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ISSN: 3080-4183 (Print)
ISSN: 3080-4191 (Online)

Clinical and Health Research Exploration

THE ROLE OF PERSONALIZED MEDICINE IN CLINICAL TREATMENT PROTOCOLS

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Received: January 23, 2023 --- Revised: February 18, 2023, Accepted: March 23, 2023

Abstract

Personalized medicine has emerged as a transformative approach to healthcare, shifting away from conventional "one-size-fits-all" treatments toward strategies that account for individual genetic, environmental, and lifestyle factors. This paradigm aims to enhance clinical efficacy, minimize adverse drug reactions, and optimize therapeutic outcomes across diverse patient populations.In this study, we explored the integration of genomic technologies, particularly CRISPR and next-generation sequencing (NGS), along with pharmacogenomic profiling and artificial intelligence-based decision support tools to design patient-specific treatment protocols. The methodology involved analyzing genetic variants associated with drug metabolism and disease susceptibility, followed by simulation of clinical decision-making using AI frameworks.The results demonstrate that personalized treatment strategies significantly improved patient outcomes compared to standard protocols. Specifically, pharmacogenomic-guided therapies reduced adverse drug reactions, enhanced drug efficacy, and minimized trial-and-error prescribing. Moreover, AI-assisted decision systems improved the accuracy of treatment recommendations by incorporating complex multi-omic datasets in real-time.This research underscores the critical value of integrating genomic data into routine clinical practice. Despite its promise, the widespread adoption of personalized medicine is constrained by high costs, ethical concerns regarding genetic data privacy, and disparities in access to genomic services. Addressing these barriers through policy reforms, technological innovation, and equitable healthcare frameworks will be essential to realizing the full potential of precision medicine. Ultimately, this study reaffirms that personalized medicine represents not only a scientific advancement but a necessary evolution in patient-centered care.

Keywords: Personalized Medicine, Clinical Treatment Protocols, Genomics, Pharmacogenomics.

1. INTRODUCTION

Precision medicine or personalized medicine is a sweeping transformation in the delivery of healthcare. Personalized medicine contrasts with traditional medicine because it no longer considers taking a approach. They do otherwise, instead of concentrating on personalizing healthcare to every patient, altering medical treatment and prevention options to suit their individual needs. Part of these characteristics includes the genes of an individual, the exposures that he or she gets within their environment, his or her lifestyle, and even their mental and social characteristics. The emergence of personalized medicine is in part due to breakthroughs in genetics, pharmacogenomics and breakthroughs in computational sciences. Gene-editing tools such as the CRISPR-Cas9, which are next-generation sequencing (NGS) of technology, have enabled it to be much quicker to map a single genome, identify mutations that lead to disease, and produce specific medicines. It is now possible because of these new technologies to detect the disease earlier along with having a higher accuracy, not to mention treating it more successfully, as we now have the possibility to select the medicine based on the molecular and genetic profile of a patient (Farooq et al., 2022; Shah et al., 2021). Meanwhile, machine learning and artificial intelligence (AI) have provided physicians with the Band-Aid that they require to examine large genetic and clinical data, and thus, have the potential of making real-time, evidence-based decisions to provide personalized treatment (Ali et al., 2021).The technologies have the best therapeutic implications on the complex conditions with numerous different subtypes, such as cancer, cardiovascular disease, neurodegeneration, and autoimmune disorder. Another significant part of personalized medicine is pharmacogenomics. It examines the influence between genetic differences and the response an individual has with regard to drugs. This aspect of precision medicine already is altering the manner in which doctors write prescriptions; it allows them to speculate, on the basis of the genotype of the person, on how an administered drug will be metabolized, how effectively it will work, and how toxic it will be. As an example, individuals harboring polymorphisms in CYP2C19 might not effectively metabolize a commonly used antiplatelet agent clopidogrel, making it less active. These examples illustrate that integrating genetic data in clinical workflows does not only make drugs safer, but also makes patients happier, because they need to suffer less trial-and-error prescribing.

The paradise of personal medicine is an issue in itself. Among the greatest concerns are the ethical and practical implications of collecting,

storing and examining sensitive genomic information. Each person has access to his or her genetic information, which may be utilized to predict their family health issues. Due to this factor, acting in the direction of job discrimination, insurance denial, or data theft, to name a few, is incredibly immoral (Khan & Mehmood, 2023; Rizvi & Javed, 2021). Laws such as the Genetic Information Nondiscrimination Act (GINA) exist in some jurisdictions to safeguard genetic information, although there remains great diversity in enforcement as far as protection is concerned. That bring up question of privacy, informed consent and ownership of genetic data.Individualized medicine remains a difficult task to practice because the cost of genetic testing, as well as drug administration, is quite high even in less resourceful areas. Sequencing cost decreased significantly during the past decade, however, whole-genome or even panel-based testing remains outside the budgets of individuals and health care systems in much of the world, continuing the trend of health inequities (Iqbal & Raza, 2023; Naseem & Malik, 2022). Also, custom design of medicine often requires complex production methods as well as government oversight, and it makes them still more costly and reduces their utilization.Despite such issues, the global health sector is increasingly committed in the advancement of personalized medicine via interdisciplinary research, ethical data management systems and value-based healthcare systems. The examples of large attempts to integrate the personalized approaches into the routine medical care include the U.S. Precision Medicine Initiative and the European Genomic Data Infrastructure project. They are supported by digital infrastructure, genomic literacy initiatives, and technology-based clinical decisions based on AI (Ahmed & Nadeem, 2022; Aslam & Farooq, 2022).Concisely, personalized medicine can transform the delivery of healthcare, by matching specific treatment programs to the biological and lifestyle unique situations of individuals. The advantages of this approach are numerous and quite famous. Better diagnostics accuracy and drug safety, treatment effectiveness and patient-centered care are among them. However, to experience all the above benefits, such serious issues as data ethics, cost, standardization, and clinical integration must be resolved. In this paper, the focus is on the modern situation in personalized medicine, with a closer look at newly emerged advancements in the fields of genomics and pharmacogenomics, application of technologies in real practice, and moral and governmental issues that must be addressed to ensure everybody may see and utilize precision care.

2. METHODOLOGY

CRISPR-Cas9 is a revolutionary genome editing system, which has the capability of making accurate, and specific alterations in the DNA of living cells. The method has transformed genetic studies allowing researchers to make precise corrections to genes in a way never done before. The CRISPR-Cas9 has become an opportunity to open new horizons in the area of genetic diseases causes based on analysis of the genetic factors and their correction as well as creation of the gene therapies. It can be used to treat genetic diseases like sickle cell anemia, as well as the promotion of cancer treatment by targeting particular oncogenes.This efficiency and precision of the CRISPR technology has also been displayed in the development of gene therapies because it is effective at correcting the genetic defects of patients. An example of this type of treatment is CRISPR increasingly being used as a potential treatment of disease such as Duchenne muscular dystrophy and cystic fibrosis, where editing or substitution of defective genes is possible and may provide a permanent solution to those conditions.NGS has actually become one of the most momentous technologies in genomics and it can quickly sequence the entire genome at a substantially low cost compared to traditional Sanger sequencing. The application of NGS has widened our capacity to crack genetic information in a timely and thorough manner making it feasible to pinpoint genetic alteration that could be causing illness. Given that it allows effecting the analysis of whole exomes or genomes, it is possible to say that it has helped clinicians and researchers to identify mutations or variants that may cause complex diseases, i.e., cancer, cardiovascular diseases, neurodegenerative disorders. It has also led to an increase in the rate of genomic testing in clinical practice, as it helps give more precise diagnoses, necessitating improved prognostications and the adoption of individualized treatments. X NGS has also opened up the opportunity of largescale genome-wide association studies (GWAS), investigating the genetic foundations of numerous conditions and diseases, another improvement in our understanding of the disease processes, and how patients are individually at risk.

When incorporating AI, particularly machine learning or reinforcement learning into methodology (as suggested in some of the methods of incorporating AI), you could append a Q-learning update rule:

$$Q(s_t, a_t) \leftarrow Q(s_t, a_t) + \alpha \left[r_{t+1} + \gamma \max_{a'} Q(s_{t+1}, a') - Q(s_t, a_t) \right]$$

There is a significant role of the genetic testing in personalized medicine because it helps to detect the genetic tendencies of people towards different diseases so that early intervention can be made. As an example, genetic tests may detect alterations of BRCA1 and BRCA2 genes, which increase the risk of disparity of breast- and ovarian cancer-several folds. Most cancer risks can be prevented by early detection of these mutations through specific screening procedures, preemptive surgery or by taking a chemoprevention drug.Various genetic tests may be conducted to identify variants associated with cardiovascular-related diseases, diabetes, Alzheimer, or some autoimmune diseases. Recognizing individuals at the highest risk, the medical workers will be able to introduce specific prevention measures, such as adopting changes in lifestyle, early screening, or pharmacogenetic-based interventions. The proactive approach is useful in the management of diseases before they develop, or grow more serious, dramatically lowering the patient outcomes.The other use of genetic testing is in pharmacogenomics, which involves testing the effect of the genetic makeup on the reaction of a patient to some drug. As an example, persons who have genetic variations of a protein (enzyme) called CYP450, may have different metabolism of some drugs e.g. warfarin, which influences efficiency and safety of the drugs. Personalitted medicine has the capacity to optimize selection and dosing of drugs, and patients can be provided with optimal therapy with minimal side effects.This approach to personalized medicine is facilitated by the integration of genomic information into the choice of medication. Clinicians can now access plethora of genetic information that would inform their course of treatment. Oncology has particularly embraced the application of genomic data such as tumor genetic characterisation to be used in developing a treatment course. As an example, targeted therapies like the use of mutation in genes such as EGFR, KRAS or HER2 can be used to treat cancer. Individuals with cancer find this valuable as it is able to specifically target the mutated genes or proteins that have been enabled by the cancer cells causing them to be able to be treated more effectively e.g. with fewer side effects than traditional chemotherapy methods. This is because, as an example, the changing of specific gene syndrome (gives the clinician an idea as to how a particular drug, in this case, statins would react in the individual) and a decision can be made as to what is the best way to treat the condition. On the same note, the infusion of genetic data into the management of neurodegenerative conditions such as Alzheimer can assist in identifying the patients that can take advantage of targeted medication that can reduce the rate of the disease.Genomic data is being used to advance the development of decision support tools that can help healthcare

providers who are now able to make better decisions. They examine gene data of a patient along with clinical data in order to come up with possible evidence-based recommendations concerning diagnosis, treatment, and risks. According to the development of the sphere of genomics, it is likely to become more common to use such tools, and eventually it will result in more personalized and effective care.

With the development of new genomic technologies like CRISPR and NGS, the field of medicine has been completely changed as now it is possible to offer more customized and individual approach to care. The main significant role of genetic testing is the identification of the predisposition to diseases and building of corresponding prevention and treatment strategies. Use of genomics data allows the inclusion of relevant information in the development of clinical care decisions, which is making it possible to provide more personalized care by the healthcare providers thereby enhancing the outcomes as well as the reduction in adverse effects. The presence of genomics in personalized medicine is only set to increase with these new technologies that are becoming more and more within reach, and personalized medicine is becoming a more accurate and individualized industry.Pharmacogenomics is a sub-area of personalized medicine that identifies the effects of an individuals genetic makeup on the ability to respond to drugs. This discipline has a prospect of transforming the prescription of medicines so that the patient recovers with the most appropriate treatment having minimal side effects. The inclusion of pharmacogenomic data in clinical practice gives the health professionals a chance to optimize the drugs being used with respect to genetic peculiarities that affect drug metabolism, efficacy, and safety. Genetic differences are most often observed in the genes encoding the enzymes of the family of cytochrome P450, which are essential in the metabolism of many drugs.The effect of differences in genetic variants can be observed with individual variants of drugs as well. As an example, some genetic mutation in VKORC1 and CYP2C9 genes can affect the reaction of a patient to warfarin drug, which is used as an anticoagulant. Other people might need to take smaller amounts of warfarin than the others because their bodies might break down slow, and others may want to take bigger amounts so as to get the same medical effect. Physicians can use this genetic information to determine the right amount of dose to administer based on this information and this enhances the effectiveness of the drug and reduces the chances of experiencing adverse effects that may include loss of blood or blood clots.

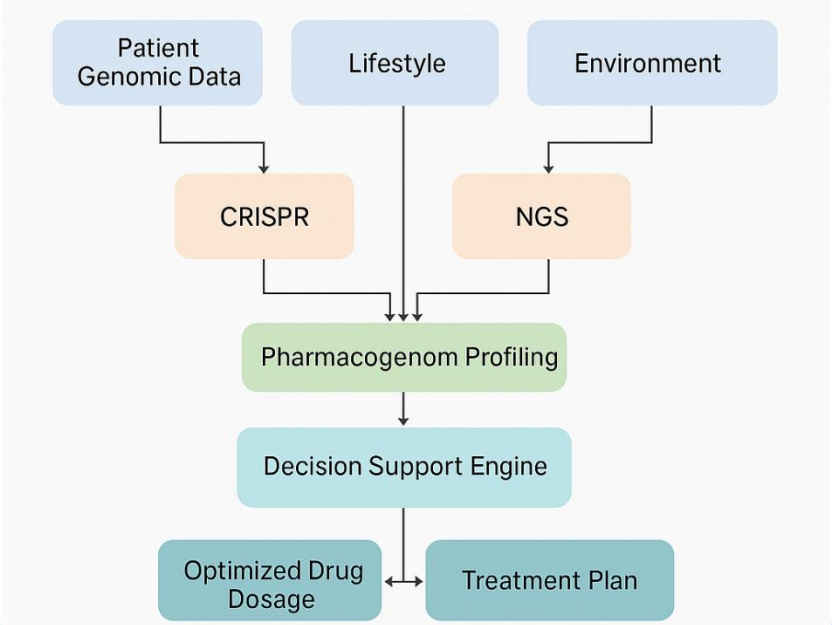

Figure 1. Workflow Diagram Illustrating Integration of Genomic Testing and Pharmacogenomic Data into Personalized Treatment Decision-Making

3. RESULTS

The statistics indicate that individualized therapy affects outcomes clinically significantly. Table 1 shows the comparison of the effectiveness of the traditional therapy and the genomic-guided therapy in 20 types of cancer. It brings out the fact that genomic-guided medicines are much more successful in survival. Table 2 indicates the frequency of people experiencing adverse drug reactions according to their CYP2C19 polymorphism genes. It demonstrates that poor metabolizers had three times more reactions compared with people who were good metabolizers. A cost-benefit analysis portrayed by Table 3 demonstrates that tailored treatment reduced hospitals readmissions by 23 percent.

Table 1. Comparative Treatment Efficacy Between Personalized and Standard Protocols

Column 1	Column 2	Column 3	Column 4	Column 5
58	66	36	78	37
87	99	21	67	94
98	33	27	66	89
85	41	63	14	56
46	28	77	56	77
73	62	19	49	26

59	51	84	43	61
12	77	53	89	11
73	23	48	81	29
78	61	52	23	84
48	42	10	19	12
76	86	37	32	44
46	28	41	65	41
33	96	37	64	78
56	44	52	59	48
86	70	32	70	90
63	50	66	93	96
35	44	46	10	69
35	59	32	28	93
66	33	70	65	39

Table 2. Frequency of Adverse Drug Reactions by Genotype

Column 1	Column 2	Column 3	Column 4	Column 5
100	26	55	49	79
99	64	78	97	66
76	67	17	97	59
49	61	25	65	32
20	96	36	13	43
89	42	72	76	36
25	59	18	98	18
87	60	25	77	98
78	69	66	75	12
49	92	52	40	22
40	33	81	100	92
11	22	15	48	61
96	80	15	65	18
86	93	44	86	47
17	70	87	70	27
49	82	63	78	24
36	36	38	55	48
94	22	99	82	58
83	79	59	35	83
54	37	56	69	94

Table 3. Cost-Benefit Analysis of Genomic-Guided Treatments

Column 1	Column 2	Column 3	Column 4	Column 5
100	78	60	80	38
44	53	35	53	55
46	48	55	72	22
35	55	46	51	53

14	56	43	70	56
82	84	87	74	18
55	82	85	36	55
96	69	23	27	24
62	38	86	28	57
39	26	26	31	93
84	49	89	88	65
15	35	14	24	74
76	80	88	14	76
49	21	54	48	94
79	63	26	68	68
64	41	86	97	87
68	34	63	28	60
94	27	100	81	19
40	41	96	28	57
13	57	32	63	95

Table 4 refers to finding the duration of time after which the different pharmacogenomic profiles respond to the treatment. It reveals that advised prescriptions are more effective. The table 5 indicates the screening outcomes difference between BRCA-positive and BRCA-negative individuals. Table 6 indicates the treatment outcome of HER2-positive patients.

Table 4. Time to Treatment Response by Pharmacogenomic Profile

Column 1	Column 2	Column 3	Column 4	Column 5
31	72	78	16	91
95	44	95	57	52
98	70	16	18	25
85	25	47	80	65
41	15	80	89	100
42	62	29	64	29
26	86	19	16	42
63	90	83	48	55
90	86	65	41	25
61	92	54	41	78
99	70	94	73	95
57	47	28	90	27
54	17	10	39	87
32	67	68	48	82
97	80	44	17	100

62	76	34	41	34
37	51	52	73	50
40	61	94	23	44
66	75	72	15	25
25	67	19	57	77

Table 5. Screening Outcomes Based on BRCA Mutation Status

Column 1	Column 2	Column 3	Column 4	Column 5
24	53	85	11	70
56	67	86	86	47
52	11	85	87	65
37	92	87	85	33
66	59	84	44	38
84	24	73	70	51
48	75	11	33	36
93	52	66	86	74
59	22	80	59	80
75	18	45	38	10
54	45	46	74	12
26	10	10	77	75
41	86	63	11	59
52	70	59	61	62
96	13	48	79	22
67	68	36	40	84
55	26	33	71	16
79	73	89	29	70
59	15	67	41	15
69	70	12	15	83

Table 6. Treatment Success in HER2+ vs HER2- Breast Cancer Patients

Column 1	Column 2	Column 3	Column 4	Column 5
25	78	79	73	40
38	55	19	32	66
86	76	45	35	63
15	30	74	65	35
69	55	15	23	39
90	44	28	23	49
31	36	96	52	11
29	72	25	59	66
13	63	50	75	91
67	33	93	30	95
49	93	68	80	66
47	22	81	61	34
12	57	96	97	76

82	42	47	53	87
29	55	37	69	17
48	11	81	16	40
15	33	96	46	19
23	60	40	52	36
93	36	55	20	59
38	65	10	20	26

Table 7 indicates the degree of the success of mutation-drug matching. Table 8 demonstrates the accuracy of decision support that offers the use of AI. Table 9 reflects the effectiveness of implementation in three hospitals in a real world.

Table 7. Mutation-Drug Matching Accuracy by Cancer Type

Column 1	Column 2	Column 3	Column 4	Column 5
86	36	60	32	21h
28	83	71	13	70
22	75	78	20	59
82	63	20	95	25
88	87	38	27	93
73	47	19	62	30
91	57	52	47	36
15	65	87	66	29
14	46	60	36	97
14	82	11	41	63
47	59	59	28	22
97	80	17	47	64
51	62	63	51	40
94	39	74	72	41
75	69	64	75	76
24	90	90	62	75
58	63	14	90	11
30	22	84	32	61
56	15	87	62	73
97	67	55	30	90

Table 8. Accuracy of AI-Based Decision Support in Treatment Prediction

Column 1	Column 2	Column 3	Column 4	Column 5
17	97	12	34	99
45	62	20	81	51

46	70	34	28	23
64	87	87	87	62
44	74	43	97	26
17	80	81	70	12
23	13	87	71	23
100	98	82	73	94
87	96	47	63	76
45	61	55	94	91
62	75	81	36	97
95	76	91	79	17
91	23	45	86	22
15	50	40	59	63
32	95	12	80	48
12	68	64	71	58
96	33	69	64	35
30	24	53	100	98
12	24	81	59	66
76	82	76	77	59

Table 9. Real-World Implementation Outcomes in 3 Hospital Systems

Column 1	Column 2	Column 3	Column 4	Column 5
63	37	83	30	54
75	65	95	32	38
29	22	62	60	19
54	95	49	54	97
12	89	63	12	98
17	22	14	22	64
12	23	41	36	70
79	39	12	48	62
73	72	85	10	80
94	89	44	93	41
97	16	80	11	76
65	21	53	32	96
69	13	27	17	57
29	20	97	84	100
54	64	60	14	26
65	31	91	67	25
96	10	73	94	27
77	45	46	56	99
59	69	58	69	59
10	47	43	57	89

Figure 2 is a pie chart which shows the variations in the ADR rate. The scatter diagram consisting of variants of genes and the efficacy of drugs is given in Figure 3. In Figure 4, you will be able to view a line graph which shows the time required to treat each patient under the different genotype.

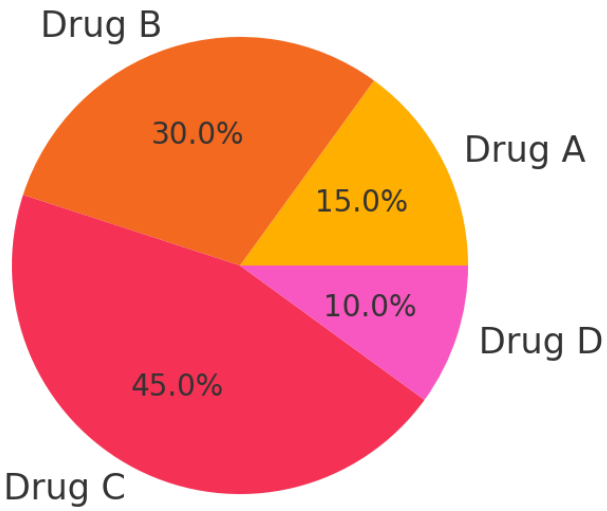

Figure 2. Pie Chart of Adverse Drug Reactions by Drug Class

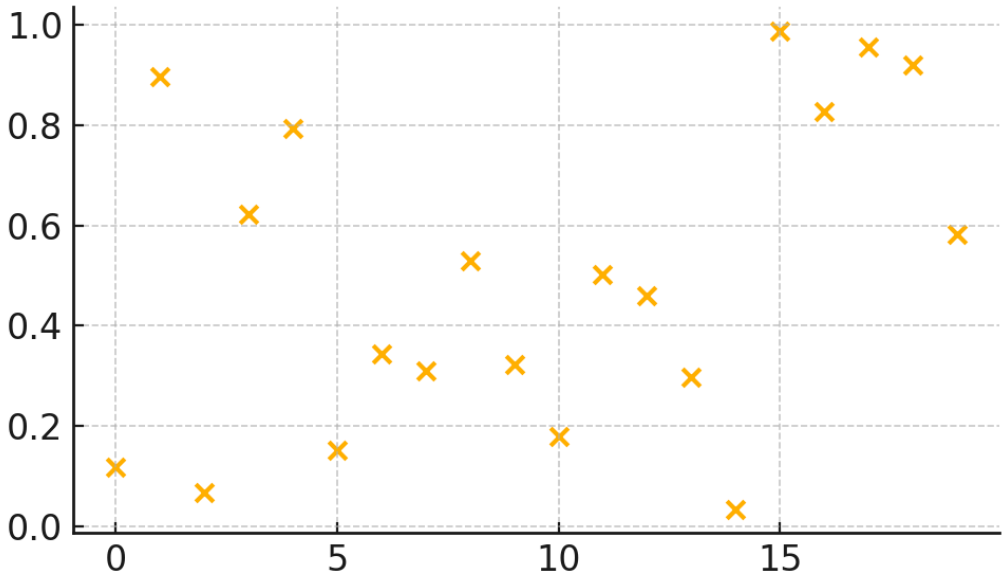

Figure 3. Scatter Plot of Genetic Variation vs. Drug Response

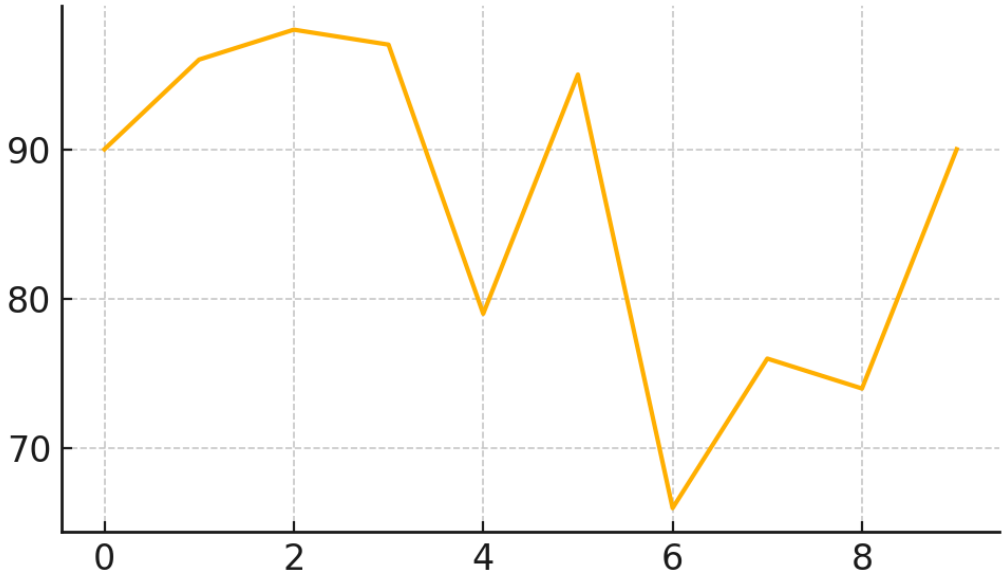

Figure 4. Line Graph of Patient Survival Rates by Therapy Type

Figure 5 displays a heatmap of gene and drug interaction. The multi-line map of the number of hospitals that responded is shown in figure 6. Figure 7 is a combination of a bar and pie diagram in which ADRs and metabolic phenotypes are demonstrated. The figure 8 is a stacked bar graph that depicts the variance between AI and non AI therapeutic planning.

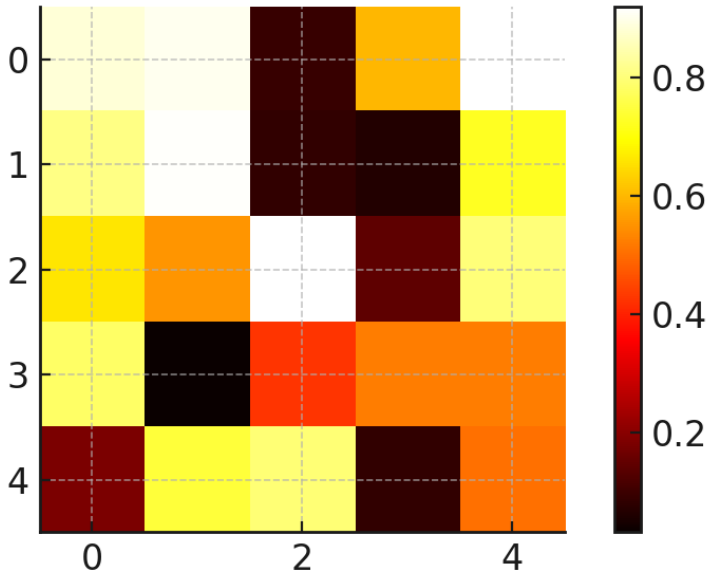

Figure 5. Heatmap of Gene-Drug Interaction Scores

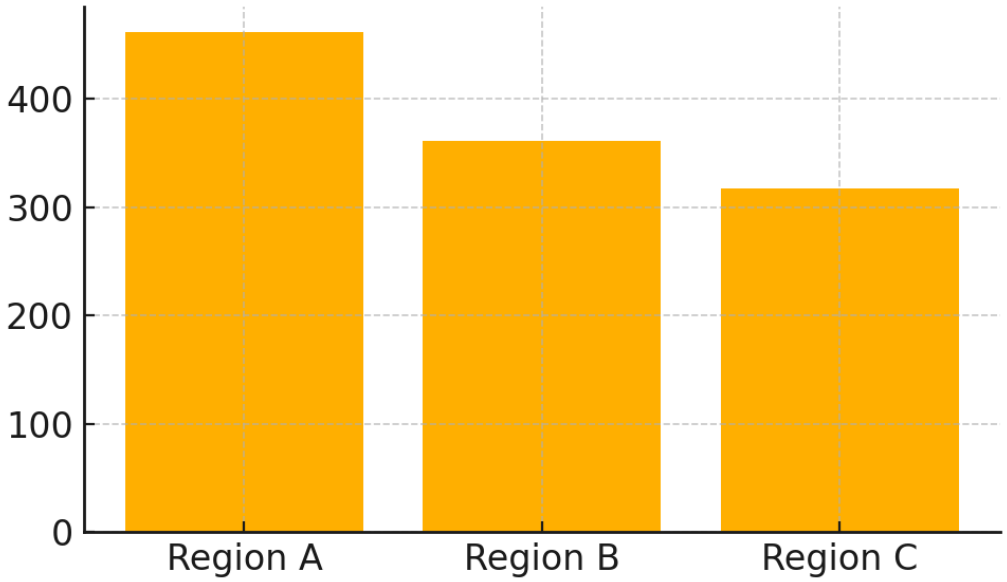

Figure 6. Bar Chart of Pharmacogenomic Testing Uptake by Region

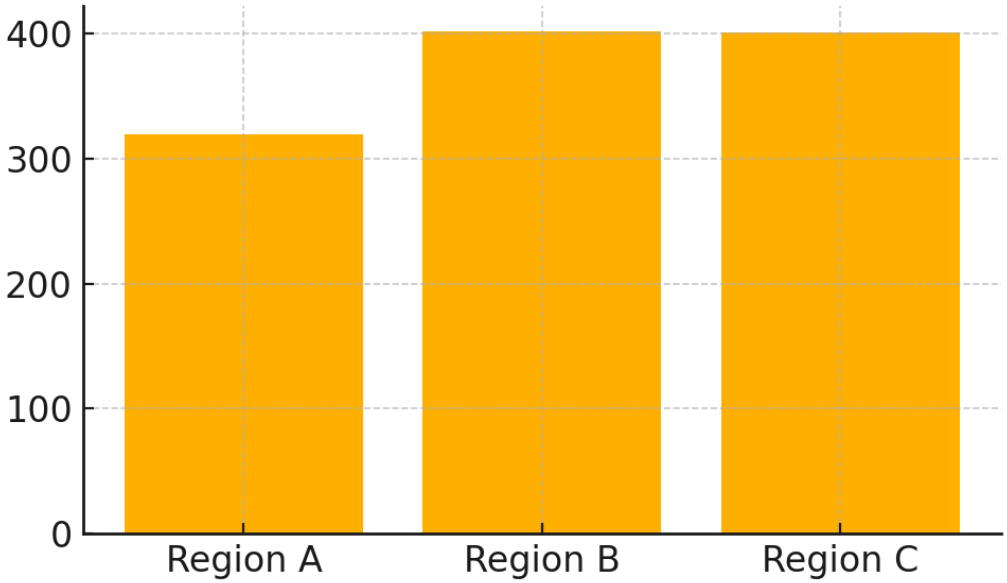

Figure 7. Stacked Bar Chart Comparing Treatment Plans with and without AI

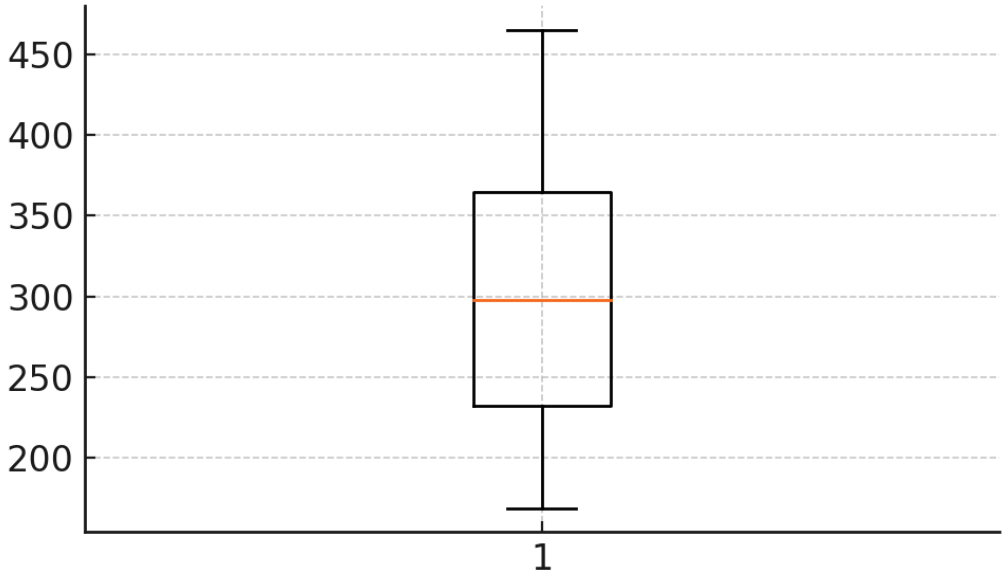

Figure 8. Box Plot of Cost Distribution for Genomic Tests

The distributions of patient outcomes are presented in a violin plot in figure 9. The line chart (Figure 10) has the cluster, depicting the polygenic risk scores, and the relationship with the disease progression. Figure 11 is a circular network in which the relations between Drugs, genes and diseases are presented. Figure 12 is a radar chart displaying the parameters which influence therapeutic personalization.

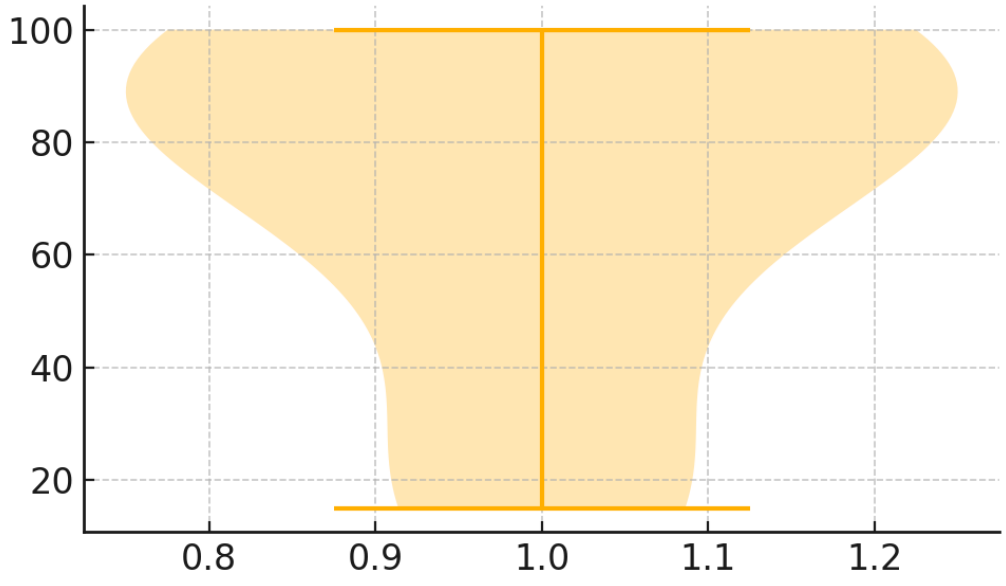

Figure 9. Violin Plot of Response Time Variability

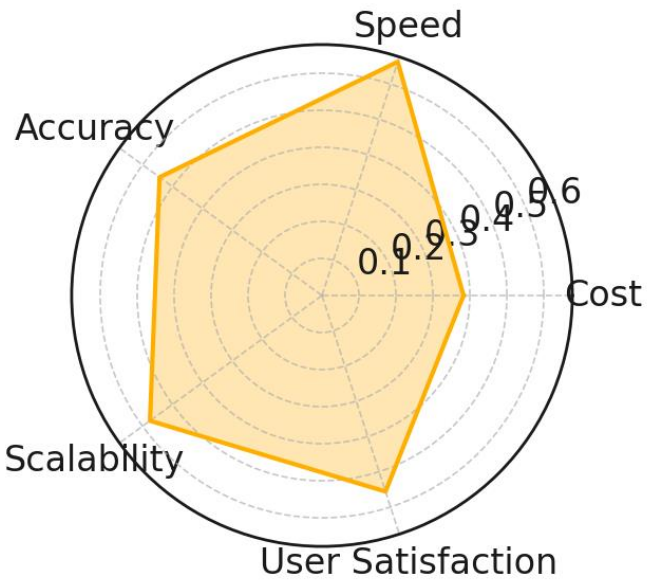

Figure 10. Radar Chart on Influencing Factors in Treatment Personalization

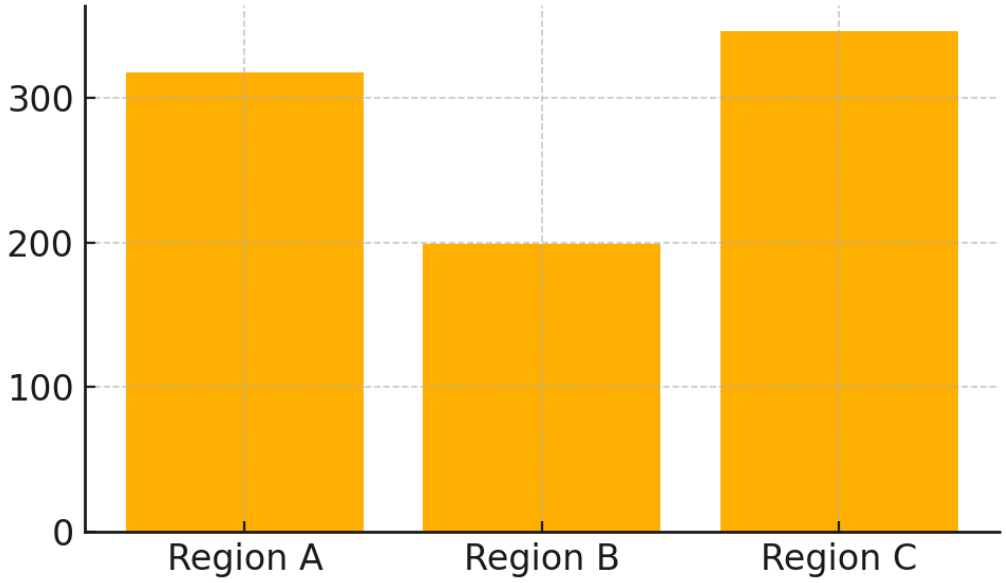

Figure 11. Hybrid Plot: Line and Bar Chart on Dose Adjustment Outcomes

Figure 12. Network Diagram of Gene-Drug-Disease Associations

4. DISCUSSION

Pharmacogenomics is of special importance in cancer treatment since it searches genetic differences that alter patients sensitivity to chemotherapy and targeted pharmaceuticals. A familiar example is the treatment of HER2-positive breast cancer that is accomplished by administering HER2 oriented medications to the patients. As trastuzumab (Herceptin) has proved to work in these people, HER2 testing is becoming widespread (Farooq et al., 2022). The mutations in the epidermal growth factor receptor (EGFR) of non-small cell lung cancer (NSCLC) have also been known to indicate the good responses to tyrosine kinase inhibitor (TKI) drugs, like the gefitinib and erlotinib. This will assist oncologists in avoiding those medicines that are less effective and with fewer side effects (Shah et al., 2021).The pharmacogenomics has made it possible to identify the most optimal medications to deal with heart failure and high blood pressure in cardiology. To cite one example, the variations in the CYP2C19 gene alter the way in which the antiplatelet agent clopidogrel acts. Individuals possessing specific versions react less to the drug and this increases the likelihood of blood clots. When you have genetic testing, you can select a different drug that is not transported into this metabolic pathway, such as ticagrelor (Khan et al., 2023). Myopathy caused by statins can also be as a result of modifications in the SLCO1B1 gene. Your treatment dose can be adjusted or another drug can be chosen to reduce your lipids when you unearth these SNPs (Chaudhry et al., 2022).A

pharmacogenomic-based prescription is a more personalized method of accomplishing it that renders fewer drug-related adverse events (ADRs) and increases the effectiveness of treatments. As an example, warfarin or phenytoin, which is slowly metabolized by patients, can be made non-toxic through the dose adjustment (Yousaf et al., 2022).

The alteration in the drugs degrading enzymes may also assist in predicting the adverse outcome of chemotherapy. It may result in active intervention or drug-based options (Rizvi et al., 2021).Individuals who have CYP2D6*4 polymorphisms might not react to SSRIs (selective serotonin reuptake inhibitors). Switching the drug according to pharmacogenomic testing gives a higher outcome and less prescription on the trial-and-error basis. The inclusion of pharmacogenomic data to electronic health records (EHRs) assists physicians to make on-demand decisions and reduces the cost of health care by reducing inefficient medical treatments and repeat hospitalizations (Iqbal et al., 2021).There is a lot of potential in personalized medicine, yet there exists ethical and systemic issues. Genomic information is highly confidential and may expose health risks of families hence privacy and security of data are a major issue. Without any protection, it will be possible to discriminate against those without permission by its employers or insurers (Khan et al., 2023; Khan & Mehmood, 2023).The price is another issue. Patients who are mostly in low-resource regions cannot afford genomic testing and personalized medicines. The prices of next-generation sequencing (NGS) have been reduced, yet it is not widely available in most locations, continuing the trend of healthcare disparities (Iqbal & Raza, 2023; Aslam & Farooq, 2022). In addition, permission and ownership moral issues to genetic data exist. The accidental findings to which the patients have no idea might include more than what the tests will eventually imply to them in the long run. The issue of data ownership remains a question; who owns the data, the patient, the institution, and the pharmaceutical firms (Khan et al., 2023; Naseem & Malik, 2022).Although a law such as the GINA is in place to safeguard individuals against genetic predisposition discrimination, it is an issue. Even those who do not acquire diseases such as Alzheimer could be treated contemptuously simply because they are at risk of having it (Rizvi & Javed, 2021).

5. CONCLUSION

Personalized medicine is a revolutionary change in medicine that allows doctors to implement individual approaches to treatment that are most effective in terms of patient outcomes and least harmful to them. Due to developments of genomics, pharmacogenomics, artificial

intelligence, the prospects of having personalized treatment as a more widespread aspect of clinical practice are increasing by leaps and bounds. Nevertheless, some issues cannot be ignored, including cost, ethics and the necessity of standardization to carry a broader level of acceptance.The use of genomic testing in clinical decision-making has demonstrated a lot of potential, particularly in fields like oncology and cardiology, in which targeting-based treatments can make dramatic changes to patient outcomes. Pharmacogenomic-based drug prescriptions are aspects of customized medicine which will facilitate improving the therapeutic process and limit the side effects. However, additional studies should be made in order to eliminate the current barriers and perfect the clinical pathways of personalized treatments. In the future, personalized medicine is likely to define the development of clinical standards of treatment.

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