

# DEVELOPING LOW-COST MANNEQUIN FOR UNDERGRADUATE IV LINE PHLEBOTOMY

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## ABSTRACT

**Background:** Skills laboratory training had been providing students the opportunity to practice medical skills in a longitudinal education curriculum with various methods. The integration of skills lab learning methods and the use of mannequins could provide the students to practice invasive medical procedures on patients like the real condition in the clinical setting, but still remains a safe simulation. However, simulations in the skills lab require commercial mannequins that have been imported with limited design options and very expensive prices. The effect of this expensive training will hamper institutions to facilitate students' learning. Therefore, Clinical Skills Laboratory, Faculty of Medicine, Universitas Gadjah Mada had initiated to produce low-cost and innovative mannequins. This study is aimed to develop low-cost mannequin in order to facilitate learning.

**Methods:** This study is a comparison study to 3 types of simple infusions mannequin which will be attached to simulated patients. These 3 types of mannequin are based from the materials: silicone, silicone plus oil, and latex. There were three groups of respondents: 30 students, 15 teachers, and 15 simulated patients and were randomly invited to review those mannequins using a questionnaire and structured interviews. The data were analyzed using Mann-Whitney test and an "inductive content analysis".

**Results:** The low-cost mannequins were highly accepted by the respondents and the best mannequin was made from silicone ( $p < 0.05$ ). However, the mannequins need improvement on the skin design and the prevention of fluid leakage from the pumps and tubes. These mannequins were designed to stimulate undergraduate students not only to practice inserting needle to veins, but also learning how to communicate with patients at the same time.

**Conclusion:** These low-cost mannequins can be used to practice integrated clinical skills in skills laboratory education. However, the mannequins should be evaluated and improved regularly.

**Keywords:** low-cost, local, mannequin, clinical skills, undergraduate medical student

## ABSTRAK

**Latar belakang:** Pendidikan laboratorium keterampilan klinis memberikan kesempatan bagi mahasiswa untuk mempraktikkan kurikulum pendidikan dengan berbagai macam metode. Integrasi metode pembelajaran laboratorium keterampilan klinis dengan penggunaan manekin dapat membantu mahasiswa dalam mempraktikkan prosedur kedokteran invasif pada pasien seperti dalam kondisi sebenarnya dalam latar klinis, tetapi masih dalam suatu simulasi yang aman. Namun, simulasi di laboratorium keterampilan klinis memerlukan manekin komersial yang diimpor dengan pilihan desain yang terbatas serta harga yang sangat mahal. Efek dari pelatihan yang mahal ini adalah terbatasnya institusi dalam memfasilitasi pembelajaran mahasiswa. Oleh karena itu, Laboratorium Keterampilan Klinis, Fakultas Kedokteran, Universitas Gadjah Mada telah memulai memproduksi manekin dengan biaya rendah yang inovatif. Penelitian ini bertujuan untuk mengembangkan manekin biaya rendah untuk memfasilitasi pembelajaran.

**Metode:** Penelitian ini membandingkan 3 jenis manekin infus sederhana yang dapat dilekatkan pada pasien simulasi. Ketiga jenis manekin ini adalah manekin yang berbahan silikon, silikon dengan minyak, dan latex. Terdapat tiga kelompok responden, yaitu 30 orang mahasiswa, 15 orang dosen, dan 15 orang pasien simulasi, lalu ketiganya diundang secara

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acak untuk mengulas manekin-manekin tersebut menggunakan kuesioner dan wawancara terstruktur. Data dianalisis menggunakan uji Mann-Whitney dan "inductive content analysis".

**Hasil:** Manekin biaya rendah diterima dengan sangat baik oleh responden dan manekin terbaik adalah yang terbuat dari silikon ( $p < 0,05$ ). Namun, manekin perlu perbaikan pada rancangan kulitnya serta pencegahan kebocoran cairan dari pompa dan selangnya. Manekin-manekin ini dirancang untuk menstimulasi mahasiswa S1, tidak hanya untuk mempraktikkan memasukkan jarum ke dalam vena, tetapi juga belajar bagaimana berkomunikasi dengan pasien di saat yang sama.

**Kesimpulan:** Manekin biaya rendah ini dapat digunakan untuk mempraktikkan keterampilan klinis terintegrasi dalam pendidikan laboratorium keterampilan klinis. Akan tetapi, manekin harus dievaluasi dan terus diperbaiki.

**Kata kunci:** biaya rendah, lokal, manekin, keterampilan klinis, mahasiswa kedokteran

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## INTRODUCTION

Skills laboratory/training has an important role to train undergraduate medical students in medical skills in order to achieve competency standards.<sup>1</sup> Several studies have shown that learning medical skills in labs can enhance learning motivation, confidence level, and prepare students for clerkship.<sup>1,2</sup> Skills lab training is a way to practice medical skills in a safe, simple, and more controlled learning environment. A medical procedure can be done many times safely without the fear of injuring a patient.

Skills laboratory/training had been providing students the opportunity to practice medical skills in a longitudinal education curriculum with various methods. Those learning methods include the practice with a mannequin, a friend/peer, a simulated patient, and a direct practice in the community.<sup>3</sup> Students are taught clinical skills by an expert/trained instructor mastering in certain medical skills. Each topic is given with different methods according to the characteristics of the subject taught. For topics that tend to be safe, such as communication skills and basic physical examination, students can practice with friends/peers as well as with simulated patients. For the topic that requires exposure to real life, students can directly go into the community under the supervision of a field supervisor. Students also are required to practice with the mannequins for skill topics that are likely invasive or contrary to ethics and local culture.

Skills laboratory for practicing procedural and technical skills requires a mannequin. Currently,

skills laboratory mannequin is produced and manufactured in overseas so that the choice of design is limited and the price is very expensive. Many medical institutions in Indonesia cannot afford to buy such commercial mannequins. If they are able to buy them, they will only buy one or two. Nevertheless, it will be used by hundreds of students, so that the mannequin is easily damaged and very short-lived. Seeing this problem, there should be a solution for the procurement of cheap mannequins with custom designs in accordance with the needs of undergraduate students in practicing medical skills.

Providing above issues, the integration of Skills Lab learning methods with the use of simulated patients and the use of mannequins can be an alternative solution. With the integration of these methods, students can practice applying invasive medical procedures on patients like the real condition in the clinical setting, but still remains in a safe simulation. Furthermore, students' opportunity to communicate directly with the patient is expected to provide more stimulation to the students to be able to empathize with the patient and quickly achieve medical skills competence.<sup>6,7</sup> Therefore, this study aims to inspire all Skills Lab managers in Indonesia to begin their own production of locally-made mannequins with custom designs and cheaper price in accordance of the needs in their own institutions. This study also aims to explore the advantages, disadvantages, and suggestions to improve those low-cost, locally-made mannequins.

## METHODS

In 2015, realizing the great urgency to meet the number and types of mannequins used to practice in the Skills Lab with the condition of limited funds whereas the imported mannequins are very expensive and almost all the mannequins have been damaged through extended use, through this article we will share the experience of Faculty of Medicine, Universitas Gadjah Mada (FM UGM), Yogyakarta, Indonesia in developing a prototype program to produce low-cost, locally made mannequins that is expected to be initiated by other institutions.

Firstly, the mannequins were produced by the Clinical Skills Laboratory in collaboration with Bengkel Anatomi of FM UGM, Yogyakarta, Indonesia. The mannequins were produced using a simple technology by making skins and tubes (as the blood vessels), which can be wrapped around the arm of a simulated patient.

The production of this IV line mannequins incorporates three components, for instance the skin, blood vessel pipes, and pumping blood bags. In this study, the manufacturing process of from 3 different materials (pure silicone, silicone plus oil, and pure latex) was not very different. First, the liquid (molten pure silicone + catalyst, silicone plus oil, and pure latex) was printed on a mold. Second, after waiting until the molten material was completely dry, we taped a streaming fabric onto the mannequin to hold the aluminum plate used as a pipe holder. Drying process was done naturally by using the sun heat because the use of an oven would be too hot and it might break or burn the skins. Finally, an adhesive fabric was sewn onto the skin. This sewing process used manual methods because the skins were thick and slippery, so it could not be sewn with a sewing machine. Meanwhile, the pumping blood bags were made by attaching a device (simple pump) to a bottle used as a blood bag that could be set to put pressure in the blood vessel tube. During the manufacturing process of the mannequins, difficulties were experienced only in the making of skins from pure latex. It took a long time due to the repeated printing and layering that were required, up to 7 times which took 1 week in minimum.

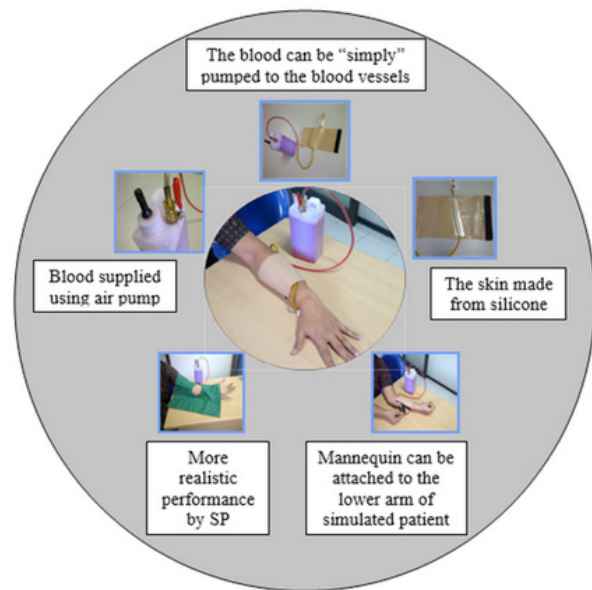


Figure 1. Intravenous insertion mannequin attached to a simulated patient

Once the mannequins were ready to use, a preliminary study was conducted by involving students, instructors, and simulated patients of FM UGM's Skills Lab. Three groups of respondents: 30 students ( $n_s = 30$ ), 15 instructors ( $n_i = 15$ ), and 15 simulated patients ( $n_{sp} = 15$ ) were randomly invited to review those mannequins using a survey questionnaire, which consists of seven questionnaire items: similarity with the original/standard, ease of use, reliability of functions, suitability with the objective of learning, integration with simulated patients, ability to stimulate students to practice and levels of durability and preservation ease. Those items were scored with a four-tiered rating scale which included very low, low, good, and very good.

Structured interviews were conducted by the research team by providing written questions with open-ended questions whose contents are advantages, disadvantages, and suggestions for the improvement of the mannequin both in the design and materials.

Thematic coding/analysis was completed by the principal investigator and skills lab instructor. The results were given back to the respondents for a member checking process. The data were analyzed using Mann-Whitney test and using inductive content analysis.<sup>8</sup> In this case, the quantitative data were

analyzed by comparing each group of respondents' average scores with descriptive analysis.<sup>9</sup> The object of this research is the Skills Lab mannequin and the evaluation has become a regular program in Skills Lab FM UGM so it does not require ethical clearance.

**RESULTS AND DISCUSSION**

*The evaluation of IV line mannequins*

The mannequin material considered the best by all respondent was the one made from pure latex material (Table 1). The results of the survey questionnaire showed that IV line mannequins on average were rated good by all respondents (Table 2).

Table 1. Respondents' assessment results of the best IV line mannequin skin material

Mannequin's Material	Frequency	%
Pure silicone	12	21%
Pure silicone & silicone	1	2%
Silicone	17	30%
Pure silicone & pure latex	2	5%
Pure latex	23	41%

Table 2. Respondents' assessment results of IV Line mannequin's quality

Items	Assessment (%)			
	Very low	Low	Good	Very good
Similarity with the original/standard	-	19,7	67,2	9,8
Ease of use	1,6	27,9	52,5	14,8
Reliability of functions	1,6	29,5	59,0	3,3
Suitability with the objective of learning	-	6,6	55,7	34,4
Integration with simulated patient	-	3,3	52,5	41,0
Ability to stimulate students to practice	-	8,2	62,3	26,2
Levels of durability and preservation's ease	4,9	32,8	44,3	9,8

In addition, the results of the structured interviews showed that the mannequins were considered good. The mannequins were considered simple to use and similar with the real ones in real settings. They were also assessed by respondents that they could be integrated with simulated patients due to their ability to train students to empathize and to interact with patients like in a real doctor-patient relationship.

*"...simpler..." (SP-3)*

*"... similar with the real condition because it uses simulated patients..." (S-10)*

*"...can interact directly with patients, so it seems real..." (S-8)*

*"...stimulates students to train better, students meet the patients directly so that they will be well-trained..." (I-7)*

However, the respondents argued that the mannequins still need improvements in some areas. For example, the color and elasticity of the skins should be adjusted with the original/standard by making them longer and thinner.

*"...less similar with actual skins..." (S-1)*

The skins should also be adjusted to the size of the simulated patient's arm. Bottles, seals, and pumps of the pumping blood bags need to be designed better because in this study the pumping blood bags still leaked fluid out when pumped. Blood fluid should be made thicker to resemble real blood. Blood vessel tubes should be easier to find.

*"...bottle of blood still leaking fluid ..." (I-5)*

*"...tubes are not quite prominent so it's difficult to identify them..." (S-9)*

In this study, the blood vessel tubes were considered not long enough, too heavy and bulky, and not prominent. It was recommended that the metal protector made of an aluminum plate should be made wider and made of a material with better quality for simulated patients' safety.

*"...aluminum should be wider..." (I-4)*

*"...if the plate is not appropriate, needle insertion can puncture the patient..." (S-6)*

The skins and blood vessel tubes should be more adapted to be more similar to the actual human anatomy.

*"...vein's large size, position, and number do not suitable with the venous anatomy in the hand..." (I-11)*

*"...real veins are branched, not straight..." (S-13)*

Finally, the simulated patient should be trained first to be able to provide the appropriate response when dealing with the students.

The results of this study indicated that the IV line mannequin was rated good in average by all respondents. However, some things still need to be improved in the manufacturing process of the mannequins. There was no significant difference among the opinions of the instructors, students and simulated patients. The mannequin skins considered the best by the respondents was the ones made of silicone. The mannequins were also considered good in integration with simulated patients for skills training because it could stimulate students to be able to empathize and to interact like in a real doctor-patient relationship.

The results also indicated that integrated learning method between mannequins and simulated patients is possible. It is based on considerations of tool's readiness and integration's benefit. Based on this study, standard mannequin skins can be made with some improvements. Making a standard mannequin skins actually does not require relatively high cost, so it allows implementation considering operational funding. With this integration, students can practice invasive medical skills, but still can safely interact with the patient. Hereafter, the IV line mannequins integrated with simulated patients is expected to reduce the problems that arise when students have to implement the medical skills practiced with a mannequin in skills lab to real patient in the hospital.

By involving the interaction of students with simulated patients, integrated medical skills training may provide clinical conditions near the real ones to the students. It is in accordance with Kneebone et al<sup>5</sup> who suggested to close the gap between laboratory-based education with professional education in the clinical settings. In this case, gap closing can be approached by making a simulation similar to the real situation, thereafter the integrated method can facilitate students to be able to practice seriously but still be within a safe setting.

Besides these advantages, another benefit of this integration is to provide exposure to clinical conditions to the students earlier. Students really should be introduced to the clinical situation as early as possible to prepare students entering clerkship in the hospital. Exposure to clinical situations will give students an overview of the medical profession from an early time and to motivate students to study harder to achieve the medical competence.<sup>6</sup> Once the students are ready, only then can they be included into the real setting in a session of Integrated Clinical Practice (ICP) in community field placements.<sup>10</sup>

Nevertheless, the implementation of this integrated method needs students' readiness. Integrated skills practice is more difficult because it integrates multiple medical skills as one, such as communication, physical examination, and procedural skills. Therefore, this integrated method should be used in the final years of learning/curriculum before students enter clerkship, i.e. the 3<sup>rd</sup> or 4<sup>th</sup> year of undergraduate medical programme. In those years, students are expected to have enough skills to practice this integrated method and become ready for clerkship.

This study has several potential limitations. The assessment of the new mannequin was only performed once. The new mannequin should also be assessed in several cohorts so that it could assess the advantages and disadvantages over a long time. However, the results of the good evaluation shown in this study are expected by the authors to be an inspiration for medical institutions and health education in Indonesia to start producing cheap, locally-made mannequins independently. The use of locally-manufactured mannequins may make it easier to design appropriate models as needed, as many as it is required/demanded, to achieve cheaper and easier maintenance rather than depending on expensive manufacturers overseas.

## CONCLUSION

This study is expected to inspire us that low-cost local mannequins can be used successfully by undergraduate students to practice integrated clinical skills in the skills laboratory settings in Indonesia. However, the mannequins should be evaluated and improved regularly to reach optimum benefits.

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