# Analysis of the Coronary Care Unit Bed Allocation policy and selecting the most suitable model for optimal allocation in a low and middle-income country: a multiphase study

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# Abstract

### Background

This study aimed to conduct a policy analysis on allocating Coronary Care Unit (CCU) beds and clarifies the well-suited model for allocating CCU beds in Iran.

### Methods

As a multiphase study, this was conducted in 4 steps, including a literature review, semi-structured interviews, an analysis of the policymaking process, and the Delphi study. The bed allocation models, their criteria, and the challenges of CCU bed allocation were explored through a literature review and semi-structured interviews. The CCU beds allocation policy was analyzed using Walt and Gilson's Health Policy Triangle (HPT). The Delphi method chose the suitable model for the optimal allocation of CCU beds in Iran.

### Results

Findings were reported in four dimensions of the policy analysis triangle, including content, context, process, and actors. Various social, economic, environmental, and political factors affect policy development. Allocating policy emphasizes fair distribution of resources and full access to health services and encourages the private sector. Achieving efficiency of hospital bed utilization put bed allocation on the agenda in Iran. Thorough literature review, 11 models and 14 indicators were found. After conducting interviews, the number of indicators increased to 58 cases, and the CCU bed allocation challenges were identified. The Trend Model was picked through the Delphi study as a framework for CCU bed allocation.

### Conclusion

Using the results of the present study and the proposed model can help to allocate hospital beds, especially CCU beds, optimally and efficiently. However, challenges and barriers identified by this study require consideration during the development of the proposed model. Also, managers and policymakers require information about the most effective strategies to reduce the need for CCU beds in the future. It is recommended that future studies and scenario planning be considered prior to the optimal allocation of hospital beds.

# Introduction

Cardiovascular diseases (CVD) are the leading cause of death worldwide [1], claiming an estimated 17.9 million lives annually, according to the World Health Organization (WHO) [2]. In Iran, despite a growing young population, the mortality rate for CVD is high, accounting for 25% of deaths, and it is the third leading cause of death after accidents and cancers [3]. The incidence of CVD in the Iranian population is expected to increase because of socioeconomic and cultural changes, nutrition transition, inadequate

physical activity, industrialization and urbanization, increasing life expectancy, increasing metabolic and physical risk factors, low accessibility and affordability to primary care, and treatment, and low compliance because of economic and psychological problems [4].

CVD patients typically receive care for an acute episode of congestive heart failure or acute myocardial infarction by being hospitalized in the cardiac care unit (CCU) [5]. The CCU beds are scarce resources, and caring for cardiovascular patients accounts for a large and growing proportion of healthcare expenditure [6]. However, cardiac care services are unquestionably one of the most challenging and time-consuming elements of intensive care services, and the CCU incurs high costs for both health institutions and the medical staff [7]. So, CCU beds are one of the health care system's most valuable and essential sources [6]. Unfair distribution of CCU beds leads to the idleness of beds or a high rejection ratio of patients [8].

Although, with today's intensive demands and increasing financial constraints, efficient CCU bed planning and allocation are becoming increasingly complex. Hospital managers and policymakers are pressured to contain costs and manage scarce resources in light of rising demands for and costs of care they provide [9]. High variability in patient arrivals and service times makes the allocation problem complex and challenging. The number of CCU beds is usually determined using ratios and target bed occupancy rates. Nevertheless, these indicators do not sufficiently respond to the increasing needs of patients to receive intensive care in the CCU. So, there is a crucial need to develop a model for planning CCU beds according to future patient demands [10].

In this regard, several studies have been conducted in the world and Iran, focusing on hospital capacity planning, justice in the utilization and distribution of beds, or determining the optimal number of hospital beds using different approaches and methods[6] [9] [11] [12] [13]. However, models for allocating coronary care units (CCU) are rarely reported. This study aimed to implement policy analysis on distributing coronary care unit (CCU) beds and select the suitable model for CCU bed allocation in Iran. Implementing the appropriate model for allocating CCU beds provides a framework to minimize cancellations of Elective surgery, maintain an acceptable level of bed occupancy, reduce waiting times, and provide quality services. The results of this study can provide valuable information to policymakers and health system managers in allocating CCU beds.

# Materials & Methods

## 2.1 Study design

A multiphase study was designed to create a deep understanding of the processes of CCU bed allocation, analyze the policymaking process qualitatively, and select the suitable model for CCU bed optimal allocation in Iran. The first phase of this study aimed to explore the models of allocating beds and their criteria in hospitals through an extensive literature review. The second phase aimed to identify indicators for allocating CCU beds in Iranian hospitals and explore the challenges of allocating CCU beds through

semi-structured interviews. The third phase analyzed the policymaking process using Walt and Gilson's policy analysis triangle framework. The fourth phase aimed to choose a model for the optimal allocation of the CCU beds in Iran by the Delphi method.

## 2.2 Literature review

A comprehensive literature review was conducted to identify the policy documents, models, and indicators for the optimal allocation of hospital beds. The literature review searched the following databases for relevant studies: PubMed, Ovid, Science Direct, Google Scholar, Medline, SID (a scientific information database developed to index articles published in Iranian journals), and relevant websites. The keywords used included: hospital, indicator*, model*, method*, allocation, rationing, priority setting, and capacity, as well as the Persian equivalents of these keywords for the period from 2000 to 2022. All articles and reports published in English and Persian languages were also searched. Manual searches were also conducted through index listings and peer-reviewed medical journals. Additional searches were conducted using Cochrane Collaboration and Evidence-Based Medicine, clinical practice guidelines, consensus reports, and best practice reports. Additionally, the official websites of the relevant organizations and stakeholders, including the Islamic Parliament Research Center, MHME, SSO, IHIO, Social Security Office of the Armed Forces, and Eastern Mediterranean Region Office (EMRO), were appraised to explore relevant national, regional, and international laws, policies, protocols, reports, and guidelines. Criteria for selecting relevant studies included indicators, methods, and models in hospitals, the provision of adequate descriptive information about indicators, and extracted, summarized, and reported results in appropriate extraction tables.

## 2.3 Interviews

In-depth semi-structured interviews were conducted via phone calls, the internet, and face-to-face meetings from March to April 2022. A guide was given to interviewees, including nine general questions and a summary clarifying the purpose of the interview that developed following the health policy triangle (HPT) framework (Supplementary 1). Purposive and snowball sampling techniques were employed to select the key Iranian informants, including health policymakers, resource-allocating policymakers, university professors, and researchers. Therefore, purposive sampling was used first and in later stages. We tried to find other suitable samples by snowball sampling. These participants were recruited purposefully based on their insights into resource allocation and policy issues, as gathered from their job titles and position descriptions. Each participant was given a letter of introduction from the Iran University of medical sciences (Health Management and Economics Research Center) explaining the purpose of the study and seeking his/her cooperation.

The time and length of interviews were set accordingly, and participants were assured of confidentiality and allowed to withdraw from the study anytime they wanted. All interviews were recorded using two electronic devices, and permission was obtained from all participants before recording. All recordings

were listened twice and annotated as written documents by researchers. Primary substantive codes were extracted from the recordings, and similar codes were categorized. In addition to the recording's critical statements, nonverbal and facial gestures were considered when transcribing recorded files. The duration of the interviews varied from 30 to 90 min. All interviews were conducted in quiet places allowing for accuracy, precision, and privacy purposes by one of the authors (M.H) of this paper. The recruiting procedure continued until data saturation was achieved. The last two interviews, which had duplicate data and no new information have been found during them, were considered to confirm data saturation. All interviews were analyzed by the MAXQDA 2020 software (A kind of software for qualitative research) and also manually. There was critical reflexivity throughout the data collection and analysis phases to remove any potential bias risk. Furthermore, the interviewer described his scientific interests and executive background during the interviews. Moreover, to promote rigor and trustworthiness, the following methods were considered to ensure the confirmability, dependability, transferability, credibility, and authenticity criteria (1) Member-checking by co-authors and participants (confirmability); (2) engaging three authors in the analysis process (dependability); (3) using purposive sampling (transferability); (4) peer debriefing, data and method triangulation, as well as long-term immersion of the first author in this field (credibility), and (5) inserting citations from various participants (authenticity).

## 2.4 Policy analysis

This step was conducted retrospectively using a combination of deductive–inductive approaches in the form of policy analysis. The Walt and Gilson policy triangle was applied as a conceptual framework, which is outlined in Figure 1. The policy analysis triangle has process, content, and context dimensions, and the actors are at the center of this framework [14].

This framework shows how these four dimensions interact in shaping and implementing a policy.

- Context refers to systemic factors – political, economic, social; national, and international – that may influence health policy;
- Process refers to how policies are initiated, developed, negotiated, implemented, and evaluated;
- Content is the substantive detail of the policy, encompassing its constituent parts;

Actors are the shorthand term to denote individuals, organizations, and governments who influence policy [14]. First, we read through the selected papers and annotated interviews to familiarize ourselves with the studies and documents and identify the key ideas and themes. No sampling was conducted, and all primary documents were analyzed. A documentary and content analysis addressed all relevant policy and service documents developed at a national and regional level from 2000 (the date of the first official statement on allocating). Thematic analysis was used to analyze the collected data [15]. Data analysis was conducted with data collection simultaneously. Braun and Clarke's methodology was adopted in this study, which consisted of six phases (namely, getting familiar with data, establishing initial codes,

discovering, evaluating, labeling emerging themes, and preparing a final report) [16]. This approach is considered appropriate for informing policy formulation and development [15]. In other words, it allows researchers to explore the anticipated and unanticipated themes. Four authors (M. H, N. M, J. A, and S.A) participated in the analysis procedure and read the written texts frequently. They open-coded the data. Then the conceptual framework was considered to refine the identified codes and detect the relationships among the emerging themes. Discussion and consensus approaches were used to solve any disagreements between the authors. Data analysis was performed manually, and MAXQDA 2020 software was used if required. Each selected paper was imported to MAXQDA software and coded using this thematic framework. Data were extracted from their original context, rearranged according to the appropriate thematic reference, and summarized in charts. Finally, synthesizing and interpreting each theme and interrelationships between themes were conducted.

## 2.5 Delphi survey

In this step, the selected indicators and models were entered into the Delphi survey phase to reach a consensus about the models. The high validity of group opinions compared to individual judgments is the main reason for applying the Delphi technique. Delphi was carried out between April 2022 and May 2022 to explore the consensus and conflict around variables and models in bed cardiac care unit beds priority setting decisions.

In this study, a purpose-based and snowball sampling method was utilized to assemble the collective insights of the individuals involved. To increase the reliability of the results, various experts consisting of hospital managers, health policy, health economics, health researchers, health insurance experts, and academics were recruited in Delphi. We defined experts as experts with information and direct experience in priority settings in healthcare organizations. We intended to capture various perceptions of Delphi members to make sampling purposive. They were identified through a literature review in bed priority setting, searching websites of MHME, health research centers, and recommendations of research team members.

The Delphi questionnaire/form was designed based on the extensive literature review and experts' comments. Questionnaires were sent to experts from different medical specialties and basic sciences, including Ph.D. in health economics (n = 4), Ph.D. in Health Services Management (n = 11), and Ph.D. in health policy (n = 2). The panelists rated each indicator in terms of "the executable capability of the model", "adaptation of the model to the structure of Iran's health system", and "adaptation of the model to the economic, cultural, and social structure of Iran", "efficiency and effectiveness of the model", "model flexibility", "comprehensibility of the model", “acceptability of the model”, “comprehensiveness of the model”, and “appropriateness of the model”. Responses were divided into a four-point Likert rating scale that ranged from ‘strongly high/ strongly low’ (see Supplementary Appendix 1).

Delphi technique with content validity index and modified kappa was used to select and propose a suitable model for Iran. To calculate kappa, the chance agreement probability must be calculated first. To

obtain the content validity index for relevancy and clarity of each item (I-CVIs), the number of those judging the item as relevant or clear (rating 3 or 4) was divided by the number of content experts. Regarding relevancy, the content validity index can be calculated for item level (I-CVIs) and scale level (S-CVI). At the item level, I-CVI is computed as the number of experts giving a rating of 3 or 4 to the relevancy of each item, divided by the total number of experts. The I-CVI expresses the proportion of agreement on the relevancy of each item, which is between zero and one [17] [18], and the SCVI is defined as “the proportion of total items judged content valid” 3 or “the proportion of items on an instrument that achieved a rating of 3 or 4 by the content experts” [19]. For this purpose, the binomial random variable formula was used:

N = number of experts

A = number of experts who agree

$$\mathrm{CVI}=\frac{A}{N}$$

Then, in the next step, kappa (k*) was calculated using the ratio of agreement on the relationship (or I-CVI) and the probability of chance agreement as follows:

Pollitt et al. have calculated and suggested necessary (fair), good, and excellent values for calculating I-CVI, as well as k* (kappa above 0.40 fair, between 0.60 and 0.74 good, and above 0.74 excellent) [20]. The values of this table were used to judge the opinion of experts. In order to evaluate and select the models, nine items were examined, including “the executable capability of the model”, “adaptation of the model to the structure of Iran's health system”, and “adaptation of the model to the economic, cultural, and social structure of Iran”, “efficiency and effectiveness of the model”, “model flexibility”, “comprehensibility of the model”, “acceptability of the model”, “The comprehensiveness of the model”, and “appropriateness of the model”. Experts expressed their opinions on the Likert scale in four options: very low, low, high, and very high, and items 1 and 2 would be considered “disagree,” and items 3 and 4 would be considered “agree”, and this way, I-CVI and k* were obtained [21].

# Results

## 3.1 Literature review

The literature review extracted the models that were mainly designed to determine hospital bed capacity. In this step, 11 models and 14 key affecting factors considered by the models were included and extracted in another systematic review [22]. The identified factors were frequency of use, the average length of stay, bed occupancy rate, current bed numbers, admission rates, population, out-of-region use (inter-regional flows), Region of patient residence (sub-regional access), waiting time, hospitalization rates, patient transfer to other providers, disease prevalence, technology advances, funding level. The identified models were used to calculate the total number of hospital beds required. Some factors, such

as admission rate, length of stay, and bed occupancy rate, were identified in most of the models. Demographic changes were included in the other models except for the Capacity Model and the Score Model. In most models, population composition was taken into account. The Capacity Model is the only model that considers external factors such as disease prevalence, technology advances, and funding level. Other models assume policies and technologies will not change, so the number of beds may be overestimated. The general characteristics of identified models and key affecting factors considered by the models are provided in Table 1.

# Table 1. Key affecting factors considered by the identified models

| Identified models | Key affecting factors considered by the models | Countries using these models |
|---|---|---|
| Trend Analysis | • Average length of stay<br>• Bed occupancy rate<br>• Admission rates<br>• Population<br>• Out-of-region use (inter-regional flows)<br>• Region of patient residence | Canada |
| The Greater Glasgow | • Bed occupancy rate<br>• Population<br>• Waiting time<br>• Patient transfer to other providers | Scotland |
| Michigan's Bed Need Methodology | • Average length of stay<br>• Bed occupancy rate<br>• Admission rates<br>• Population | United States |
| The Swiss Health Observatory | • Average length of stay<br>• Bed occupancy rate<br>• Admission rates<br>• Population<br>• Out-of-region use (inter-regional flows) | Switzerland |
| Lausanne University Hospital (CHUV) | • Average length of stay<br>• Bed occupancy rate<br>• Admission rates<br>• Population | Switzerland |
| Basic scenario model | • Average length of stay<br>• Bed occupancy rate<br>• Admission rates<br>• Population | Switzerland |
| Current Use Projection | • Bed occupancy rate | Canada |

| | | |
|---|---|---|
| | • Population<br>• Region of patient residence (sub-regional access) | |
| Capacity model | • Average length of stay<br>• Population<br>• Out-of-region use (inter-regional flows)<br>• Region of patient residence (sub-regional access)<br>• Patient transfer to other providers<br>• Disease prevalence<br>• Technology advances<br>• Funding level | New Zealand |
| Israeli Model | • Bed occupancy rate<br>• Admission rates<br>• Population<br>• Region of patient residence (sub-regional access) | Israel |
| Score Model | • Bed occupancy rate<br>• Admission rates<br>• Patient transfer to other providers | France |
| The Status Quo model | • Population | Canada |

## 3.2 Interview

In this step, ten semi-structured interviews have been conducted to identify indicators and models for allocating CCU beds in Iranian hospitals and explore the challenges of allocating CCU beds. The number of beds required to provide quality healthcare depends on various factors. Fifty-eight factors affecting the allocation of CCU beds were identified through interviews. The influential factors were divided into ten categories. While the highest number of indicators was related to organizational and geographical determinants, the lowest number was associated with international and economic determinants. However, due to the lack of approved guidelines and standards for allocating CCU beds in Iran's health system, the political dimension plays a critical role in allocating CCU beds. The bargaining power of local politicians was the more important key factor. According to experts, the items associated with the organizational dimension, bed occupancy rate, bed rotation, admission rate, and average length of stay had a greater impact on bed distribution. In the geographical dimension, the patients' residency region,

the referral hospital system, and travel time to referral levels was the most significant factor according to the key informants' expressions. Another effective dimension of the CCU bed distribution is the economic dimension, in which the health investors and donors in the Region play a critical role and have paramount significance on the issue. Among the demographic variables affecting the CCU bed allocation, the population age group had the most significant effect on the distribution of CCU beds (Table 2).

The first challenge was that there is no precise definition of a CCU bed and a patient who needs to receive services in a CCU bed, and the diagnosis of this need is based on a specialist's opinion. This can lead to supplier-induced demand. On the other hand, the needs of the population change due to various epidemiological, geographical, and demographic factors, as well as changes in the economic power of the people. So, the population's need for CCU services is very difficult to predict. The most suitable method for determining the need for special cardiovascular care is to measure the prevalence, occurrence, and geographical distribution of cardiovascular diseases in the country. As a result, the standard definition of CCU beds should be established and approved. Therefore, there is a need for a simple and practical scoring system for the admission of cardiovascular patients to the CCU, as well as a need to address organizational barriers, such as administrative policies that conflict with the available guidelines and recommendations. Also, managers and policymakers require information about the most effective strategies to reduce the need for CCU beds in the future. The most effective way of doing this appears to be through health promotion and CVD prevention.

The second challenge was the impact of social, economic, cultural, and political characteristics on the access and extent of people's use of CCU services. So developing a strategy to increase equity in accessing acute cardiovascular care and reducing the disparity is needed. The complete implementation of regionalization, referral system, and family physician can lead to justice in access to intensive cardiac care.

The third challenge was the lack of health literacy on the part of patients. Health literacy is an individual and social capacity to access, understand and evaluate health information and the optimal use of health services to promote the health of society. Inadequate health literacy is related to the individual's economic status, health status, improper use of drugs, improper nutrition, lack of knowledge about self-care activities, failure to follow doctor's orders, poor control of blood sugar and blood pressure, increased prevalence of cardiovascular diseases, and less acceptance of treatment. Therefore, improving the fundamental health literacy of cardiovascular patients by using different educational methods and training in a healthy lifestyle in a targeted and continuous manner is mandatory for patients with heart failure.

The fourth challenge was to evaluate the pattern of diseases leading to hospitalization in the CCU. Determining the rate and burden of cardiovascular diseases provides the most objective evidence for the policymaking, design, and management of CCU beds. However, due to their uncertainty, it is difficult to control factors outside the health system, such as disease patterns. So, an analysis of the

social, economic, political, biological, and demographic trends affecting the increase in the need for CCU beds is recommended.

The fifth challenge was the increase in demand for exceptional care in CCUs. Related medical advancements and aging populations have increased the proportion of multi-comorbid patients. It means that many patients hospitalized in the CCU do not need the care of this unit and are admitted to be monitored and receive better quality services. Creating intermediate care units for patients who do not need intensive care in CCU but cannot be admitted to standard wards can reduce the need for ICU beds. Therefore, using more care facilities and equipment and engaging more skilled nursing staff in other wards is highly recommended by experts.

The sixth challenge was the deficiencies in current regionalization in Iran, including the emphasis on the concept of “admission rate” and “the average length of stay” instead of paying attention to the “population's needs” and “distribution of the population”. The absence of an efficient access system causes a low admission rate and length of stay. So, there is a need to be reviewed and enhanced the indices of bed allocation and attention to population needs in Iran's health regionalization.

The seventh challenge was the lack of guidelines and practical models for managing patients in the CCU and the lack of CCU admission criteria in Iran's health system. In addition, there is insufficient supervision in implementing the approved guidelines. Modification of clinical guidelines to empower care providers to involve patients in the care process and personalization of care were recommended. Furthermore, supervision planning must include the design of appropriate monitoring and evaluation systems. Due to the lack of necessary laws and an appropriate structure, physicians are not obliged to comply with clinical guidelines. So, the Iran health insurance system should be strengthened to supervise the implementation of the guidelines.

The eighth challenge was induced demand in bed allocation. Induced demand can lead to the misallocation of resources, which are spent on patients that do not require care. In Iran, physicians act as overseers and decision-makers, leading to their interests taking precedence over patients' interests. This is even though we have experts in the field of health policy, health economics, and health management in the country. Weak laws, ineffective implementation of health policies, and inadequate scientific capacity can also contribute to the rise in induced demand. The medicalization of Iranian society and the service delivery model in the country has created an environment where everything is defined and treated as a medical condition. It is better to choose health policy and health provision representatives who have a complete understanding of how to allocate the CCU beds.

The ninth challenge was that before any action to allocate CCU beds, no (cost-benefit) analysis and economic evaluation were done in Iran's health system. In university hospitals, requests for beds and medical equipment are made through faculty members and cardiologists, and the decision-makers of the type and amount of beds and equipment needed by hospitals are not health policymakers and medical economists. It is necessary to strengthen the health economics department in the country's hospitals and universities of medical sciences and emphasize their role in allocating beds.

The tenth challenge was the pressure of local politicians and the bargaining power of local politicians to allocate CCU beds without considering the actual needs of the regions. These pressures increase when health donors finance CCU beds or equipment. For the equitable distribution of CCU beds, comprehensive management should be established that considers all influential factors and indicators. This comprehensive management must be able to withstand political pressure.

The eleventh challenge was the political nature of policymaking processes that tend to advocate for curative interventions and invest in building large hospitals and wards since they perceive it as the best way to foster health and wellbeing. However, the healthcare system has other tasks such as prevention, health promotion, health education, and early disease detection even before one becomes ill and requires a hospital visit. Thus, the health policy focus must shift to upgrading the healthcare system to become more proactive, comprehensive, and integrated. The challenges and solutions identified by experts are summarized in Table 3.

# Table 2. Key factors affecting coronary care units beds allocation

| Dimensions | Variables |
|---|---|
| Demographic factors | Population (density, growth rate, size, age distribution) |
| | The pattern of population change |
| | Population over 60 years old |
| | Birth and death rate |
| | Immigrability and floating populations |
| Geographical factors | Geographical position or Region of patient residence |
| | The roads and communications status |
| | Suitable road accessibility |
| | Travel time to referral levels |
| | Industrial areas |
| | Existence of other centers providing cardiac services and their status |
| | Travel time to the nearest cardiac intensive care center |
| | Transportation status to nearest provinces |
| | Being the referral center of the province |
| | Air pollution |
| Epidemiological factors | Prevalence of cardiovascular diseases |
| | The ratio of cardiovascular patients to the general population |
| | Regional disease patterns |
| | The needs of the population |
| | Reduction in physical activity of the community |
| | Morbidity rate, the burden of cardiovascular disease |
| | The health status of vulnerable groups in society |
| cultural factors | Culture, religion, and language of the Region |
| | lifestyle (improper nutrition or inactivity) |
| | Real health literacy |
| | Customer Service Culture |
| Political factors | Political parties and coalitions of groups |
| | Political pressure, conformity pressure, and officials acting on political |

| | |
|---|---|
| | Power and political influence of the petitioner |
| | Bargaining power of local politicians |
| | Justice and solidarity in priority setting in health care |
| | Improving the quality of special cardiac care services as an agenda setting |
| Economic factors | Budget allocation |
| | The economic status of the people of the Region |
| | Presence of healthy donors and investors in the Region |
| Organizational factors | National health policies and strategies in services delivery |
| | Rationing rules for CCU |
| | General hospitals or specialty cardiac hospitals |
| | Hospital bed productivity |
| | Bed occupancy rate and bed rotation |
| | The rate of admission and discharge of cardiovascular patients |
| | Average waiting time for cardiovascular patients |
| | Number of heart surgeries |
| | The average length of stay of patients in the CCU |
| | Per capita allocated to the CCU |
| | The level of urgency and complexity of service delivery |
| | Dedicated space of the cardiac intensive care unit |
| Structural factors | The number of cardiologists and other heart physicians in the hospital |
| | Distribution of cardiologists in the country |
| | Resources requested by cardiology professors and their students in teaching hospitals |
| | Number of trained nurses in the Region |
| | Infrastructure factors |
| | The ratio of cardiac intensive care beds to hospital beds |
| Technological factors | Diagnostic and therapeutic technological advances |
| | The existing technologies status (angiography, imaging, …) |
| | Dependence of special cardiac care services on medical equipment |
| | Management, maintenance, and protection of equipment related to unique |

| | |
|---|---|
| | cardiac beds |
| International factors | Global standards in CCU bed allocation |

# Table 3. The main challenges and solutions in CCU bed allocation in Iran.

| No | Challenges | Solutions |
|---|---|---|
| 1 | Definition of a CCU bed and also a patient who needs to receive services in a CCU bed | -Measure the prevalence, occurrence, and geographical distribution of cardiovascular diseases.<br><br>- Established and approved the standard definition of CCU beds.<br><br>- Identification and weighting of all factors affecting the prevalence and occurrence of cardiovascular diseases to predict the need for CCU beds. |
| 2 | The impact of social, economic, cultural, and political characteristics on the access and extent of people's use of CCU services. | -complete implementation of regionalization, referral system, and family physician. |
| 3 | The lack of health literacy on the part of patients | -Improving the fundamental health literacy level of society. |
| 4 | Evaluation of environmental changes, nutritional changes, and changes in the pattern of diseases leading to hospitalization in CCU | -An analysis of the social, economic, political, biological, and demographic trends affecting the increase in the need for CCU beds. |
| 5 | The increase in demand for exceptional care in CCU | -Creating intermediate care units<br><br>-Using more care facilities and equipment and engaging more skilled nursing staff in other wards |
| 6 | Much emphasis on "admission rate" and "the average length of stay" indicators | -Reviewed and enhanced the indices of bed allocation and attention to population needs in Iran's health regionalization. |
| 7 | the lack of guidelines and practical models for managing patients in the CCU and the lack of CCU admission criteria in Iran's health system. | -Strengthening supervision of the implementation of guidelines. |
| 8 | Induced demand in bed allocation and The medicalization of Iranian society and service delivery model in the country. | -Choosing health policy and health provision representatives who have a complete understanding of how to allocate CCU beds. |
| 9 | No cost-benefit analysis and economic evaluation are done in Iran's health system before allocating CCU beds | -Strengthen the health economics department in the country's hospitals and universities of medical sciences and emphasize their role in allocating beds. |
| 10 | the pressure local politicians and the bargaining power of local politicians to allocate CCU beds without considering the actual needs of the regions | -Creating comprehensive management that considers all factors and indicators effective in allocating CCU beds. |
| 11 | The political nature of policymaking processes that tend to advocate for curative interventions | - The health policy focus must shift to upgrading the healthcare system to become more proactive, comprehensive, and integrated |

## 3.3 Policy analysis

We applied the “policy analysis triangle” as a framework to examine what the policy entailed, where the key ideas originated, why the policy process was activated, who the key actors were, and the main consequences.

- **Policy context**

Various social, economic, environmental, and political factors affected the CCU bed allocation shown in Table 2. The geographical distribution of CCU beds is critical for access to special cardiovascular care. On the other hand, environmental changes, air pollution, nutritional changes, lifestyle changes, and disease patterns increase the need for CCU beds. As CCU beds are an essential indicator to estimate the need for other resources such as specialists, trained nurses, and specialized medical equipment, equity in the distribution of CCU beds is implicitly essential for the distribution of other resources. Despite the national development plans of Iran and, recently, the health transformation plan, which has mainly focused on equity in access to healthcare services, only focusing on equitable bed distribution could not be effective. Simultaneous interventions in public health (including primary care, family physicians, and strengthening self-care), health networks, and curative services (strengthening the referral system) need to be taken into account, aiming to meet the demand for special cardiovascular care. Moreover, local and national policymakers should design and implement a comprehensive surveillance system for tracking and allocating CCU beds, both qualitatively and quantitatively.

Formal and informal criteria were used to set bed allocation. Formal criteria are objective criteria that, at least on paper, the Ministry of Health and Medical Education (MHME) claims to use in bed allocation. Informal criteria refer to subjective considerations influencing allocation practices in MHME and hospitals. CCU bed allocation in Iran is greatly influenced by two main factors, the population and the bargaining power of local politicians. Therefore, formal criteria such as population needs and regional epidemiology of cardiovascular diseases have received lower attention in CCU bed allocation. Also, the leading health criteria used in CCU bed allocation in Iran was the perceived medical need in the hospital by specialists.

- **Policy content**

The content of the policy includes a set of goals and actions planned in national allocation plans. The national documents generally attempt to present guidelines for equitable resource allocation in the country. The purpose of all these documents was the fair distribution of resources, full access to health services, and encourage the private sector to develop.

During the last decades, Iran’s government and parliament have developed several policies to equitable resource allocation. Due to the importance of hospital bed utilization in Iran, research about hospital beds efficiency had been conducted by MHME in 1994 to 1996 and put bed allocation on the agenda in Iran. With the approval of Article 193 of the Third Development Plan in 2000, a plan for inpatient bed

distribution was developed to improve fair access to inpatient facilities and to prevent unnecessary investments. Afterward, the country was divided into geographical regions (provincial, university, regional). So, any construction, creation, development, and equipping of the country's inpatient services were announced following the health resources allocation priorities.

In the country's third to sixth development programs, fair access to health services in the form of equitable allocations of health budgets to geographical areas of a health system has been developed. Furthermore, several policy documents were found, directly or indirectly, related to allocating hospital beds and resources. The established document in 2011 pointed directly to the CCU bed allocation (Table. 4).

Furthermore, the government and MHME have developed various strategies to improve equity of resource allocation, including; establishing the Ministry of Welfare and Social Security (MWSS) in 2005, incorporating all health insurance organizations under MWSS to separate the health care providers/MOHME from the financiers [23], and establish the Technology Assessment Unit within MOHME in 2007 [24]. Despite these efforts, the extent to which evidence from economic analyses is used to inform CCU bed allocation in national strategic planning and decision-making remains unclear.

Despite the existence of policies to support the private sector, the government’s incentives were not valuable in encouraging the private sector to develop in deprived areas of Iran because the activities of the private sector in health care were always based on the principle of profit. However, health donors played a significant role in distributing and equipping CCU beds in the regions.

# Table 4. History of key policy documents

| Year | Policy document |
|---|---|
| 1970 | Treatment Planning Council |
| 1979 | The Constitution of the Islamic Republic of Iran, Principles 29 and 43. |
| 2000 | Third Five-year Development Plan, Article 193 |
| 2003 | Iran's 1404 Vision Policy |
| 2004 | Fourth Five-year Development Plan, Article 89 and 90 |
| 2006 | Land-use planning, Article 104, 160, 215, 228 |
| 2010 | Fifth Five-year Development Plan, Article 32 and 215 |
| 2010 | Comprehensive science map of the country |
| 2011 | Road map for the treatment sector till 2025 |
| 2017 | Sixth Five-year Development Plan, Article 72 and 74 |

- **Actors**

This study phase showed different stakeholders in Iran's bed allocation decisions and policymaking processes. In addition, the position, power, interest, and influence level of the identified stakeholders were varied. Recognizing the critical stakeholders and their roles can be necessary to develop, adopt, and implement effective policy solutions [25]. CCU bed allocation and its policy-led implementation is an inherently cross-sectoral field. The key actors were:

- Central Government: The Ministry of Health and Medical Education (MOHME), Universities of Medical Sciences, Iran Health Insurance Organization (IHIO), Planning and Budget Organization, the Parliament, and Governorate/municipality

-Local Government: Regional health administrators, Deputy for the curative affair, Members of Parliament, and politicians.

-Voluntary and community groups: including the healthy donors and incorporating many local campaigning groups across the Region.

Table 5 demonstrates the estimated position, power, interest, and influence of the stakeholders involved in the CCU beds allocating related decision- and policymaking processes.

Table 5. Rating the stakeholders according to position, power, interest, and influence

| stakeholders | Position analysis | | | | | Interest analysis | | Influence analysis | | | | | | Power analysis | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Person | Group | Organization | Internal organization | External organization | Financial | Non-financial | Influential | Influenced | Positive | Negative | Obvious | Hidden | Conscious | Unconscious | Design | Implementatio |
| Cardiologists & Physicians | * | | | * | | * | * | * | | * | | * | | * | | | * |
| Commission Article 20 in the Ministry of Health and Medical Education | | * | | * | | | * | * | | * | | * | | * | | * | |
| Deputy for Curative Affairs in universities of medical sciences | * | | | * | | | * | * | | * | | * | | * | | * | * |
| Deputy for Curative Affairs in the Ministry of Health and Medical Education | * | | | * | | | * | * | | * | | * | | * | | * | |
| Deputy for Education in the Ministry of Health and Medical Education | * | | | * | | | * | * | | * | | * | | * | | * | |
| Deputy for Management Development and Finance in the Ministry of Health and Medical Education | | * | | * | | * | * | * | * | * | | * | | * | | * | |
| Elites | * | | | | * | | * | | * | * | | | * | * | | | * |
| Governorate/municipality | | * | * | | * | | * | * | | * | | * | * | * | | * | * |
| Health donors | * | | | | * | * | * | * | * | * | | * | * | * | | | * |
| Heyat Omana Arzi | | * | | * | | * | | * | | * | | * | * | * | | | * |
| Households or Users | * | * | | | * | * | * | | * | * | * | * | | * | * | | * |
| Insurance organizations | | * | * | | * | * | * | * | | * | * | | * | * | | | * |
| Medical Council of the Islamic Republic of Iran | | * | * | | * | | * | * | | * | | | * | * | | | * |
| Parliament | * | * | | | * | | * | * | | * | | | * | * | | * | |
| Planning and Budget Organization | | * | * | | * | * | | * | | * | | * | | * | | * | * |
| Private hospital | | * | | * | | * | | | * | * | * | * | * | * | | | * |
| Regionalization department in the Ministry of Health and Medical Education | | * | | * | | | * | * | | * | | * | | * | | * | |
| University board | | * | | * | | | * | * | | * | | * | | * | | * | |
| University Hospital | | * | | * | | * | | * | * | * | * | * | | * | | | * |
| University President | * | | | * | | | * | * | | * | | * | | * | | * | |

### -Policy Process

The absence of a reliable, comprehensive process for allocating CCU beds leads to increased political pressures on bed allocation. Nevertheless, in general, the process of allocating CCU beds in Iran is as follows. The process of allocating CCU beds starts based on the need declared by regional hospitals or specialists. The requests are investigated by the province's universities of medical sciences, and if approved, they are sent to the MOHME. The department of allocating of the MHME has investigated the universities' demands, and if it complies with the official rules and formal indicators, it will be approved. The issued permits are financed by the Planning and Budget Organization.

## 3.4 Delphi

In the Delphi phase, full explanations were given to all the critical informants regarding the components of the model and the key factors affecting each model. Then each individual scored each model in nine perspectives of importance and applicability. In this section, the individuals' scores from 1 and 2 that

disagree and items 3 and 4 agree were given to each perspective. In the information analysis step of this section, the scores were sorted from right to left. For example, the number 4 in “very high” was considered, and the number 1 in “very low” was considered. Then, the Content Validity Index (CVI) was computed for each model in scale (I-CVI) as well as for the overall scale (S-CVI). Kappa was used to determine the inter-rater agreement among the raters. The I-CVI for all models was under 0.76, except for the trend analysis model (0.83). Ultimately, the Trend Model was accepted as a well-suited model for Iranian hospital settings (Table 6).

# Table 6. Content validity index

| Model name | I-CVI | | | | | | | | | S-CVI | Model rating |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | The executable capability | The adaptation to the structure of Iran's health system | The adaptation to the economic, cultural, and social structure of Iran | Efficiency and effectiveness | Flexibility | Comprehensibility | Acceptability | The comprehensiveness | Appropriateness | | |
| Trend Analysis | 0.82 | 0.69 | 0.82 | 1 | 0.82 | 0.76 | 0.82 | 0.94 | 0.82 | 0.83 | 1 |
| The Greater Glasgow | 0.52 | 0.42 | 0.69 | 0.76 | 0.69 | 0.61 | 0.52 | 0.76 | 0.42 | 0.59 | 2 |
| Michigan's Bed Need Methodology | 0.76 | 0.76 | 0.52 | 0.35 | 0.52 | 0.94 | 0.61 | 0.28 | 0.52 | 0.58 | 3 |
| The Swiss Health Observatory | 0.69 | 0.52 | 0.61 | 0.76 | 0.52 | 0.76 | 0.69 | 0.35 | 0.31 | 0.58 | 4 |
| Lausanne University Hospital | 0.82 | 0.69 | 0.61 | 0.31 | 0.42 | 0.82 | 0.69 | 0.31 | 0.42 | 0.56 | 5 |
| Basic scenario model | 0.69 | 0.69 | 0.69 | 0.31 | 0.52 | 0.82 | 0.52 | 0.31 | 0.28 | 0.54 | 6 |
| Current Use Projection | 0.61 | 0.61 | 0.52 | 0.35 | 0.31 | 0.88 | 0.61 | 0.28 | 0.31 | 0.5 | 7 |
| Capacity model | 0.28 | 0.26 | 0.42 | 0.82 | 0.61 | 0.26 | 0.35 | 0.76 | 0.61 | 0.49 | 8 |
| Israeli Model | 0.52 | 0.76 | 0.61 | 0.35 | 0.42 | 0.69 | 0.31 | 0.28 | 0.28 | 0.47 | 9 |
| Score Model | 0.52 | 0.42 | 0.42 | 0.31 | 0.35 | 0.61 | 0.22 | 0.26 | 0.22 | 0.37 | 10 |
| The Status Quo model | 0.52 | 0.69 | 0.35 | 0.059 | 0.26 | 0.82 | 0.35 | 0.12 | 0.06 | 0.36 | 11 |

# Discussion

This study has been conducted as a policy analysis on allocating Coronary Care Unit (CCU) beds to select the suitable model for CCU bed allocation in Iran. The number of beds in the CCU must suit the reference population's needs and the hospital's relatively specific workload. Skilled physicians, an attending cardiologist on call, and adequately trained nurses should always be present in the CCU. Furthermore,

dieticians, computer experts, ventilation technicians, social workers, physiotherapists, porters, and cleaners impact patient care [26]. Allocating CCU beds have caused many challenges for health managers and policymakers, such as lack of equipment, the high prices of equipment, and budget restriction. Meeting these challenges in the fairest way possible depends upon developing a standardized strategy for delivering CCU services in times of limited supply [27].

According to the reviewed studies, there have been two main approaches to overcoming these challenges. The first one, “rationing”, requires the development of specific guidelines for determining CCU admission and discharge policies. The second approach involves improving the health system's efficiency. Both require establishing a standard of care to improve fair service utilization and reduce the potential for personal biases in the decision-making process. Also, several dimensions and complex factors should be considered for bed allocation.

In this study, we identified the models for bed allocation that can be used to determine the required number of CCU beds and the influencing factors on bed rationing. In addition, we have identified the factors and variables affecting the distribution of CCU beds in 10 dimensions and 58 relevant variables that could improve the utilization and accessibility of these resources.

One of the most compelling dimensions of CCU bed distribution mentioned in most conducted interviews was the political dimension, in which the critical subcomponents were local politicians' bargaining power. The lack of approved guidelines, established standards, and practical models has aggravated the challenges of CCU bed allocation in Iran. So, the role of upstream documents and policies, political parties, and the bargaining power of local politicians has become prominent in CCU bed allocating in Iran's health system. Also, one of the most compelling dimensions that emphasized the model of bed distribution identified through review was the organizational dimension, in which the critical subcomponents were the patient’s waiting list, bed occupancy rate, admission rates, and the average length of stay.

In addition, population, age and gender composition, population size, and regional distribution were the most significant factors considered for hospital bed capacity planning, regardless of the population's needs. Even though a proper understanding of the needs in different regions leads to optimal allocation and facilitates the distribution of CCU beds, using population-level indicators as a basis for measuring the state of distribution of health resources can be effective if the burden of CVD disease is equally distributed at the population level or at least lack of any underlying indicator. However, if there are need-oriented indicators, such as the number of cardiovascular patients in each geographic Region, it is no longer logical to distribute resources based on the population level [28]. Furthermore, population growth and aging can affect the demand for CCU services [29]. Aghamohamadi et al. indicated that changing patterns of disease and moving toward chronic diseases, as well as the population age pyramid transitions, means the aging phenomenon and shifts in gender structure would greatly influence the future demands for hospital beds in Iran [30]. Older people are typically the primary users of CCU services, increasing admission rates and the average length of stay in CCUs [11].

Additionally, investment costs, the presence of healthy donors, and the physical and environmental attributes of the Region are among the essential factors in allocating CCU beds and medical facilities. This leads to inequality in access to intensive cardiac care in less prosperous provinces. Meskarpour-Amiri et al. demonstrated that the inequalities in the distribution of CCU beds significantly increased from 2010 to 2012. So, Yazd province had the highest CCU beds than any other provinces (two times more than that other provinces), while Qazvin province and Kohkiluyeh Province had the lowest CCU beds per 100.000 population [31]. In a study, Kiadaliri et al. showed that Yazd province enjoys an equal distribution of CCU beds, and Ilam province suffers from the least equal distribution of CCU beds [32].

In 2018, a study was conducted by Abbasi et al. to develop a hospital bed distribution model in Iran. In this study, 23 factors in 5 dimensions have been identified that affect hospital bed distribution. This study indicated that the organizational and geographical dimensions had the most substantial and lowest influence on hospital bed distribution [33]. In another study conducted by Farrokhyar et al. in 2019 to design a model for the distribution of intensive care beds in Iran, 34 variables were identified in the form of 6 main components that impact the distribution of intensive care beds. Among the influential components, the demographic factor component plays a very prominent role in the distribution of intensive care beds [9]. In the study by Ataolahi et al., the average wait time for using the bed was considered an essential factor in hospital allocations [34]. Goudarzi et al. introduced the bed-to-population ratio as one of the criteria for predicting the number of required beds in hospitals [35]. In a study on the distribution of active hospital beds in Iran by Tofighi et al., Yazd province had the maximum, and Lorestan province had the minimum number of beds per population [11].

However, the attitude of managers and policymakers plays a significant role in prioritizing these factors. On the other hand, factors external to the health system, such as epidemiological and demographic changes, are harder to predict and control. Therefore, policymakers prefer to use predictable indicators to allocate CCU beds without considering political, technological, and epidemiological uncertainties and changes in the future. In this study, despite identifying all the influential factors in allocating CCU beds, the experts considered organizational indicators more to choose the appropriate model for allocating CCU beds. Since these factors had less uncertainty, experts picked the Trend Model through the Delphi method and according to the Iranian health system context for allocating CCU beds. Trend Model in hospital care utilization is examined through population age and sex composition, Region of residence (urban or rural), and clinical specialty (or diagnosis-related group). The most influential factors considered by the Trend Model were the average length of stay, bed occupancy rate, admission rates, population, Out-of-region use (inter-regional flows), and Region of patient residence. This model accounts for changes and trends in demand, such as surgical and non-surgical services, based on a specific time horizon [22]. Despite this, one of the disadvantages of the selected model is that it does not consider political, demographic, epidemiological, and technological changes.

## Limitation

The first limitation was related to some interviewees' difficulty recalling information related to past policymaking and legislative processes. Conducting multiple interviews and using documents as mechanisms were used to address this challenge. In addition, some related aspects to the understudied subject may be considered “political,” and some participants were unwilling to disclose all information due to the fear of coercive measures. For this reason, numerous interviews and documents were used to reduce the effects of this issue. Also, the researcher tried to gain the trust of the participants.

Furthermore, selecting the key informants who participated in this study from resource allocation and regionalization policymaking process members can lead to response bias due to their experiences and involvement in the policy process. However, data from informants were comparable to data extracted from the document review. Therefore, this bias cannot impact the study's results much.

# Conclusion

The result of the study demonstrated that the allocation of intensive care beds in Iran is challenging. In order to manage these challenges, approving guidelines and creating legal enforcement to follow guidelines are crucial. Using the model can systematize the bed allocation. According to the current research results, it could be concluded that the chosen model in this research, the Trend Model, has provided a means of decision-making for the health system policymakers to improve CCU bed distribution even though further accurate information over different periods is required for this model. Considering that the trend model does not consider future changes, it is suggested to use the foresight approach in future studies to develop the model for allocating CCU beds. In the first step, all the factors that decrease the need for CCU beds and increase the demand for beds are identified, and then a force field is drawn. Future scenarios (optimistic, pessimistic, and realistic) should be developed based on the cross-impact analysis. At last, the best match scenario should be used to identify and develop the most appropriate strategies.

# Declarations

### Ethics declarations

The study was approved by the Health Management and Economics Research Center, Iran University of Medical Sciences, with the code IR.IUMS.REC.1399.924.

The authors certify that this study has received ethical approval from the appropriate ethical committee described above. Informed consent was obtained in the Persian language.

### Conflict of interest

The authors declare that they have no conflict of interest.

### Availability of data and material

All data generated or analyzed during this study were included in the published article.

### Competing interests

The authors declare that they have no competing interests.


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### Authors' contributions

Designing the study, data collection, analysis, drafting the first version of the article and finalization of the article conducted by M.H., N.M., J.A. and S.A. cooperated in study design and data collection. All other authors read and approved the final manuscript. Consent for publication is not applicable as this study did not include names, images, or videos relating to individual participants

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# Figures

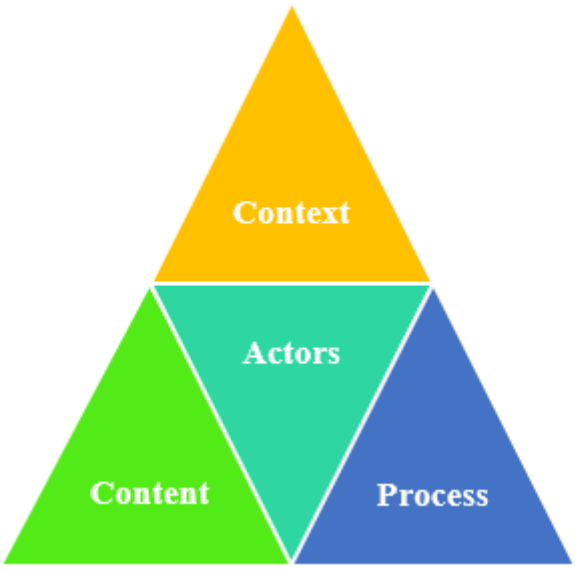


Figure 1

Walt and Gilson's policy triangle framework [14]

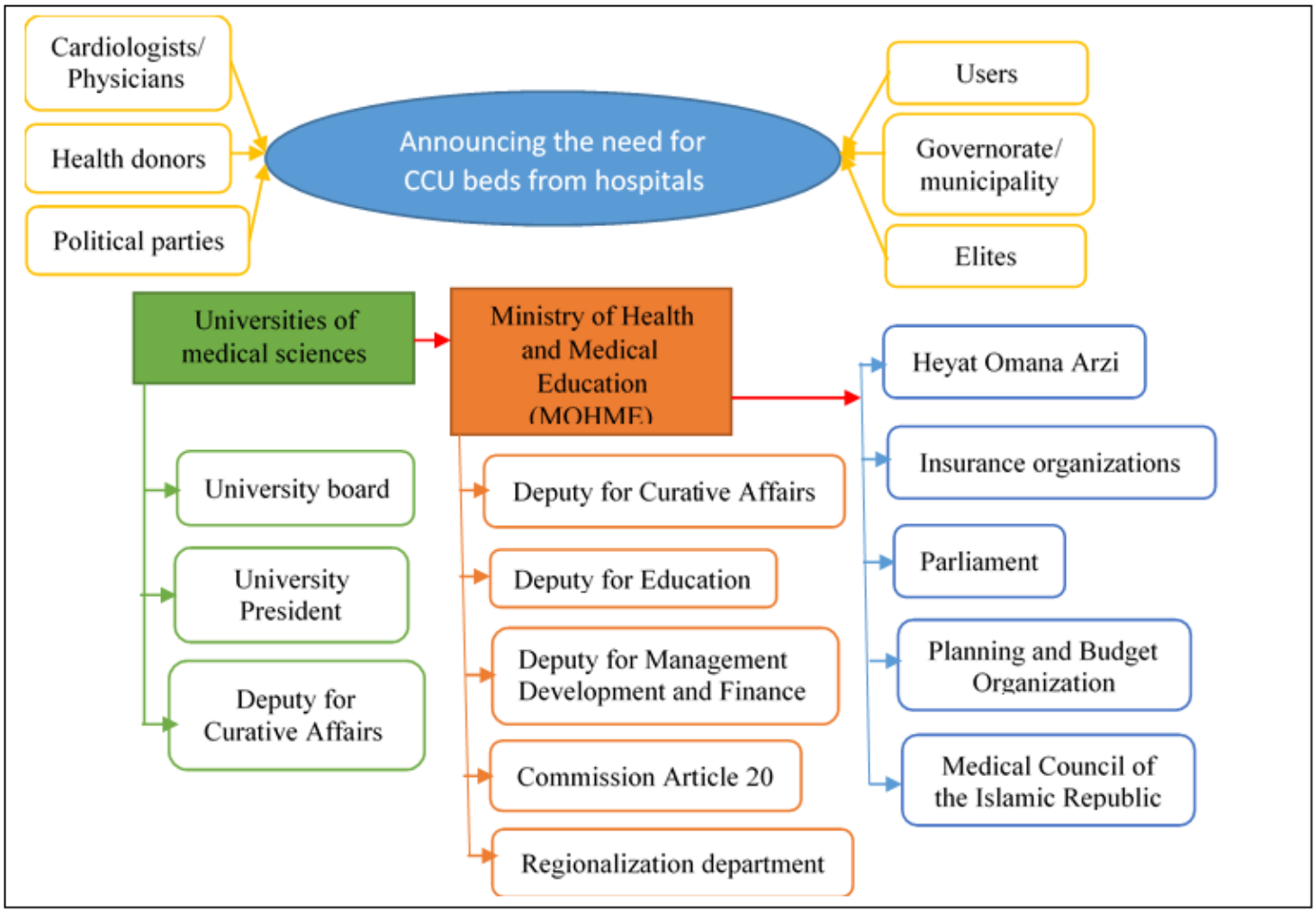


Figure 2

National action process for CCU bed allocation in **Iran**

## Supplementary Files

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