Adult Standardized Concentration of Antibiotics Intravenous Infusion: New Initiative in Saudi Arabia

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Received: 25-8-2019;
Accepted: 28-11-2019;

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ABSTRACT

Objectives: To demonstrate the adult standardized concentration of Antibiotics intravenous infusion as new initiatives in the Kingdom of Saudi Arabia. Methods: It is a new initiative project drove by national standardized concentration of Antibiotics services. The projects formulated from the international business model, pharmacy project guidelines and project management institution guidelines of a new project. The initiative project is written through project management professionals and contained of several parts, including the initial phase, the planning phase, the execution phase, the monitoring and controlling phase. Results: The adult standardized concentration of Antibiotics intravenous infusion services with a defined vision, mission and goals. The services had various benefits including clinical and economic on patients as exemplified in the review. The continuous of the project assured by risk management model description. In addition, the monitoring and controlling of the services as declared. The transition to operation project though closing project stage was explored in the analysis. Conclusion: The adult standardized concentration of Antibiotics intravenous infusion services is a new initiative part of the intravenous admixture program. The standardized concentration of Antibiotics will lessening drug-related problems and improve patient safety at hospital practice; it is highly recommended to implement in the Kingdom of Saudi Arabia.

Keywords: Adult, Standardized, Concentration, Antibiotics, Intravenous, Services, Saudi Arabia.

INTRODUCTION

Over the past years, multiple pharmacy practice projects had been implemented in the kingdom of Saudi Arabia.[1] The intravenous admixture (IV) and stewardship antimicrobial programs were among them.[2,3] The both programs implemented to meet the high consumption of parenteral antibiotics with the high-cost burden on the healthcare system ath.4,5 The IV admixture program developed adult’s medication dilution manual as guidelines for the preparation of parenteral medications and including antibiotics among them to prevent antibiotics related problems.[6,7] Beside, one of the essential factor to prevent antibiotics preparation errors for adults was the standardized antibiotics intravenous infusions. Multiple studies showed significant reductions of errors after the implementation of antibiotics standardized concentration in adults and pediatric healthcare services. [6-11] Besides, various investigations discussed the pattern of standardized concentration of different medications, including antibiotics.[12-14] Various local studies discussed standardized the physician’s total parenteral nutrition order for adults, standardized the concentration of emergency medication and adult electrolytes.[15-17] The authors, based on their current knowledge, are not familiar with any scientific research about adult’s standardized concentration of antibiotics. The aim of the current review to declare the adult’s standardized concentration of antibiotics as new initiatives project in the kingdom of Saudi Arabia.

MATERIALS AND METHODS

It is a new initiative project drove from the national IV admixture and chemotherapy program.[18] The task force team of adults standardized concentration of Antibiotics intravenous formulated and contained of from the author’s expertise in the adults parenteral medications. The committee focused and drove the pharmacy parenteral administration guidelines, from the textbook, international literature adults standardized concentration of Antibiotics intravenous written by utilizing the international business model, pharmacy project guidelines and project management institution guidelines of a new project.[19-21] The adult’s standardized concentration of Antibiotics intravenous infusions adjusted based on the acceptable concentration, daily dose and the volume of bag as possible. The project is written through project management professionals and consisted of several parts, including the initial phase, the planning phase, the execution phase, the monitoring and controlling phase.

Initiative Phase

Assessment Needs

Pharmacists play a vital role in pharmacy practice, for instance, implementing standardized
antibiotic concentrations. The pharmacy profession has continuous to grow over recent years. Nevertheless, standardized antibiotic concentrations have not been implemented due to insufficient knowledge regarding using several concentrations of medications. There have also been various factors affecting of administering unstandardized antibiotic concentration to patients, such as drug-related problems. Besides, there was also the demand for the workload analysis for pharmacists and the economic impact of unstandardized antibiotic concentrations.

Market Analysis
The majority of the parenteral admixture services in the Kingdom of Saudi Arabia had various methods of Antibiotics intravenous medications concentrations. The guidelines of preparation contained of medications, route of administration, the stability of preparation, concentration and medication compatibility. Most of the healthcare institutions had the same guideline with different medications. The adult standardized concentration of Antibiotics intravenous infusion or standardized diluent solution has not existed. The adult standardized concentration of Antibiotics intravenous infusion is an excellent method to encourage the manufacturers to produce the same ready-made, standardized concentration. However, there were some ready-made medications with specific concentration a variable in the market but wanted all Antibiotics medications and the concentration was not appropriate.

SWOT Analysis
The SWOT analysis of this program elaborate an in-depth analysis of how to implement adult standardized concentration of Antibiotics intravenous infusion at healthcare institutions. The strengths included the presence of standardization of antibiotic concentration for east preparations, prevent parental medications related errors, the role of pharmacists in addressing cost avoidance in this matter and the measurement of the workload of pharmacists. Besides, the project had weaknesses such as the time required to come up with the final concentration. The fact that the standardization is the most operative quality required for the national agency of pharmacy accreditation and minimizing the use of different antibiotic concentrations and its effects created a massive opportunity for this project. The threat points are administration planner and the pharmacy strategic plan does not exist.

Planning Phase
Scope of the Project
The project contained the Adult's standardized concentration of Antibiotics with specific diluent solutions. The concentration drove from typical daily dose and frequency administration. The adult's standardized concentration of Antibiotics intravenous encourages the pharmaceutical companies to make ready-made Antibiotics with resembling concentration and diluent solution.

Vision, Missions, Goals
The vision of the project to reach the best with high quality of Adult’s standardized concentration of Antibiotics intravenous infusions, while the message to provide high quality adults intravenous infusions of Antibiotics with specific concentrations with an appropriate diluent solution. The goal of the project is to prevent medications errors related to the Antibiotics for adults, to decrease the workload of pharmacy, other allied professionals and to avoid the additional economic burden on healthcare system including Adult’s antibiotic preparations, to encourage the pharmaceutical companies of producing the ready standardized of intravenous infusions of Antibiotics concentration for adult’s populations.

Project Description
The following policies were put in place for every pharmacist and other health care individuals:
✓ The adult standardized concentration of Antibiotics intravenous infusion committee should be formulated at healthcare organizations.
✓ The adult standardized concentration of Antibiotics intravenous infusion committee should consist of IV pharmacist and pharmacy technician, adults nursing representative and adult surgical or medical representative.
✓ The committee revises the adult standardized concentration of Antibiotics intravenous infusion and updates at least annually.
✓ The adult standardized concentration of Antibiotics intravenous infusion education and training sessions should be conducted by the committee to all healthcare providers, including physicians and nurses, with pharmacy staff.
✓ The adult standardized concentration of Antibiotics intravenous infusion distributed to healthcare sectors at the institutions (Table 1).

Planning Cost Management
For this project to be implemented, funding is vigorous to educate, train pharmacy and healthcare professionals. The conversion of use several concentrations into specific concentrations will also involve the use of financial resources to complete.

Execution Phase
Plan Cost Management
The requirements budget should be specified in every for current project adult standardized concentration of Antibiotics intravenous infusion. The cost, including the educational courses, the management team meeting and updated references. Furthermore, the budget should be supervision for the overall period.

Executing Phase
Management Team
The adult standardized concentration of Antibiotics intravenous infusion project should lead by the administration team. The team consisted of adult infectious diseases clinical pharmacists, adults intravenous admixture pharmacists and pharmacy technicians, medications physician with infectious disease.
Table 1: Suggested Adult Standardized Concentration of Antibiotics Intravenous Infusion

<table>
<thead>
<tr>
<th>No</th>
<th>Generic name</th>
<th>Initial Strength</th>
<th>Diluents (preferable)</th>
<th>Reconstitution Volume</th>
<th>Final concentration</th>
<th>IVBP</th>
<th>Final preparation with maximum Concentration</th>
<th>Stability of Solution</th>
<th>Rate of Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acyclovir</td>
<td>25 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>2</td>
<td>Amikacin</td>
<td>50 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>3</td>
<td>Amoxicillin/ Clavulenic Acid</td>
<td>1.2 gm/20 ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>4</td>
<td>Ampicillin</td>
<td>500 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>5</td>
<td>Amphotericin B</td>
<td>5 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>6</td>
<td>Amphotericin B Lipid complex</td>
<td>100 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>7</td>
<td>Carbenicillin</td>
<td>500 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>8</td>
<td>Cephalothin</td>
<td>100 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>9</td>
<td>Cefuroxime</td>
<td>100 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>10</td>
<td>Cefazolin</td>
<td>100 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>11</td>
<td>Ceftriaxone</td>
<td>100 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>12</td>
<td>Cefotaxim</td>
<td>100 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>13</td>
<td>Cefotaxim</td>
<td>100 mg/ml</td>
<td>D5W</td>
<td>10 ml SWFI</td>
<td>24 hrs</td>
<td>Ref</td>
<td>60 min or 2 hrs</td>
<td>RT</td>
<td>15 min</td>
</tr>
<tr>
<td>Table 1: Suggested Adult Standardized Concentration of Antibiotics Intravenous Infusion[^38-46]</td>
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</tr>
<tr>
<td><strong>14</strong></td>
<td>Ceftriaxone</td>
<td>100mg/ml</td>
<td>D5W NS</td>
<td>9.6 ml SWFI</td>
<td>10 mg/ml</td>
<td>1g/50ml D5W 1g/50ml NS</td>
<td>40mg/ml</td>
<td>2g/50ml D5W 2g/50ml NS</td>
<td>2 days</td>
</tr>
<tr>
<td><strong>15</strong></td>
<td>Cefuroxime</td>
<td>100mg/ml</td>
<td>D5W NS</td>
<td>7.2 ml SWFI</td>
<td>7.5mg/ml</td>
<td>750mg/50ml D5W 750mg/50ml NS</td>
<td>15mg/ml</td>
<td>1.5g/25ml D5W 1.5g/25ml NS</td>
<td>24 hrs</td>
</tr>
<tr>
<td><strong>16</strong></td>
<td>Cephradine</td>
<td>100mg/ml</td>
<td>D5W NS</td>
<td>5-10ml SWFI</td>
<td>100mg/ml</td>
<td>1g/25ml D5W 1g/100ml NS</td>
<td>200mg/ml</td>
<td>2g/25ml D5W 2g/100ml NS</td>
<td>24 hrs</td>
</tr>
<tr>
<td><strong>17</strong></td>
<td>Ciprofloxacin</td>
<td>2mg/ml</td>
<td>D5W NS</td>
<td>NA</td>
<td>0.2mg/ml</td>
<td>200mg/100ml D5W 200mg/100ml NS</td>
<td>2mg/ml</td>
<td>200mg/100ml D5W 200mg/100ml NS</td>
<td>14 days</td>
</tr>
<tr>
<td><strong>18</strong></td>
<td>Clindamycin</td>
<td>150mg/ml</td>
<td>D5W NS</td>
<td>NA</td>
<td>6mg/ml</td>
<td>600mg/50ml D5W 600mg/50ml NS</td>
<td>18mg/ml</td>
<td>900mg/50ml D5W 900mg/50ml NS</td>
<td>16 Days</td>
</tr>
<tr>
<td><strong>19</strong></td>
<td>Cloxacillin</td>
<td>100mg/ml</td>
<td>D5W NS</td>
<td>2.5-4.8ml SWFI</td>
<td>20mg/ml</td>
<td>1g/50ml D5W 1g/50ml NS</td>
<td>50mg/ml</td>
<td>1g/25ml D5W 1g/25ml NS</td>
<td>4 hrs</td>
</tr>
<tr>
<td><strong>20</strong></td>
<td>Erythromycin 500mg</td>
<td>50mg/ml</td>
<td>NS</td>
<td>10-20ml SWFière</td>
<td>1mg/ml</td>
<td>500mg/50ml NS</td>
<td>5mg/ml</td>
<td>500mg/100ml NS</td>
<td>8 hrs</td>
</tr>
<tr>
<td><strong>21</strong></td>
<td>Flucloxacillin</td>
<td>250mg powder 250mg/100ml premixed 500mg/100ml</td>
<td>NS</td>
<td>5ml WFI</td>
<td>5mg/ml</td>
<td>1g/50ml D5W 1g/50ml NS</td>
<td>20mg/ml</td>
<td>1g/25ml D5W 1g/25ml NS</td>
<td>2 hrs</td>
</tr>
<tr>
<td><strong>22</strong></td>
<td>Fluconazole</td>
<td>200mg/100ml 400mg/200ml Premixed</td>
<td>NA</td>
<td>NA</td>
<td>2mg/ml</td>
<td>200mg/100ml 400mg/200ml Premixed</td>
<td>2mg/ml</td>
<td>200mg/100ml 400mg/200ml Premixed</td>
<td>NA</td>
</tr>
<tr>
<td><strong>23</strong></td>
<td>Gancyclovir</td>
<td>50mg/ml</td>
<td>D5W NS</td>
<td>10ml SWFI</td>
<td>5mg/ml</td>
<td>500mg/100ml D5W 500mg/100ml NS</td>
<td>10mg/ml</td>
<td>500mg/50ml D5W 500mg/50ml NS</td>
<td>12 hrs</td>
</tr>
<tr>
<td><strong>24</strong></td>
<td>Gentamicin Regular dose</td>
<td>10mg/ml 40mg/ml</td>
<td>D5W NS</td>
<td>NA</td>
<td>0.8mg/ml</td>
<td>80mg/50ml D5W 80mg/50ml NS</td>
<td>4mg/ml</td>
<td>80mg/25ml D5W 80mg/25ml NS</td>
<td>48 hrs</td>
</tr>
<tr>
<td>No.</td>
<td>Antibiotic</td>
<td>Concentration</td>
<td>Administration</td>
<td>Storage</td>
<td>Note</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>25</td>
<td>GENTAMICIN</td>
<td>10 mg/ml</td>
<td>NS</td>
<td>0.8 mg/ml</td>
<td>400 mg/250 ml D5W 400 mg/250 ml NS 4 mg/ml 400 mg/100 ml D5W 400 mg/100 ml NS 48 hrs 48 hrs 16-18 hrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Imipenem/ cilastatin sodium</td>
<td>50 mg/ml vial</td>
<td>10 ml SWFI</td>
<td>5 mg/ml</td>
<td>500 mg/100 ml NS 500 mg/250 ml D5W 5 mg/ml 500 mg/100 ml NS 500 mg/100 ml D5W 4 hrs with d5% 10 hr with NS Over 30 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Levofloxacin Premixed 500 mg/100 ml</td>
<td>5 mg/ml</td>
<td>NS</td>
<td>2 mg/ml</td>
<td>600 mg/300 ml 2 mg/ml 600 mg/300 ml 2 hrs Use fresh NA 30-120 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Meropenem 500 mg</td>
<td>50 mg/ml</td>
<td>NS</td>
<td>1 mg/ml</td>
<td>1 g/ 100 ml NS 20 mg/ml 1 g/ 50 ml NS 1 hr 15 hrs 15-30 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Metronidazole 500 mg</td>
<td>5 mg/ml</td>
<td>NS</td>
<td>5 mg/ml</td>
<td>500 mg/100 ml NS 500 mg/100 ml D5W 5 mg/ml 500 mg/100 ml NS 500 mg/100 ml D5W 24 hrs NA Over 60 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Micafungin sodium 500 mg</td>
<td>10 mg/ D5W</td>
<td>5 mL NS or D5W</td>
<td>0.5 mg/ml</td>
<td>100 mg/100 ml NS 100 mg/100 ml D5W 1 mg/ml 150 mg/100 ml NS 150 mg/100 ml D5W 24 hrs NA 60 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Moxifloxacin 1.6 mg/ml</td>
<td>NA</td>
<td>NA</td>
<td>1.6 mg/ml</td>
<td>400 mg/250 ml 1.6 mg/ml 400 mg/250 ml Use fresh NA 60 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Penicillin G sodium 200000U/ml</td>
<td>4.6 mL SWFI</td>
<td>500 000 U/ml</td>
<td>4 MU/ 100 ml D5W 4 MU/ 100 ml NS 100 000 U/ml 4 MU/50 ml D5W 4 MU/50 ml NS 24 hrs 7 days 15-30 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Piperacillin/ Tazobactam 225 mg/ml</td>
<td>20 mg/ml D5W</td>
<td>10 SWFI</td>
<td>20 mg/ml</td>
<td>4.5 g/ 250 ml D5W 4.5 g/ 250 ml NS 80 mg/ml 4.5 g/ 100 ml D5W 4.5 g/ 100 ml NS 24 hrs 48 hrs 30 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Rifampicin 60 mg/ml</td>
<td>10 mL SWFI</td>
<td>1.2 mg/ml</td>
<td>600 mg/ 250 ml D5W 6 mg/ml 600 mg/ 100 ml D5W 4 hrs NA 3 hrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Sulfamethoxazole + Trimethoprim SMX 80 mg/ml +TMP 16 mg/ml</td>
<td>D5W</td>
<td>NA</td>
<td>0.64 mg/ml</td>
<td>5 ml/100 ml D5W 10 ml/250 ml D5W 1.07 mg/ml 5 ml/100 ml D5W 2-6 hrs NA 60-90 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Vancomycin 50 mg/ml</td>
<td>10 mL SWFI</td>
<td>5 mg/ml</td>
<td>500 mg/ 250 ml D5W 500 mg/ 250 ml NS 10 mg/ml 500 mg/ 100 ml D5W 500 mg/ 100 ml NS 24 hrs 24 hrs 2 hrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** IVBP: Intravenous Piggyback, NA: Not Applicable/ Not available, NS: Normal Saline, Ref: Refrigerate, RT: Room Temperature, SWFI: Sterile Water For Injection, Hrs :hours, Mint: Minutes

**Note:** The healthcare professionals should adjust the concentration and the dose requirement according to the patient condition.

The pharmacist should review the appropriate concentration of final preparations according to the strength of the medications, prescribing dose, and their local healthcare institution policy.
specialty, pharmacy total quality management and Adult medications safety pharmacist. The team will implement and monitor the project, setup the performance indicators, policies and procedures. In addition to updating the adult standardized concentration of Antibiotics intravenous infusion list occasionally. Perform all education and training of the project for pharmacists, healthcare providers and related issues.

**Education and Training**

Multiple educational and training sessions about the adult standardized concentration of Antibiotics intravenous infusion should be conducted for pharmacy staff, including pharmacists and pharmacy technicians. Also, healthcare providers, including physicians and nurses, should obtain education and training before starting the project. Another candidate for the adult standardized concentration of Antibiotics intravenous infusion education courses, the management team and adequate alignment for new pharmacy or healthcare staff join the healthcare institutions.

**Monitoring and Controlling Phase Project**

**Total Quality Management**

There are various methods used for total quantity management outcomes with new project adult’s standardized concentration of Antibiotics during the implementation stage. The balance scored cards; one method was among them.[22] The elements monitor contained of four-part that’s including the customer, finance, internal process, education and innovation. The assessment of healthcare services of adult’s standardized concentration of Antibiotics was an example of an internal process type. The clinical outcome of adult’s standardized concentration of Antibiotics was an example of an internal process type. The financial type had another example in the future. The annual celebration of all IV admixture pharmacy staff with pharmacists and pharmacy technicians is highly recommended in the Kingdom of Saudi Arabia.

**Closing of the Project**

The standardized concentration of adults Antibiotics medications at all healthcare institutions of governmental and private sectors is required to prevent drug-related problems during preparation of medications lead to morbidity and mortality and to prevent an unnecessary economic burden on hospitals and primary healthcare centers services in Saudi Arabia. The project should continue during the preparation of parenteral medications at each pharmacy department and related committees.

The standardized adult’s concentration of Antibiotics and related education and training should be conducted periodically. Adults Standardized concentration of Antibiotics should inform regularly and more expansion of number medications is highly suggested in the future. The annual celebration of all IV admixture pharmacy staff with pharmacists and pharmacy technicians is highly recommended in the Kingdom of Saudi Arabia.

**ACKNOWLEDGEMENT**

None.

**CONFLICT OF INTEREST**

None.

**FUNDING**

None.

**CONSENT FOR PUBLICATIONS**

Informed consent was obtained from all the participants.

**ETHICAL APPROVAL**

This research exempted from research and ethical committee or an institutional review board (IRB) approval.


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**ABBREVIATIONS**

MOH: Ministry of Health; KSA: Kingdom of Saudi Arabia; SWOT: Strengths, Weaknesses, Opportunities and Threats; IV: Intravenous.

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**REFERENCES**


