

# A Humerus Arterial Bleeding Simulation Model for Hemostasia

Aijuan Ni, Qiuming Sun, Feng Tian, Gaofeng Wei, Jian Yang, Changjun Liu

Institute of Medical Equipment Academy of Military Medical Sciences, Tianjin, China

Email: niba1203@163.com

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## ABSTRACT

In our daily life, accident would happen with arterial haemorrhage, and death would be brought out by continuous arterial bleeding for little time if emergency has not been implemented in time. This paper presents a humerus arterial bleeding simulation model (HABSM) for hemostasia, which has a high-fidelity, practical model for the humerus arterial hemostasia operation that is not only for the surgeons and nurses, but also for commons in urgent bleeding accident. The functional components of HABSM are arm model, fluid circulated pipeline and circuit controlling system. The arm model is made of elastic material as human muscle. Fluid circulated pipeline contains wiggly pump, inlet pipe and outlet pipe. And circuit controlling system has single chip micropy system (SCM), keyboard, pressure sensor and vision circuit. SCM controls pump and valve to realize humerus arterial blood circulation. Both surgeons and commons thought well of HABSM which provided a task trainer for humerus arterial hemostasia.

**Keywords:** Haemorrhage; Hemostasia; Simulator; Humerus Arterial Pressure

## 1. Introduction

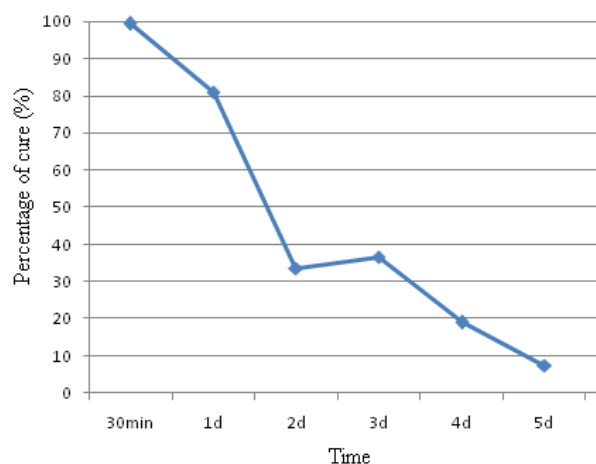
Hemostasia is one of the most important emergency skills. If bleeding wound could be managed immediately in effective hemostasia method, the death in bleeding accident would have drop to a lower rate (Relation between cure time and survived percentage in Tangshan earthquake, see **Figure 1**). Given the importance of valuable cure humans should master emergency hemostasia. Hence, in the accident, prompt and proper operation would be carried out by yourself or others beside you not only by the surgeons and nurses faraway, so that we would have gained precious time for the wounded. The ability to hemostasia correctly is thought to master with practical operation. To date, this training relies heavily on the actual injured patients that commons couldn't have practical opportunities to operate on [1]. Because the act of emergency hemostasia is a separate and valuable skill, we would present an equipment of HABSM that allows the arm humerus arterial hemostasia of high-fidelity blood pressure. With such a simulator model, hemostasia training could be accomplished without subjecting a patient to possible discomfort and offering a reduplicate environment with bleeding arm.

In this technical report, we describe our attempts to create a simulator model with fluid circulated pipeline and circuit controlling system. We introduced arm model, fluid circulated pipeline and circuit controlling system

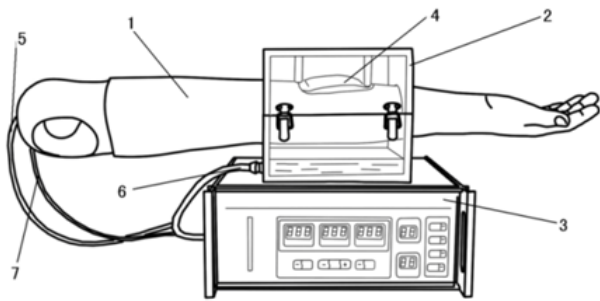
respectively in detail and the relationship among them. When developed as described the simulator model can act as a high-fidelity HABSM that allows participants even with no medical knowledge to learn the emergency skill and to practice the hemostasia.

## 2. Methods

As we can see configuration in **Figure 2**, there were an arm model, a complex box and a fluid reservoir. First, Arm model had arm, outlet pipe, pressure sensor and



**Figure 1.** Relation between cure time and survived percentage in Tangshan earthquake.



**Figure 2. Components of HABS. 1: arm; 2: fluid reservoir; 3: circuit controlling box; 4: displaceable wound; 5: outlet pipe; 6: inlet pipe; 7: pressure detector joined pipe.**

pressure detector joined pipe. The arm model supplied our elastic requirement as human muscle is developed by agent factory with episplastic materials and technique. Embedding a lower elastic plastic pipe in the arm model, wiggly pump in complex box outlet fluid through this outlet pipe. The outlet pipe joined with complex box by two access interface accessory. In the 1/3 of top arm, Pressure sensor of ME501 (Metallux Electronic, 752 mmHg in measurement) could detect exactly to control the inlet power of pump of the fluid circulated pipeline.

Second, in the complex box, there were single chip micropy system (SCM), vision circuit of circuit controlling system and wiggly pump, inlet pipe of fluid circulated pipeline inside, keyboard front, interfaces of outlet pipe, pressure detector joined pipe, power supply and other accessorial functions (e.g. Interfaces of computer and printer) back. As the core of SCM, the single chip C8051f330 has AD module, amplified and lower filtered pressure sensor signal that was inlet simulate signal; The wiggly pump outlet 2 - 3 L/min was direct current in function and was controlled by C8051f330 outlet PWM signal with photoelectricity isolation and power amplification to realize pipe outlet 1 - 2 L/min [2]. The keyboard and vision was realized by I/O interface of C8051f330. In this paper, we mainly introduced the simulated blood circulation function referred to humerus arterial pressure fidelity; keyboard and vision circuit wouldn't be presented in detail.

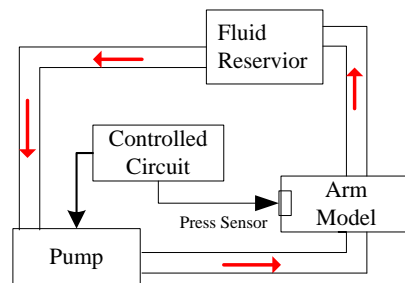
At last, the fluid reservoir was used to gather the outlet fluid from the interface access and to inlet the fluid into the wiggly pump through inlet pipe of complex box joined with fluid reservoir, so that fluid circulation was developed. **Figure 2** shows that to avoid any fluid leakage into the interior compartment of the complex box, reservoir and interfaces of inlet pipe and outlet pipe were placed outside it.

To develop humerus arterial pressure fidelity, we introduced that the three primary functional components of the model were the arm model, fluid circulated pipeline and circuit controlling system. The arm model has been

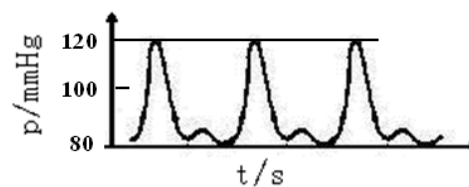
presented before. The fluid circulated pipeline was made up of pump and fluid reservoir. **Figure 3** shows that the fluid in the reservoir flowed into the pump, and out of the altered flowing velocity. When it came into the arm model participants played an operation on, the hemostasia pressure was detected and the pump was controlled to open in which size of power or close.

Though there was different arterial pressure among human beings. Given more referred conditions of arterial pressure [3], we chose a range of standard curve of humerus arterial pressure referred to the physiology in **Figure 4** [4]. According to the standard data of the curve, **Figure 5** shows that we produced simulation humerus arterial pressure curve consulting with physiologist teaching physiology in medical college. The cycle time of arterial fluctuation was supposed to be 60 times/min [5]. The correlation between voltage of y-axis and the arterial pressure was linear, and linearity coefficient was 1. So that, the arterial pressure quantity was calculated easily.

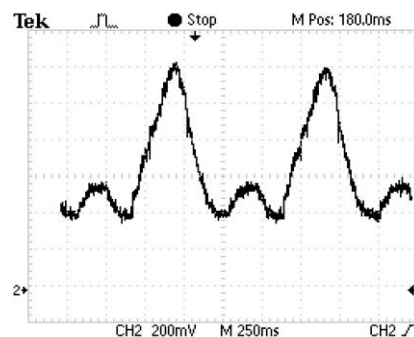
Above all, primary functions were accomplished and humerus arterial pressure was performed well.



**Figure 3. Frame of fluid cycle pipe.**



**Figure 4. Curve of humerus arterial blood press.**



**Figure 5. Curve of outlet pipe.**

### 3. Results

This HABSMM seems to perform well as a task trainer for the humerus arterial hemostasia. Almost all participants agreed or strongly agreed that the HABSMM presented a well work for them during their training. All simulation participants enjoyed the method to practice emergency humerus arterial hemostasia, whereas one common participant of our research institute was neutral.

The total statistic results are given in **Table 1**. All emergency experts agreed or strongly agreed that emergency humerus arterial hemostasia was an import skill to practice during HABSMM. Nine of 20 participants (4 experts and 5 common participants) strongly agreed that the HABSMM performed well. Ten of 20 experts agreed that HABSMM worked well in high simulation fidelity of humerus arterial hemostasia and would be a wonderful teaching task trainer.

### 4. Discussion

Emergency hemostasia is one of the most important skills of the emergency skills in accident or at war. Accident happened with arterial haemorrhage at 30% to bring on death or deformity. At war, according to the statistical data in the local war after Second World War, death under shield are produced by plentiful haemorrhage at 30% - 60%; and 50% deaths could be saved [6]. However, the wounded are dead on arrival as a result of no operation hemostasia in time. So that, we should master the emergency hemostasia skill to save the haemorrhage wounded. This HABSMM offer a unique opportunity to practice valuable procedures in a simulated environment that does not subject patients to potential discomfort or harm. This high-fidelity, practical model provides an opportunity to operate humerus arterial hemostasia.

**Table 1. The proportion of answers to each response to the statement: "This model would be a useful teaching Tool to learn the humerus arterial hemostasia". (n = 15, 5 emergency experts emergency experts in 120 of Tianjin, 10 common participants of our research institute).**

Response	Proportion of Response (%)
"Strongly Agree"	45(n = 9)
"Agree"	50(n = 10)
"Neutral"	5(n = 1)
"Disagree"	0(n = 0)
"Strongly Disagree"	0(n = 0)

In an attempt to provide a high-fidelity arterial hemostasia model, Lateral Medical develops broken limbs (381550) which provide haemorrhage apparent wound in fidelity, but it doesn't provide neither arterial hemostasia pressure in fidelity, nor the operation opportunity in practice. Our simulation model has managed above limitations and worked well according to the responses of participants.

In future work, we aim to extend more kinds of wound to simulate various injuries contains either gun wound or earthquake wound etc. Given agreeable responses of the participants, femoral arterial haemorrhage model can be developed to extend the simulation task. The femoral arterial haemorrhage would provide different simulation models, different pressure parameters, but the element is the same as HABSMM.

Ultimately, we aim to provide simulation tasks to induce the emergency haemorrhage wound or death, and participants to operate humerus arterial hemostasia without thinking of mistaken results of improper operation on patients. Hence, participants would advance the arterial hemostasia skill at ease.

### 5. Acknowledgments

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