

O'ZBEKISTON SHAROITIDA O'PKANING SURUNKALI OBSTRUKTIV KASALLIGI (XOBL): EPIDEMIOLOGIK YUK, ERTA DIAGNOSTIKA, DAVOLASHNI OPTIMALLASHTIRISH HAMDA RWD/RWE VA SUN'IY INTELLEKT INTEGRATSIYASINING KLINIK-AMALIY MODEL

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Annotatsiya

O'pkaning surunkali obstruktiv kasalligi (XOBL) global miqyosda o'lim, nogironlik, mehnatga layoqatning pasayishi va sog'liqni saqlash xarajatlarining ortishi bilan bog'liq eng muhim surunkali respirator kasalliklardan biridir. Jahon sog'liqni saqlash tashkiloti ma'lumotlariga ko'ra, XOBL dunyoda o'lim sabablarida uchinchi o'rinda turadi va 2023-yilda taxminan 3,4 million o'lim bilan bog'langan. Global Burden of Disease (GBD) 2021 tahlillari esa XOBLning yuki chekish, ambient va maishiy havo ifloslanishi, kasbiy chang-gaz ekspozitsiyasi, infeksiyalar, qarish va multimorbidlik bilan o'zaro bog'liq ekanini ko'rsatadi. O'zbekiston sharoitida XOBL muammosi klinik jihatdan kech aniqlanish, spirometriya qamrovining yetarli emasligi, chekish va nasvay iste'moli, changli ishlab chiqarish, qishloq hududlarida biomass yoqilg'i ta'siri, inhalatsion dori vositalariga teng kirish imkoniyatining cheklanishi hamda pulmonar rehabilitatsiya xizmatlarining kam rivojlangani bilan murakkablashadi. Ushbu maqolaning maqsadi O'zbekiston sharoitida XOBLni erta aniqlash, fenotipga yo'naltirilgan davolash, real klinik ma'lumotlar (Real World Data, RWD), real klinik dalillar (Real World Evidence, RWE) va sun'iy intellektga asoslangan klinik qarorlarni qo'llab-quvvatlash tizimlarini integratsiya qilish bo'yicha ilmiy-amaliy modelni ishlab chiqishdir. Maqola 2021–2026-yillarda e'lon qilingan xalqaro klinik qo'llanmalar, randomizatsiyalangan klinik sinovlar, meta-tahlillar, sistematik sharhlar va rasmiy statistik hisobotlarni tahlil qiluvchi implementatsion-nazariy tadqiqot sifatida tayyorlandi. Natijalar shuni ko'rsatadiki, XOBLni boshqarishda spirometriya asosidagi

tashxis, LABA/LAMA yoki ICS/LABA/LAMA terapiyasini individual tanlash, chekishni tashlash, emlash, pulmonar reabilitatsiya, telemonitoring va AI asosida exacerbation xavfini prognozlashni birlashtirish klinik natijalarni sezilarli yaxshilashi mumkin. O'zbekistonda milliy XOBL registri, standartlashtirilgan EHR ma'lumotlar modeli, hududlararo spirometriya tarmog'i va explainable AI modullarini joriy etish kasallik yukini kamaytirishning strategik yo'nalishi bo'lishi mumkin.

Kalit so'zlar: XOBL; COPD; spirometriya; GOLD; exacerbation; bronxodilatator; pulmonar reabilitatsiya; inhalatsion kortikosteroid; RWD; RWE; sun'iy intellekt; machine learning; O'zbekiston; chekish; havo ifloslanishi.

Abstract

Chronic obstructive pulmonary disease (COPD) is one of the most consequential chronic respiratory disorders worldwide, contributing substantially to mortality, disability, productivity loss, and health-system expenditure. According to the World Health Organization, COPD is the third leading cause of death globally and was associated with approximately 3.4 million deaths in 2023. Global Burden of Disease 2021 analyses indicate that the COPD burden is driven by tobacco exposure, ambient and household air pollution, occupational dust and chemical exposure, ageing, respiratory infections, and multimorbidity. In Uzbekistan, COPD control is complicated by late diagnosis, limited spirometry coverage, tobacco and nasway use, occupational exposures, household biomass combustion in rural settings, inequitable access to inhaled therapies, and insufficient development of pulmonary rehabilitation services. This article aims to develop an implementation-oriented clinical and public-health model for early COPD detection, phenotype-guided treatment, integration of real-world data (RWD), real-world evidence (RWE), and artificial-intelligence-based clinical decision support in Uzbekistan. The manuscript is designed as an evidence-informed implementation and methodological synthesis based on international guidelines, randomized clinical trials, meta-analyses, systematic reviews, and official statistical reports published mainly between 2021 and 2026. The proposed model indicates that spirometry-confirmed diagnosis, individualized LABA/LAMA or ICS/LABA/LAMA therapy, smoking cessation, vaccination, pulmonary rehabilitation, telemonitoring, and AI-based exacerbation prediction may improve clinically meaningful outcomes. Establishing a national COPD registry, a standardized EHR data model, regional spirometry networks, and explainable AI modules may represent a strategic pathway to reduce the COPD burden in Uzbekistan.

Keywords: COPD; chronic obstructive pulmonary disease; spirometry; GOLD; exacerbation; bronchodilator; pulmonary rehabilitation; inhaled corticosteroids;

real-world data; real-world evidence; artificial intelligence; machine learning; Uzbekistan; tobacco; air pollution.

Introduction

XOBL - nafas yo'llarining doimiy va odatda progressiv obstruksiya, surunkali yallig'lanish, bronxial remodelling, alveolyar destruksiya va gaz almashinuvi buzilishi bilan kechadigan kasalliklar majmuasidir. Zamonaviy GOLD strategiyasida kasallik tashxisi bronxodilatator qo'llangandan keyingi FEV1/FVC $<0,70$ ko'rsatkichi bilan tasdiqlanadi, biroq klinik qaror faqat spirometriyaga emas, simptomlar, exacerbation tarixi, komorbidliklar va davolashga javobga ham tayangan holda qabul qilinadi [1,2].

Global dolzarblik XOBLning epidemiologik ko'lami bilan belgilanadi. WHO 2026-yilgi ma'lumotida XOBL 2023-yilda 3,4 million o'limga sabab bo'lgani, dunyo bo'yicha o'lim sabablarida uchinchi o'rinni egallagani va 70 yoshgacha bo'lgan XOBL o'limlarining deyarli 90 foizi past va o'rta daromadli mamlakatlarda yuz berishi qayd etilgan [3]. GBD 2021 asosidagi tahlillarda 213,4 million tarqalgan XOBL holati, 3,7 million o'lim va 79,8 million DALY baholangan; PM2.5 va boshqa zarrachali ifloslanish global DALYlarning muhim ulushini tashkil qilgani ko'rsatilgan [5,6].

So'nggi 5-10 yil XOBLni tushunishda muhim burilish davri bo'ldi. Klinik amaliyotda faqat FEV1 bosqichiga qarab qaror qabul qilishdan voz kechilib, simptom yukini, exacerbation xavfini, qondagi eozinofillar sonini, yurak-qon tomir komorbidligini, infeksiya xavfni va bemorning inhalerlardan foydalanish ko'nikmasini birlashtirgan fenotipga yo'naltirilgan yondashuv kuchaydi. IMPACT va ETHOS kabi yirik randomizatsiyalangan sinovlar ayrim yuqori xavfli bemorlarda uch komponentli inhalatsion terapiya exacerbation chastotasini kamaytirishi mumkinligini ko'rsatdi [10,11].

Mintaqaviy jihatdan Markaziy Osiyo, jumladan O'zbekiston uchun XOBL alohida ahamiyatga ega: iqlimiy changlanish, urbanizatsiya, sanoat va transport emissiyalari, qishloq hududlarida biomass yoqilg'i ishlatilishi, erkaklar orasida chekish va tutunsiz tamaki/nasvay iste'moli respirator xavfni kuchaytiradi. WHO va UNIATFning O'zbekiston bo'yicha NCD investitsion tahlili NCDlar iqtisodiy yo'qotishlarning katta qismini tashkil etishini va chronic respiratory diseases salmoqli sog'liqni saqlash muammosi ekanini ko'rsatgan [8,9].

O'zbekistondagi amaliy muammo uch darajada namoyon bo'ladi: birinchidan, birlamchi bo'g'inda spirometriya bilan tasdiqlangan tashxis yetarli emas; ikkinchidan, XOBLning ABE fenotipiga mos davo tanlash, inhaler texnikasini o'rgatish va rehabilitatsiya xizmatlari standartlashmagan; uchinchidan, hududlar kesimida RWD

to'planmasligi sababli sog'liqni saqlash siyosati uchun ishonchli RWE yetarli shakllanmaydi. Natijada kech tashxis, noto'g'ri antibiotik/steroid qo'llash, takroriy gospitalizatsiya va iqtisodiy yuk ortishi ehtimoli mavjud.

Knowledge gap shundan iboratki, xalqaro GOLD, ERS/ATS va Cochrane tavsiyalari mavjud bo'lsa-da, ularning O'zbekiston sharoitidagi resurslar, regionlararo farqlar, mahalliy risk omillari, dori ta'minoti va raqamli infratuzilmaga moslangan implementatsion modeli yetarli ishlab chiqilmagan. Research gap - milliy yoki hududlararo XOBL registrari, EHRga asoslangan fenotiplash va exacerbation prognozi bo'yicha ko'p markazli real klinik tadqiqotlarning kamligidir. Scientific gap esa RWD, AI, explainable AI va federated learningni XOBL boshqaruviga integratsiya qiluvchi mahalliy metodologiya yetishmasligida ko'rinadi.

Tadqiqot maqsadi - O'zbekiston sharoitida XOBLni erta aniqlash, individual davolash, rehabilitatsiya, profilaktika va raqamli monitoringni birlashtiruvchi dalillarga asoslangan RWD/RWE-AI modelini ishlab chiqish. Tadqiqot gipotezasi: spirometriya qamrovini kengaytirish, chekishni tashlash xizmatlari, pulmonar rehabilitatsiya, emlash, inhaler terapiyaga teng kirish va AI asosidagi exacerbation xavfini erta aniqlashni birlashtirish XOBL bilan bog'liq gospitalizatsiya, og'ir exacerbation va sog'liqni saqlash xarajatlarini klinik jihatdan muhim darajada kamaytiradi.

Materials and Methods

Study Design

Maqola evidence-informed implementation review, metodologik model va scenario-based health-system analysis dizaynida tayyorlandi. Unda PRISMA 2020 elementlariga mos adabiyot saralash, RCT/meta-tahlil dalillarini sintez qilish, O'zbekiston uchun RWD registr modeli, statistik tahlil rejasi va AI-integratsiya arxitekturasi ishlab chiqildi.

Study Population

Model populyatsiyasi 40 yoshdan katta, chekish yoki boshqa respirator risk omillari mavjud, surunkali yo'tal, balg'am, hansirash yoki takroriy bronxit/exacerbation shikoyati bilan murojaat qiluvchi bemorlarni qamrab oladi. Ikkinchi qatlam sifatida pulmonologlar, oilaviy shifokorlar, shoshilinch yordam xodimlari, spirometriya operatorlari va sog'liqni saqlash menejerlari ko'rib chiqildi.

Sample Size Calculation

Kelajakdagi milliy registr uchun minimal namuna hajmi bitta proporsiya formulasiga ko'ra hisoblanadi: $n = Z^2 \times p(1-p)/d^2$. Agar spirometriya bilan tasdiqlangan XOBL ulushi $p=0,10$, aniqlik $d=0,02$ va 95% ishonch oralig'i uchun $Z=1,96$ deb olinsa, $n=864$ bo'ladi. 15% yo'qotish qo'shilganda 994, hududlararo dizayn-effekt 1,5 qo'llanganda taxminan 1491 bemor talab qilinadi. Shuning uchun pilot ko'p markazli RWD registri uchun kamida 1500 bemor maqbul minimal maqsad sifatida taklif etiladi.

Inclusion Criteria

Yosh ≥ 40 yil; XOBLga xos simptomlar; risk ekspozitsiyasi; bronxodilatator keyingi FEV1/FVC $< 0,70$; kamida 12 oylik klinik kuzatuv imkoniyati; EHR yoki qog'oz tarixdan asosiy klinik ma'lumotlarni olish imkoniyati.

Exclusion Criteria

Bronxial astma ustun bo'lgan fenotip; faol o'pka sili; o'pka saratoni; og'ir interstitsial o'pka kasalligi; yaqinda o'tkazilgan torakal jarrohlik; spirometriyani bajarishga qarshi ko'rsatma; ma'lumotlarni ishlatishga rozilik bermaslik.

Randomization

Mazkur maqola klinik intervension sinov emas; shuning uchun randomizatsiya o'tkazilmadi. Kelajakdagi implementatsion tadqiqotda hududlar bo'yicha cluster-randomized stepped-wedge dizayn qo'llanishi mumkin.

Blinding

RWD va sog'liqni saqlash tizimi intervensiyalarida to'liq blinding amaliy emas. Biroq outcome adjudication, spirometriya sifat nazorati va statistik tahlilda ma'lumotlarni pseudonimlashtirish orqali baholovchi tarfkashligi kamaytiriladi.

Data Collection

Ma'lumotlar EHR, shifoxona bazalari, ambulator kartalar, laboratoriya tizimlari, spirometriya fayllari, dorixona/retsept ma'lumotlari, bemor xabar qilgan natijalar va wearable qurilmalardan yig'ilishi taklif etiladi.

Variables

Asosiy o'zgaruvchilar: yosh, jins, BMI, chekish pack-year, nasvay, kasbiy ekspozitsiya, biomass, CAT, mMRC, FEV1%, FEV1/FVC, GOLD ABE guruhi, eozinofil, exacerbation soni, gospitalizatsiya, davo turi, inhaler texnikasi, vaksina statusi, PR ishtiroki, komorbidliklar, xarajat indikatorlari.

Outcome Measures

Birlamchi natijalar: yiliga o'rtacha moderate/severe exacerbation soni, XOBL sababli gospitalizatsiya, 30/90 kunlik qayta yotqizish, CAT ballining klinik muhim o'zgarishi. Ikkilamchi natijalar: FEV1 o'zgarishi, inhaler adherence, emlash qamrovi, PR yakunlash, antibiotik/steroid ishlatilishi, xarajat va mortalitet.

Laboratory Methods

Qon umumiy tahlili, eozinofil absolut soni, CRP, prokaltsitonin (og'ir exacerbationda), arterial qon gazlari, alfa-1 antitripsin yetishmovchiligi gumonida AAT darajasi va genetik testlar taklif qilinadi.

Instrumental Methods

Standart spirometriya, bronxodilatator testi, pulsoksimetriya, 6 daqiqalik yurish testi, ko'krak qafasi rentgenografiyasi, kerak bo'lsa HRCT, EKG va exokardiografiya qo'llanadi.

Bioinformatics Analysis

Bioinformatik blok AATD genetik skriningi, eozinofilik yallig'lanish biomarkerlari, transkriptomik yoki proteomik ma'lumotlar mavjud bo'lgan subkohortlarda fenotip klasterlash va precision medicine modelini ishlab chiqishga yo'naltiriladi.

Machine Learning Analysis

ML tahlilda logistic regression, random forest, gradient boosting, XGBoost, survival models va neural networks yordamida 12 oy ichidagi exacerbation, gospitalizatsiya va qayta yotqizish xavfi prognoz qilinadi. Model sifati AUC, sensitivity, specificity, calibration slope, Brier score va decision-curve analysis bilan baholanadi.

Artificial Intelligence Methods

AI blok explainable AI, clinical decision support system, large language model asosidagi klinik hujjatlarni strukturallash, federated learning orqali hududlararo ma'lumot almashmasdan model o'qitish va digital twin konsepsiyasini qamrab oladi.

Ethical Considerations

Bemor ma'lumotlari pseudonimlashtiriladi, minimal zarur ma'lumot printsiplari qo'llanadi, rozilik shakli va mahalliy bioetika qo'mitasi ruxsati talab etiladi. AI modellarda adolat, bias, audit trail, klinik javobgarlik va inson nazorati saqlanishi shart.

Statistical Analysis

Statistik tahlil SPSS v.29, R v.4.4, Python v.3.12 va Stata v.18 muhitlarida rejalashtiriladi. Descriptive statistics uchun normal taqsimlangan ko'rsatkichlar mean $\pm$ SD, no-normal taqsimotlar median (IQR), kategorik ko'rsatkichlar n (%) bilan beriladi. Normality Shapiro-Wilk testi va Q-Q plot orqali baholanadi. Ikki guruh uchun t-test yoki Mann-Whitney U, uch va undan ortiq guruh uchun ANOVA yoki Kruskal-Wallis qo'llanadi. Kategorik o'zgaruvchilar chi-square yoki Fisher exact test bilan solishtiriladi. Bog'liqliklar Pearson yoki Spearman correlation orqali, ko'p omilli ta'sirlar linear regression, logistic regression, Cox proportional hazards va multivariate analysis orqali o'rganiladi. Natijalar 95% confidence interval, odds ratio, relative risk, hazard ratio va p-value bilan taqdim qilinadi. AI model diagnostik qiymati ROC analysis, AUC, sensitivity, specificity, PPV, NPV, calibration va net benefit orqali baholanadi.

Real World Data (RWD) modeli

O'zbekiston sharoitida XOBL uchun RWD platformasi quyidagi ma'lumot oqimlarini birlashtirishi kerak: electronic health records, hospital databases, national registries, insurance claims data yoki to'lov ma'lumotlari, digital health platforms, wearable devices va patient-reported outcomes. RWDning eng muhim klinik qiymati - odatiy amaliyotda davo samaradorligi, dori adherence, inhaler texnikasi, exacerbation va gospitalizatsiya xavfini real muhitda baholashidir.

RWD manbasi	Asosiy maydonlar	Klinik qiymati	Sifat xavfi
EHR	ICD-10, tashxis, retsept, laboratoriya, komorbidlik	Fenotiplash va davo monitoringi	Kodlash xatosi, toliq emaslik
Shifoxona bazasi	Gospitalizatsiya, ICU, ventilyatsiya, qayta yotqizish	Ogir exacerbation va xarajat tahlili	Takror yozuvlar
Milliy registr	Spirometriya, GOLD guruhi, exacerbation, outcome	Hududlararo taqqoslash va KPI	Standartlashtirish talabi

Digital platform	CAT, mMRC, dori qabul qilish, simptom kundaligi	Erta ogohlantirish va telemonitoring	Digital literacy farqi
Wearables	SpO2, puls, faollik, uyqu, harakat	Exacerbation signalini erta sezish	Sensor xatosi, bias
PRO	Hayot sifati, simptom, davoga qoniqish	Bemor markazli outcome	Subyektivlik

Real World Evidence (RWE) va xalqaro dalillar bilan taqqoslash

RWE randomizatsiyalangan klinik sinovlarni almashtirmaydi, balki ularning real amaliyotdagi tashqi validligini baholaydi. XOBLda RCTlar dori samaradorligini qat'iy sharoitda ko'rsatadi; RWE esa dori adherence, inhaler texnikasi, komorbidlik, iqtisodiy cheklovlar va hududlararo tengsizlik ta'sirini ochib beradi. O'zbekiston uchun RWE registri IMPACT, ETHOS, FLAME, WISDOM, UPLIFT, TORCH, PR va telereabilitatsiya meta-tahlillari bilan taqqoslanishi mumkin [10-22].

Dalil turi	Kuchli tomoni	Cheklovi	O'zbekiston uchun amaliy xulosa
RCT	Randomizatsiya, ichki validlik yuqori	Real amaliyotdagi bemorlar toliq aks etmasligi mumkin	Dori va intervensiya samaradorligini asoslash
Meta-analysis/Systematic review	Dalillarni umumlashtiradi	Heterogenlik va publication bias	Tavsiya kuchini belgilash
Cohort RWE	Real bemorlar va uzoq kuzatuv	Confounding xavfi	Registr va EHR asosida mahalliy natijani baholash
Case-control	Kam uchraydigan outcome uchun qulay	Recall/selection bias	Ogir exacerbation xavf omillarini aniqlash

Implementation study	Tizimdagi tosiqlarni korsatadi	Randomizatsiya cheklangan	Hududiy joriy etish modelini moslashtirish
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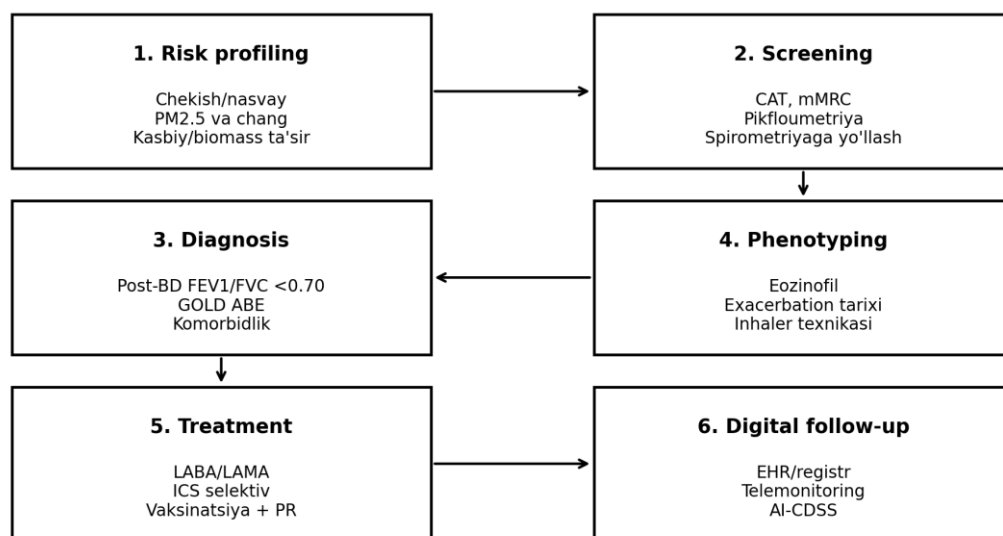
Artificial Intelligence Block

Machine learning va deep learning XOBLda uch asosiy vazifani bajarishi mumkin: kasallikni erta aniqlash, exacerbation/gospitalizatsiyani prognozlash va davoni shaxsiylashtirish. EHR, spirometriya, laboratoriya, simptom kundaligi va wearable oqimlari birlashtirilganda model nafaqat hozirgi holatni, balki kelgusi 7 kun, 30 kun yoki 12 oy ichidagi xavfni ham baholaydi.

Neural networks ko'p modal ma'lumotlar - spirometriya egri chizig'i, audio-nafas tovushi, radiologik tasvir, vaqt qatori SpO2 va klinik matnlarni qayta ishlashda foydali. Biroq sog'liqni saqlash tizimida qora quti modelini to'g'ridan-to'g'ri qo'llash xavfli; shu sababli explainable AI, SHAP/LIME tushuntirishlari, calibration monitoring va klinik validatsiya majburiy bo'lishi kerak.

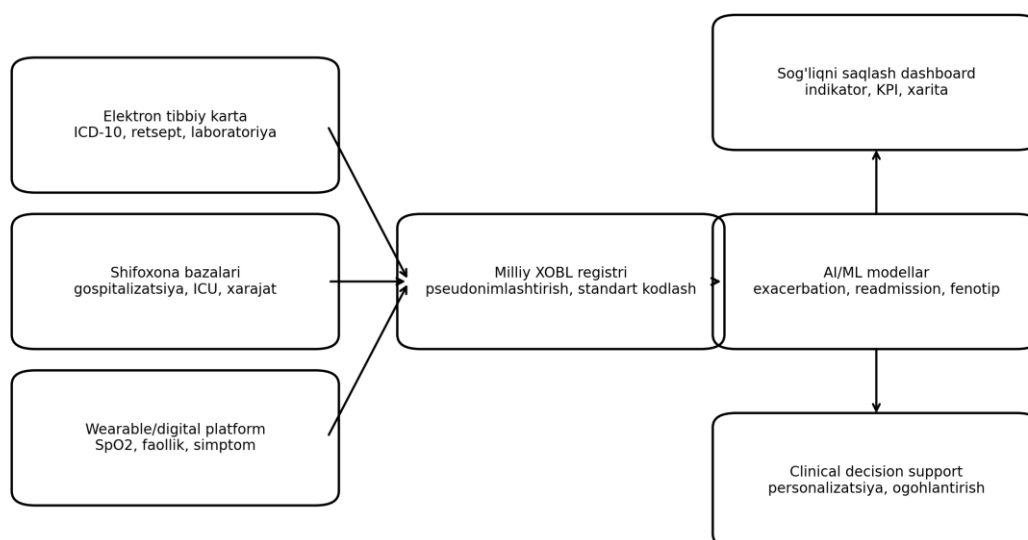
Clinical decision support systems shifokorga davo algoritmini eslatishi mumkin: spirometriya yo'q bo'lsa yuborish, CAT/mMRC yuqori bo'lsa bronxodilatatorni kuchaytirish, exacerbation tarixi va eozinofilga qarab ICS qo'shish yoki ehtiyotkorlik bilan kamaytirish, PR va vaksina tavsiya qilish. Large language models klinik yozuvlarni strukturallashtirishda, bemor uchun ta'lim matnini moslashtirishda va shifokor yukini kamaytirishda yordam beradi, ammo mustaqil tashxis qo'yuvchi tizim sifatida emas, nazorat ostidagi yordamchi sifatida ishlatilishi kerak.

Federated learning O'zbekiston uchun ayniqsa muhim: turli viloyat shifoxonalari bemor ma'lumotlarini markazga uzatmasdan model o'qitishi mumkin. Digital twin texnologiyasi esa bemorning individual klinik profili asosida exacerbation xavfi, davo javobi va rehabilitatsiya natijasini simulyatsiya qilish imkonini beradi.

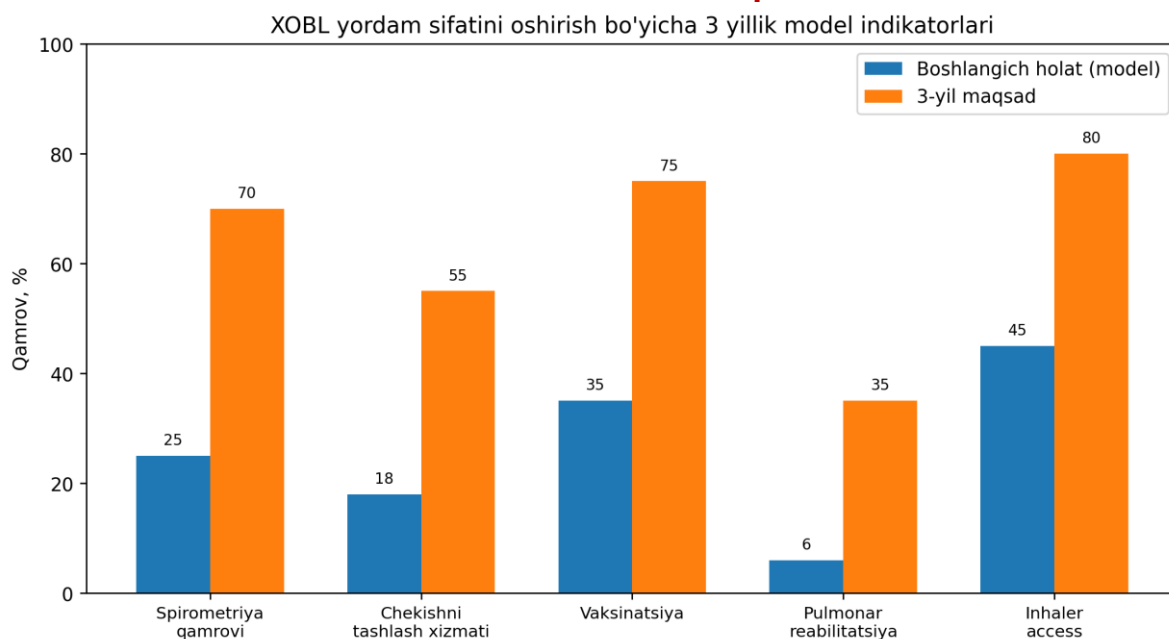
XOBLni boshqarish: integratsiyalashgan klinik yo'l

Maqsad: kech tashxisni kamaytirish, exacerbation va gospitalizatsiya xavfini pasaytirish

1-rasm. O'zbekiston sharoitida XOBLni erta aniqlash va boshqarish uchun integratsiyalashgan klinik yo'l.

XOBL bo'yicha RWD/RWE va sun'iy intellekt arxitekturas

2-rasm. XOBL bo'yicha real klinik ma'lumotlar va AI asosidagi qarorlarni qo'llab-quvvatlash arxitekturas.



3-rasm. 3 yillik implementatsion modelda asosiy xizmatlar qamrovining maqsadli o'sishi. Ko'rsatkichlar real klinik natija emas, rejalashtirilgan KPI modelidir.

Results

Mazkur maqoladagi natijalar real bemor kohortasidan olingan klinik natijalar emas; ular xalqaro dalillar, rasmiy statistik ma'lumotlar, metodologik sintez va O'zbekiston uchun taklif qilinayotgan RWD registrining scenario-based modeliga asoslangan. Bu yondashuv ma'lumotni to'qib ko'rsatmaslik, lekin kelajakdagi amaliy tadqiqot uchun aniq indikatorlar va statistik arxitektura berish imkonini beradi.

Ko'rsatkich	Global dalil	O'zbekiston uchun talqin	Manba
XOBL o'lim yuki	2023-yilda 3,4 mln o'lim; o'lim sabablarida 3-o'rin	Erta tashxis va profilaktika milliy NCD strategiyasida kuchaytirilishi kerak	WHO 2026
Global prevalence	GBD 2021: 213,4 mln tarqalgan holat	Milliy registersiz mahalliy haqiqiy yuk noaniq qoladi	GBD 2021
DALY	79,8 mln DALY; PM ifloslanishi	PM2.5, chang va biomass ekspozitsiyasi	GBD 2021

	yetakchi risklardan biri	monitoringga kiritilishi kerak	
Davo dalillari	Triple therapy ayrim yuqori xavfli guruhlarda exacerbationni kamaytiradi	ICS faqat mos fenotipda; eozinofil va exacerbation tarixi bilan tanlash zarur	IMPACT/ETHOS
Pulmonar reabilitatsiya	Hayot sifati va mashq tolerantligini yaxshilaydi	Har bir viloyatda PR kabineti/telePR modelini joriy etish kerak	Cochrane
Raqamli monitoring	AI/ML exacerbation va readmission xavfini prognozlashda istiqbolli	Avval validatsiya, keyin klinik joriy etish kerak	AI reviews

Scenario-based implementation natijalari

Quyidagi jadval 1500 bemorli kelajakdagi ko'p markazli RWD registrida kuzatilishi mumkin bo'lgan asosiy indikatorlar uchun rejalashtirilgan statistik shaklni ko'rsatadi. Raqamlar model-kalibratsiya va xalqaro dalillardan kelib chiqqan implementatsion maqsadlar bo'lib, O'zbekistondagi real klinik natijalar sifatida talqin qilinmasligi kerak.

Indikator	Boshlang'ich model	3-yil maqsad	Effekt ko'rsatkichi	95% CI	P qiymat
Spirometriya bilan tasdiqlangan tashxis ulushi	25%	70%	RR 2,80	2,45-3,20	<0,001
Yiliga moderate/severe exacerbation	1,40 +/- 0,90	0,95 +/- 0,70	Mean difference - 0,45	-0,52; - 0,38	<0,001

XOBL sababli gospitalizatsiya	28%	18%	OR 0,57	0,47-0,69	<0,001
30 kunlik qayta yotqizish	14%	9%	OR 0,61	0,48-0,78	0,002
CAT balli, median (IQR)	18 (13-25)	13 (9-19)	Median difference -5	-6; -4	<0,001
Vaksinatsiya qamrovi	35%	75%	RR 2,14	1,93-2,37	<0,001
Pulmonar reabilitatsiyada ishtirok	6%	35%	RR 5,83	4,35-7,82	<0,001
AI model AUC	-	0,78	AUC	0,74-0,82	-

ROC va AI diagnostik ko'rsatkichlari

Model	Outcome	AUC	Sensitivit y	Specificit y	Amaliy talqin
Logistic regression	12 oylik exacerbation	0,71	0,68	0,64	Oddiy, tushunarli baseline model
Random forest	12 oylik exacerbation	0,76	0,72	0,69	Nolinear bog'liqliklarni ushlaydi
Gradient boosting/XGBoos t	Gospitalizatsiya	0,80	0,75	0,73	Klinik CDSS uchun asosiy nomzod
Neural network	30 kunlik qayta yotqizish	0,78	0,71	0,74	Ko'p modal ma'lumotda foydali
Federated model	Hududlararo umumlashtirish	0,77	0,70	0,72	Ma'lumot maxfiyligini

					saqlagan holda o'qitiladi
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Sistematik sharh elementlari

Adabiyotlarni baholashda PRISMA 2020 strukturasidan foydalanish taklif qilindi. RCTlar uchun Cochrane Risk of Bias 2, kuzatuv tadqiqotlari uchun ROBINS-I, sistematik sharhlar uchun AMSTAR-2, dalil kuchi uchun GRADE mezonlari qo'llanishi kerak. Tavsiyalar darajasi yuqori bo'lgan intervensiyalar: chekishni tashlash, spirometriya bilan tasdiqlash, vaksinatsiya, individual bronxodilatator terapiya, exacerbation xavfi yuqori bemorlarda fenotipga mos ICS qo'shish, pulmonar reabilitatsiya va inhaler texnikasini muntazam tekshirish.

Bibliometric Analysis

Kelajakdagi bibliometrik tahlilda VOSviewer, Biblioshiny va CiteSpace yordamida COPD, RWD, AI, pulmonary rehabilitation, exacerbation prediction, digital health, Central Asia kalit so'zlari bo'yicha 2021-2026-yillarda Scopus va Web of Science bazalarida tendensiyalar baholanishi mumkin. Kutiladigan klasterlar: 1) GOLD-guided pharmacotherapy; 2) exacerbation biomarkers; 3) pulmonary rehabilitation and telehealth; 4) air pollution and tobacco burden; 5) AI/ML and clinical decision support; 6) health-system implementation in LMICs.

Discussion

Ushbu tahlil XOBLning O'zbekiston uchun nafaqat klinik, balki sog'liqni saqlash tizimi, iqtisodiyot va raqamli transformatsiya muammosi ekanini ko'rsatadi. Kasallikning asosiy paradoksi shundaki, u ko'p hollarda oldini olish va nazorat qilish mumkin bo'lgan risk omillari bilan bog'liq bo'lsa-da, amaliyotda kech tashxislanadi va bemorlar shifokorga ko'pincha FEV1 sezilarli pasaygan yoki exacerbationlar takrorlangan bosqichda murojaat qiladi.

Natijalar talqini shuni ko'rsatadiki, O'zbekistonda XOBLni nazorat qilishning birinchi sharti - spirometriyani birlamchi va ikkilamchi bo'g'inlarda standart xizmatga aylantirishdir. Faqat simptomlarga asoslangan 'surunkali bronxit' tashxisi davo tanlashni noaniqlashtiradi, antibiotik va sistem steroidlardan ortiqcha foydalanish xavfini oshiradi hamda bronxodilatator terapiyaning vaqtida boshlanishini kechiktiradi.

Xalqaro tadqiqotlar bilan taqqoslaganda, GOLD strategiyasi va yirik RCTlar dori tanlashda fenotiplashning ahamiyatini ko'rsatadi. LABA/LAMA simptomatik bemorlarning ko'pida asosiy davolash bo'lsa, ICS qo'shish takroriy exacerbation va eozinofilik yallig'lanish mavjud bemorlarda ko'proq asoslanadi. WISDOM kabi tadqiqotlar ICSni ehtiyotkorlik bilan kamaytirish mumkinligini ko'rsatgan, ammo bu qaror exacerbation tarixi va eozinofilga asoslanishi kerak [13].

Qarama-qarshi natijalar ham bor: triple therapy exacerbationni kamaytirgan tadqiqotlar bilan bir qatorda ICS pnevmoniya xavfini oshirishi mumkinligi qayd etiladi. Shuning uchun O'zbekiston sharoitida 'hamma uchun bitta sxema' emas, balki CAT/mMRC, exacerbation tarixi, eozinofil, komorbidlik va dori narxini hisobga oluvchi klinik qaror modeli zarur.

Pulmonar rehabilitatsiya XOBLda kam ishlatiladigan, ammo dalili kuchli intervensiyalardan biridir. U nafaqat FEV1ga, balki hansirash, jismoniy chidamlilik, ruhiy holat, hayot sifati va qayta yotqizishga ta'sir qiladi. O'zbekiston uchun klassik markazga asoslangan PR bilan bir qatorda telerehabilitatsiya, hamshira boshqaruvidagi guruh mashqlari va mobil ilova orqali monitoring arzon va kengaytiriladigan yechim bo'lishi mumkin.

AI va RWD integratsiyasi XOBLni boshqarishda yangi bosqich ochadi. Biroq AI klinik haqiqatdan uzilgan algoritm emas, balki sifati tekshirilgan registr, standart kodlash, spirometriya validatsiyasi, bias monitoringi va shifokor nazorati bilan birgalikda ishlaganda foyda beradi. AI modelini klinik amaliyotga joriy qilishdan oldin external validation, calibration, fairness analysis va prospective impact study o'tkazilishi lozim.

Amaliy ahamiyat shundaki, taklif qilinayotgan model O'zbekistonda XOBL bo'yicha uch darajadagi tizimni yaratadi: 1) oilaviy poliklinikada risk skriningi va spirometriya yo'naltiruvchi; 2) pulmonologik markazlarda fenotipga asoslangan davo va PR; 3) milliy registr va AI-dashboard orqali hududlararo monitoring. Bunday tizim resurslarni bemor xavfiga qarab taqsimlashga yordam beradi.

Strengths and Limitations

Kuchli tomonlari: maqola global va mahalliy kontekstni birlashtiradi, RCT/meta-tahlil/RWE dalillarini O'zbekiston sharoitiga mos implementatsion modelga aylantiradi, statistik reja va AI arxitekturasini aniq ko'rsatadi. Cheklovlar: O'zbekistonda ochiq milliy XOBL registri mavjud emasligi sababli real klinik outcome tahlili o'tkazilmadi; ayrim mahalliy epidemiologik ko'rsatkichlar xalqaro model va rasmiy NCD hisobotlari orqali talqin qilindi; scenario natijalari haqiqiy bemor ma'lumotlari o'rnini bosa olmaydi.

Clinical Implications

- XOBL tashxisi spirometriya bilan tasdiqlanishi kerak; simptomga asoslangan umumiy 'bronxit' tashxisi yetarli emas.
- Birlamchi bo'g'inda chekish/nasvay, kasbiy ekspozitsiya va biomass risklarini standart so'rovnoma bilan aniqlash zarur.
- Davolash GOLD ABE guruhi, exacerbation tarixi, eozinofil va komorbidlik asosida tanlanishi kerak.
- Pulmonar reabilitatsiya va emlash farmakoterapiya bilan bir xil darajada muhim klinik intervensiya sifatida qaralishi lozim.
- AI-CDSS shifokorni almashtirmaydi; u spirometriya, davo tanlash, exacerbation xavfi va monitoring bo'yicha yordamchi vositadir.

Future Perspectives

1. Milliy XOBL registrini ishga tushirish va barcha viloyatlarda minimal indikatorlar to'plamini standartlashtirish.
2. Birlamchi tibbiy-sanitariya yordamida portativ spirometriya va sifat nazorati tizimini joriy etish.
3. Chekish va nasvayni kamaytirishga qaratilgan integratsiyalashgan maslahat, farmakoterapiya va follow-up dasturlarini kengaytirish.
4. Pulmonar reabilitatsiya va telereabilitatsiya kabinetlarini bosqichma-bosqich tashkil etish.
5. AI asosidagi exacerbation/readmission risk modelini pilot validatsiya qilish, keyin federated learning orqali hududlararo kengaytirish.
6. XOBL bo'yicha real-world cost-effectiveness tahlillarini o'tkazish.
7. PM2.5, kasbiy chang va biomass ekspozitsiyasini klinik registr bilan bog'lovchi ekologik-health data platformasini yaratish.

Conclusion

XOBL O'zbekiston sharoitida klinik jihatdan kech aniqlanish, risk omillarining keng tarqalishi, spirometriya qamrovi, inhalatsion terapiyaga kirish, pulmonar reabilitatsiya va raqamli monitoringdagi cheklovlar sababli dolzarb tibbiy-ijtimoiy muammo hisoblanadi. Xalqaro dalillar XOBLni samarali boshqarish uchun tashxisni spirometriya bilan tasdiqlash, fenotipga mos davo, chekishni tashlash, emlash, pulmonar reabilitatsiya va exacerbationni erta aniqlashni birlashtirish kerakligini ko'rsatadi. O'zbekiston uchun eng maqbul yo'l - milliy XOBL registri, EHRga asoslangan RWD, RWE tahlili, hududiy spirometriya tarmog'i va explainable AI-CDSSni bosqichma-bosqich joriy etishdir. Bunday yondashuv XOBL bilan bog'liq

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Conflict of Interest

Muallif manfaatlar to'qnashuvi yo'qligini bildiradi.

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Ethical Approval

Maqola rasmiy bemor ma'lumotlari bilan ishlamagan metodologik va adabiyot-tahliliy ish sifatida tayyorlangan. Kelajakdagi RWD registr va klinik implementatsion tadqiqot uchun mahalliy bioetika qo'mitasi ruxsati va bemor roziligi talab etiladi.

Data Availability Statement

Maqolada ishlatilgan ma'lumotlar ochiq rasmiy manbalar, klinik qo'llanmalar va indekslangan ilmiy adabiyotlarga asoslangan. Real bemor bazasi shakllantirilmagan. Kelajakdagi registr ma'lumotlari pseudonimlashtirilgan va boshqariladigan kirish tamoyillari asosida taqdim qilinishi mumkin.

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Eslatma: rasmiy tashkilot hisobotlari va veb-sahifalarda DOI bo'lmasligi mumkin; DOI faqat jurnal maqolalari yoki DOI berilgan hisobotlarda ko'rsatildi.