correctly study the ST segment of ECG. Also 3 channel vacuum tube ECG amplifier was produced by Maeda for preoperational check (Figure 4). Its recorder was electromagnetic vibrator system. The system was improved afterwards using the differential input amplifier, ink-writing and heat-pen recorder.

Transistor age

Vacuum tube age was transitional and changed over to the age of broad transistor application including fetal surveillance, e.g. fetal heart sound listner (TOITU,Tokyo) (Figure 5), which was composed of a low impedance-microphone, step-up transformer, transformer

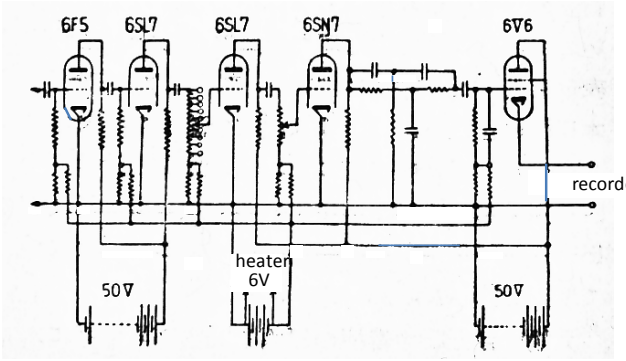

Figure 1: Maeda's EEG amplifier circuit.

***Corresponding author:** Kazuo Maeda, Department of Obstetrics and Gynecology (Emeritus), Tottori University Medical School, Yonago, Japan, Tel: +81-859-22-6856; E-mail: maedak@mocha.ocn.ne.jp

Received May 12, 2014; **Accepted** May 17, 2014; **Published** July 05, 2014

Citation: Maeda K (2014) Medical Electronics Story. J Health Med Informat 5: 157. doi:10.4172/2157-7420.1000157

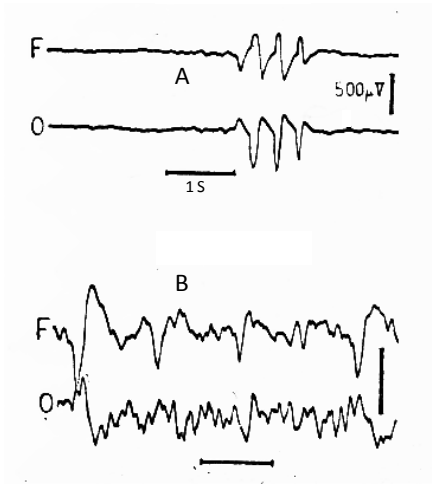

Figure 2: EEGs in two eclampsia cases. F: frontal, O: occiptal A: Seizure waves in the coma. B: Delta waves in the coma.

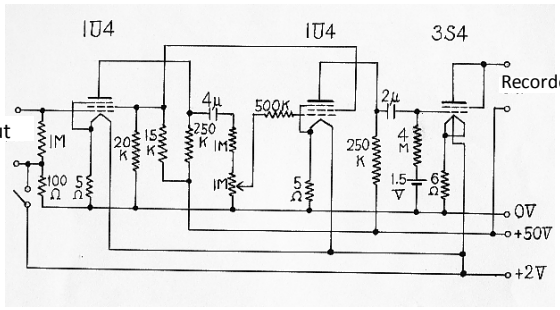

Figure 3: DC drive ECG amplifier produced by Maeda.

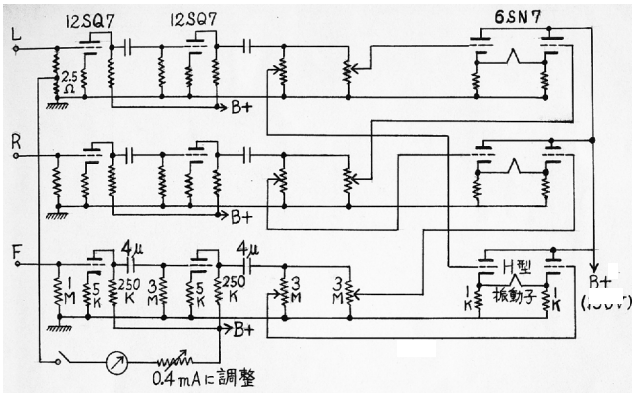

Figure 4: Three ECG leads' vacuum tube amplifier. L: left arm, R: right arm, F: left foot. H: type H vibrator of recorder. Direct current of 0.4 mA is for 1 mV calibration.

coupled transistor amplifiers and large speaker, which covered such low frequency of fetal heart sound as 60 Hz. The amplifier was also the fetal heart sound preamplifier in the fetal heart rate recorder.

A high pitched transistorized small fetal heart beat listener was hand-made by Maeda, which oscillated 1,000 Hz sound by fetal heart sound signals. It was small and portable, highly sensitive to the ear, no howling, easy listening, easy recording by common voice recorder, and transmitted by telephone (Figure 6). No abnormality was listened in an anemic fetus, but the sinusoidal heart rate appeared when the reproduced signals recorded on a tape were processed by a fetal heart rate monitor and revealed the sinusoidal heart rate. Although the fetal heart beats were the most clearly listened, the fetal heart beats listening was unable to detect abnormal fetal heart rate. Thus, the machine was not commercialized.Fetal phonocardioram was studied using three frequency characteristics in a Maeda's handmade transistorized amplifier (Figure 7), where fetal systolic murmur was recorded in 17% of normal pregnancy, which was not detected after the birth [2]. The systolic murmur was supposed to be caused by the blood flow of ductus arteriosus. If so, the murmur is caused by a physiologic blood flow.

The age of integrated circuits

Various integrated circuits (IC) and large scale integration (LSI) were commercialized, e.g. amplifier, filter, multi-vibrator, Schmitt-trigger, flip-flop, which were conveniently utilized in hand-made production of medical electronic devices.

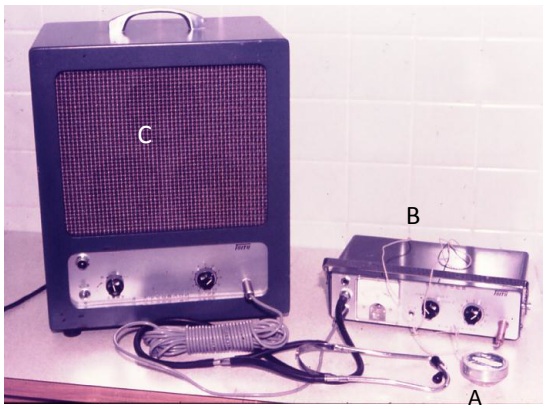

Figure 5: Transistorized fetal heart sound listener machine (TOITU, Tokyo). No shield wire was used in microphone due to its low impedance. A: microphone, B: re-amplifier, C: speaker.

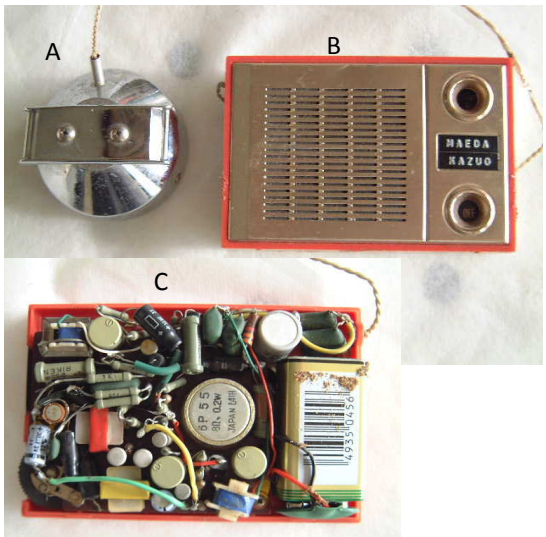

Figure 6: High-pitched fetal heart sound listener. A: microphone, B: outside, C: inside Maeda's hand-made device using the case and speaker of a transistor radio.

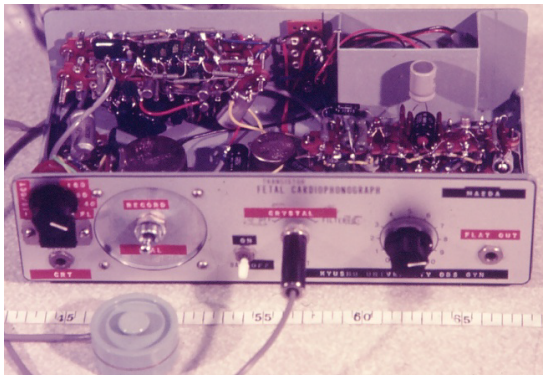

Figure 7: Maeda's hand-made transistorized fetal phonocardiographic amplifier, which prepared 40, 80 and 160 Hz high-pass filters.

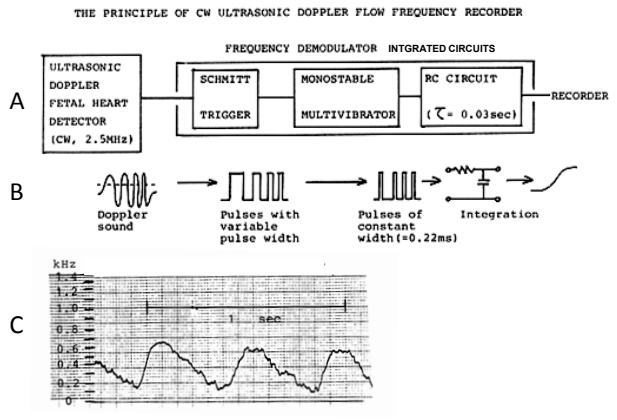

Figure 8: Frequency demodulation composed of integrated circuits (A,B) to record world first umbilical arterial blood flow wave C) using CW ultrasound Doppler method .

Actually, world-first CW Doppler umbilical arterial blood flow wave was recorded in 1968 by Maeda using the output CW Doppler signal of Doptone and the hand-made frequency demodulator composed of some ICs (Figure 8) [3]

Customized board age at present

The customized circuit is programmed by specialists, and made up to a real boards by the engineer to produce various electronic devices, micro-computer, personal computer or large scale computer, which are composed of many boards with several ICs, LSIs, central processing unit directly attached on the board and wired on it. Users work only by using completed machines, but do not produce the electronic machines by themselves. Even simple regression equations are allowed to program with BASIC only in the past SHARP pocket computer PC1261 series (SHARP, Tokyo).

Reduced mortalities of mother, fetus, neonate and the reduction of cerebral palsy

The reduction of maternal and neonatal mortalities were 1/3 in the 50 years in home deliveries in Japan between 1900 and 1950, while maternal and neonatal mortality reduced to 1/40 in hospital deliveries in Japan between 1950 to 2010, due to the progresses of medicine and medical care including the progress in medical electronics [4,5]. Infantile cerebral palsy significantly reduced to 1/3 or less after the wide use of fetal heart rate monitoring by CTG and ACG after 1980 in Japan [6-8].

Discussion and Conclusion

The vacuum tube preamplifier for the fetal abdominal ECG attached to adult ECG recorder, neonatal respirograph [9], fetal actocardiogram which was simultaneous FHR and fetal movement recorder [10], the IC data recorder preamplifier attached to common voice recorder and so on were other hand-made products of the author which were created because they were mandatory to the research but they were rarely provided by the manufacturer. Since researches progressed, medical devices are complicated, safety regulation is severe, hand-making is not allowed at present. Medical doctors and researchers must ask manufacturers and engineers to provide newly progressed products, which are mandatory in the medicine and research.

References

1. Maeda K (1954) Electroencephalographic investigations on the eclampsia and preelampsia. J Jap Soc Obstet Gynecol 6: 75-99.
2. Maeda K, Nakano H (2013) Systoliv fetal heart murmur in fetal pooardiogaphy. Occup Med Health 1:101.
3. Maeda K, Kimura S, Nakano H, et al. (1969) Pathophysiology of Fetus, Fukuoka Printing, Fukuoka. The 21st Ann meeting, Japan. Obstet Gynecol Soc.
4. Maeda K Highly improved perinatal states in Japan. (2014) J Obstet. Gynecol. Res, In press.
5. Maeda K (1998) why the perinatal mortality rate in Japan is very low: message to European perinatologists. In A Kurjak (eds) Textbook of Perinatal Medicine, UK.
6. Maeda K (1979) Healthy baby and reduced fetal death by improved obstetric management. Proceedings of the 1st ASIA Oceania Congress of Perinatology, Republic of Singapore.
7. Tsuzaki T, Sekijima A, Morishita K,Takeuchi Y, Mizuta M, et al.(1990) The survey on the perinatal variables and the incidence of cerebral palsy for 12 years before and after the application of the fetal monitoring system. 42: 99-105.
8. Takeshita K, Ando Y, Otani K, Takashima S. (1989) Cerebral palsy in Tottori Japan. Neuroepidemiology 4: 184-192.
9. Maeda K (1954) Neonatal respirograph.World Obstet Gynecol (Japanese) 6: 527-528.
10. Maeda K (1984) New ultrasonic Doppler fetal movement recorder and its clinical studies. J Jap Soc Obstet Gynecol 36: 280-288.