



在线全文

消化道早癌高危患者内镜复查依从性的影响因素分析*

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【摘要】目的 应用随机森林分析疾病感知、医患沟通、认知负荷与消化道早癌高危患者内镜复查依从性的关系。**方法** 选取2022年1月-2022年12月303例消化道早癌高危患者为研究对象,采用一般资料调查表、简化版疾病感知问卷、医患沟通评价量表、不同认知负荷量表进行问卷调查。Spearman分析疾病感知、医患沟通、认知负荷、消化道早癌高危患者内镜复查依从性之间的关系,多因素logistic分析患者内镜复查依从性的影响因素,随机森林模型对患者内镜复查依从性特征变量进行重要性排序,通过受试者工作特征(receiver operating characteristic, ROC)曲线下面积(area under the curve, AUC)评估模型效能,并应用五折法验证。**结果** Spearman分析显示:消化道早癌高危患者内镜复查依从性差与疾病感知、医患沟通呈负相关($r_s = -0.788, -0.815, P < 0.05$),与认知负荷呈正相关($r_s = 0.619, P < 0.05$);经多因素logistic分析得出,年龄[比值比(odds ratio, OR)=1.159, 95%置信区间(confidence interval, CI): 1.052 ~ 1.276]、消化道肿瘤家族史(OR=0.081, 95%CI: 0.008 ~ 0.865)、家庭人均月收入(OR=0.994, 95%CI: 0.991 ~ 0.997)、疾病感知(OR=0.745, 95%CI: 0.639 ~ 0.870)、医患沟通(OR=0.694, 95%CI: 0.602 ~ 0.801)、认知负荷(OR=1.351, 95%CI: 1.136 ~ 1.608)是消化道早癌高危患者内镜复查依从性的影响因素($P < 0.05$);随机森林模型变量重要性排序为医患沟通>疾病感知>认知负荷>家庭人均月收入>年龄>消化道肿瘤家族史,其预测AUC为0.899(95%CI: 0.843 ~ 0.921),经五折交叉验证随机森林模型平均准确率为0.893。**结论** 疾病感知、医患沟通、认知负荷、家庭人均月收入、年龄、消化道肿瘤家族史是消化道早癌高危患者内镜复查依从性的关键因素。

【关键词】 消化道 内镜 随机森林 医患沟通

Analysis of Factors Affecting Endoscopic Follow-up Compliance in High-Risk Patients With Early Gastrointestinal Cancer

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[Abstract] Objective The random forest method was used to analyze the relationship between disease perception, doctor-patient communication, cognitive load, and the compliance of high-risk patients with early digestive tract cancer regarding endoscopic re-examination. **Methods** A total of 303 patients at high risk for early digestive tract cancer from January 2022 to December 2022 were selected as research subjects. Questionnaire surveys were conducted using general information questionnaires, a simplified disease perception questionnaire, a doctor-patient communication evaluation scale, and various cognitive load scales. Spearman analysis was used to examine the relationships among disease perception, doctor-patient communication, cognitive load, and compliance with endoscopic reexamination in patients at high risk for early digestive tract cancer. Multivariate logistic analysis was performed to identify factors influencing patients' compliance with endoscopic reexamination. A random forest model was used to rank the importance of characteristic variables for compliance. The area under the receiver operating characteristic (ROC) curve (AUC) was used to evaluate model efficacy, and five-fold cross-validation was applied for validation. **Results** Spearman analysis showed that poor compliance with endoscopic re-examination among patients at high risk for early digestive tract cancer was negatively correlated with disease perception and doctor-patient communication ($r_s = -0.788, -0.815, P < 0.05$), and positively correlated with cognitive load ($r_s = 0.619, P < 0.05$). Multivariate logistic analysis identified age (odds ratio [OR] = 1.159, 95% confidence interval [CI]: 1.052-1.276), family history of digestive tract tumors (OR = 0.081, 95% CI: 0.008-

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0.865), average monthly family income (OR = 0.994, 95% CI: 0.991-0.997), disease perception (OR = 0.745, 95% CI: 0.639-0.870), doctor-patient communication (OR = 0.694, 95% CI: 0.602-0.801), and cognitive load (OR = 1.351, 95% CI: 1.136-1.608) as factors influencing compliance with endoscopic re-examination in these patients ($P < 0.05$). The variable importance ranking in the random forest model was doctor-patient communication > disease perception > cognitive load > average monthly family income > age > family history of digestive tract tumors. The model's prediction AUC was 0.899 (95% CI: 0.843-0.921), and the average accuracy after five-fold cross-validation was 0.893. **Conclusion** Disease perception, doctor-patient communication, cognitive load, average monthly household income, age, and family history of digestive tract tumors are key factors influencing compliance with endoscopic re-examination in patients with early digestive tract cancer.

[Key words] Gastrointestinal tract Endoscope Random forest Doctor-patient communication

2021年我国胃癌新发病例约35.9万例,食管癌约22.4万例,结直肠癌超51.7万例,总死亡病例达68.7万例,占全年癌症死亡人数的26.7%^[1-2]。尽管近年来随着医疗技术的发展,临床对消化道癌症的诊断效能有所提高,但85%以上患者确诊时已进展至中晚期,错失根治机会^[3]。ZHANG等^[4]表明,消化道早癌经规范治疗后5年生存率可达90%以上,而中晚期患者5年生存率不足30%。因此,早期筛查与定期复查是改善预后的关键。消化道早癌具有高度隐匿性,多数病例无明显症状,依赖定期内镜复查实现早期发现,但研究发现高危人群对于内镜复查依从性仅有50%~59%,成为早诊早治的核心瓶颈^[5]。与此同时,多数患者对疾病风险存在认知偏差,难以理解内镜复查的必要性,以及医患沟通中疾病信息传递不充分,共同构成了影响其复查行为的障碍,甚至会出现因过度担忧检查风险而产生回避行为^[6]。鉴于消化道早癌高危患者内镜复查依从性受多种因素影响,且传统回归模型难以准确捕捉这些非线性关系及变量间的协同作用,导致关键预测因素识别不足。针对这一局限,随机森林作为一种集成学习算法,具有处理高维数据、捕捉非线性关系及交互作用的优势,且能通过变量重要性排序直观识别关键影响因素,有效克服传统模型的假设限制^[7]。目前,随机森林算法在医疗健康行为依从性预测领域已得到初步应用,但针对消化道早癌高危人群内镜复查依从性的相关研究仍处于空白阶段^[8]。基于此,本研究选取消化道早癌高危患者为研究对象,采用随机森林方法分析疾病感知、医患沟通及认知负荷与内镜复查依从性的关联,识别影响依从性的核心预测因素及其相对重要性,为临床制定个体化依从性干预方案提供科学依据,进而提高高危人群内镜复查参与率。

1 资料与方法

1.1 一般资料

依据“哈佛癌症风险指数”“消化道风险评估模型”^[9-11],并结合《居民常见恶性肿瘤筛查和预防推荐》评估

出消化道早癌高危人群,并结合WATANABE^[12]提出的多因素分析样本量估算方法, n 不低于纳入变量数量的10倍,本研究计划纳入13个自变量,考虑10%的脱落率, n 最低为143例。因此,本次研究回顾性选取天津市人民医院/南开大学第一附属医院2022年1月-2022年12月303例消化道早癌高危患者,收集这些患者2023-2024年期间内镜检查记录,以近2年内是否坚持内镜复查1~2次分为依从性高组($n=192$)和依从性差组($n=111$)。纳入标准:①年龄 ≥ 18 岁;②认知与阅读能力无障碍、可正常沟通;③知情同意本研究并签署同意书;④资料完整无缺失。排除标准:①已确诊消化道肿瘤或其他部位肿瘤者;②胃肠道手术史;③主要器官严重功能障碍;④存在内镜禁忌证;⑤精神疾病。本研究遵循知情同意原则,并经天津市人民医院医学伦理委员会批准[意见函号:(2025)年快审第(B184)号]。

1.2 研究方法

1.2.1 一般资料调查表

收集受试者性别、年龄、消化道肿瘤家族史、受教育程度、家庭人均月收入、吸烟史、饮酒史、幽门螺旋杆菌感染、医疗付费方式、工作情况等。

1.2.2 疾病感知

采用简化版疾病感知问卷^[13](The Brief Illness Perception Questionnaire, BIPQ),从认知、情绪、理解能力3个维度8个条目进行评估,以Likert 11级评分法,分别记0~10分,其中条目3、4、7为反向计分,总80分,分值与疾病感知成正比,该量表Cronbach's α 为0.872。

1.2.3 医患沟通

采用医患沟通评价量表^[14](Set Elicit Give Understand End Framework, SEGUE),从准备阶段、信息收集、信息给予、理解患者、结束问诊5个维度25个条目评估,以Likert 5级评分法,分别记0~4分,总100分,分值与医患沟通成正比,该量表Cronbach's α 为0.866。

1.2.4 认知负荷

使用不同认知负荷量表^[15](Measuring Different Types

of Cognitive Load, MDT-CL)中内在认知负荷与外在认知负荷维度,共6个条目,以Likert 11级评分法,分别记0~10分,总60分,分值与认知负荷成正比,该量表Cronbach's α 为0.848。

1.3 统计学方法

采用SPSS 28.0进行分析,计数资料以例数(%)表示,计量资料以 $\bar{x} \pm s$ 表示,行 t 检验或 F 方差分析。采用Spearman分析疾病感知、医患沟通、认知负荷、内镜复查依从性之间的关系;以近2年内是否坚持内镜复查1~2次为因变量,多因素logistic回归分析消化道早癌高危患者内镜复查依从性的独立影响因素;通过R4.4.1建立随机森林模型,采用受试者工作特征(receiver operator characteristic, ROC)曲线下面积(area under the curve, AUC)、混淆矩阵相关指标来评估模型,以五折交叉验证随机森林模型一致性,同时绘制五折ROC曲线。 $\alpha=0.05$ 。

2 结果

2.1 消化道早癌高危患者不同内镜复查依从性组间差异分析

经对比,两组受试者年龄、消化道肿瘤家族史、家庭

人均月收入、疾病感知、医患沟通、认知负荷水平差异均有统计学意义($P<0.05$),见表1。

2.2 疾病感知、医患沟通、认知负荷与消化道早癌高危患者内镜复查依从性的关系

Spearman分析显示(表2):消化道早癌高危患者内镜复查依从性差与疾病感知、医患沟通呈负相关($r_s=-0.788, -0.815$),与认知负荷呈正相关($r_s=0.619$), P 均 <0.05 。

2.3 多因素logistic分析消化道早癌高危患者内镜复查依从性的影响因素

以消化道早癌高危患者内镜复查依从性为因变量(依从性高=0,依从性差=1),将表1中 $P<0.05$ 的变量纳为自变量,进行赋值[年龄、家庭人均月收入、疾病感知、医患沟通、认知负荷原值代入;消化道肿瘤家族史(有=1,无=0)]。多因素logistic分析显示:年龄[比值比(odds ratio, OR)=1.159, 95%置信区间(confidence interval, CI): 1.052~1.276]、消化道肿瘤家族史(OR=0.081, 95%CI: 0.008~0.865)、家庭人均月收入(OR=0.994, 95%CI: 0.991~0.997)、疾病感知(OR=0.745, 95%CI: 0.639~0.870)、医患沟通(OR=0.694, 95%CI: 0.602~0.801)、认知负荷

表 1 消化道早癌高危患者不同内镜复查依从性的组间差异

Table 1 The differences between groups in compliance with various endoscopic reexaminations among patients at high risk for early digestive tract cancer

Factor	High compliance ($n = 192$)	Poor compliance ($n = 111$)	χ^2/t	P
Sex/case (%)			0.007	0.934
Male	103 (53.65)	59 (57.28)		
Female	89 (46.35)	52 (46.85)		
Age/yr.	53.33 $\pm$ 12.23	60.47 $\pm$ 11.96	4.936	< 0.001
Family history/case (%)	48 (25.00)	17 (15.32)	3.915	0.048
Educational attainment/case (%)			3.153	0.207
High school and below	102 (53.13)	58 (52.25)		
Junior college	64 (33.33)	30 (27.03)		
Bachelor's degree or above	26 (13.54)	23 (20.72)		
Monthly income/yuan	4 225.74 $\pm$ 433.64	3 789.65 $\pm$ 354.42	8.998	< 0.001
Smoking history/case (%)	53 (27.60)	34 (30.63)	0.315	0.575
History of alcohol consumption/case (%)	90 (46.88)	55 (49.55)	0.211	0.653
<i>Helicobacter pylori</i> infection/case (%)	42 (21.88)	26 (23.42)	0.097	0.756
Medical payment methods/case (%)			0.009	0.996
Urban residence	63 (32.81)	37 (33.33)		
Medical insurance	108 (56.25)	62 (55.86)		
Others	21 (10.94)	12 (10.81)		
Work situation/case (%)			0.007	0.932
Employed	84 (43.75)	48 (43.24)		
Retirement/Others	108 (56.25)	63 (56.76)		
BIPQ/score	44.96 $\pm$ 5.74	37.78 $\pm$ 3.89	11.711	< 0.001
SEGUE/score	67.14 $\pm$ 6.65	55.94 $\pm$ 4.27	15.940	< 0.001
MDT-CL/score	28.52 $\pm$ 3.49	34.61 $\pm$ 4.56	13.046	< 0.001

BIPQ: The Brief Illness Perception Questionnaire; SEGUE: Set Elicit Give Understand End Framework; MDT-CL: Measuring Different Types of Cognitive Load.

表 2 疾病感知、医患沟通、认知负荷与消化道早癌高危患者内镜复查依从性的关系 (n=303)

Table 2 The relationship between disease perception, doctor-patient communication, cognitive load, and compliance of high-risk patients with early digestive tract cancer for endoscopic re-examination (n = 303)

Factor	r_s	P	Standard error	95% CI
BIPQ	-0.788	< 0.001	0.019	-0.821 to -0.746
SEGUE	-0.815	< 0.001	0.016	-0.842 to -0.780
MDT-CL	0.619	< 0.001	0.038	0.537 to 0.693

BIPQ: The Brief Illness Perception Questionnaire; SEGUE: Set Elicit Give Understand End Framework; MDT-CL: Measuring Different Types of Cognitive Load.

(OR=1.351, 95%CI: 1.136 ~ 1.608)是消化道早癌高危患者内镜复查依从性的影响因素, P均<0.05, 见表3。

表 3 多因素logistic分析消化道早癌高危患者内镜复查依从性的影响因素
Table 3 Multivariate logistic analysis of factors influencing endoscopic re-examination compliance in patients with high-risk early digestive tract cancer

Factor	β	Standard error	Wald χ^2	P	OR (95% CI)
Age	0.147	0.049	8.962	0.003	1.159 (1.052-1.276)
Family history	-1.104	0.839	1.736	0.038	0.081 (0.008-0.865)
Monthly income	-0.006	0.002	16.336	< 0.001	0.994 (0.991-0.997)
BIPQ	-0.294	0.079	13.915	< 0.001	0.745 (0.639-0.870)
SEGUE	-0.365	0.073	20.952	< 0.001	0.694 (0.602-0.801)
MDT-CL	0.301	0.089	11.533	0.002	1.351 (1.136-1.608)
Intercept	40.907	9.359	19.105	-	-

BIPQ: The Brief Illness Perception Questionnaire; SEGUE: Set Elicit Give Understand End Framework; MDT-CL: Measuring Different Types of Cognitive Load; OR: odds ratio.

2.4 消化道早癌高危患者内镜复查依从性的随机森林分析

将年龄、消化道肿瘤家族史、家庭人均月收入、疾病感知、医患沟通、认知负荷纳为自变量, 消化道早癌高危患者内镜复查依从性为因变量, 应用R4.4.1建立随机森林模型。结果显示, 当参数ntree=500、mtry=2、nodesize=5时, 随机森林模型错误率最低(图1), 其相对重要预测因子排序依次为医患沟通、疾病感知、认知负荷、家庭人均月收入、年龄、消化道肿瘤家族史(图2), AUC为0.899 (95%CI: 0.843 ~ 0.921)、准确度86.4%、灵敏度85.7%、特异度92.3%、精确度84.2%、召回率92.1%、F1值0.953(图3)。

2.5 对消化道早癌高危患者内镜复查依从性随机森林模型的内部验证

应用五折交叉验证将数据集分成5个子集, 轮流使用4个进行训练, 1个进行验证, 结果显示: 测试集准确率在不同验证次数之间波动, 其中最小值为0.792(95%CI: 0.722 ~ 0.846), 最大值为0.930(95%CI: 0.901 ~ 0.966), 平均值为0.893, 表明模型具有较高的分类能力(图4)。

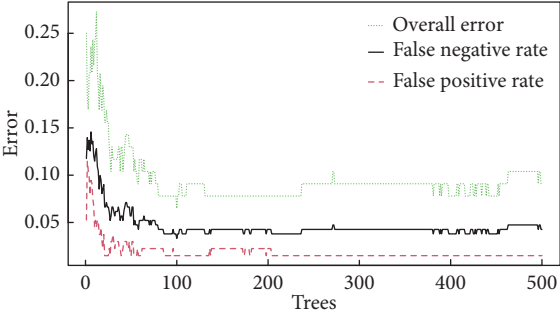


图 1 决策树量与模型错误率关系

Fig 1 The relationship between the number of decision trees and the model error rate

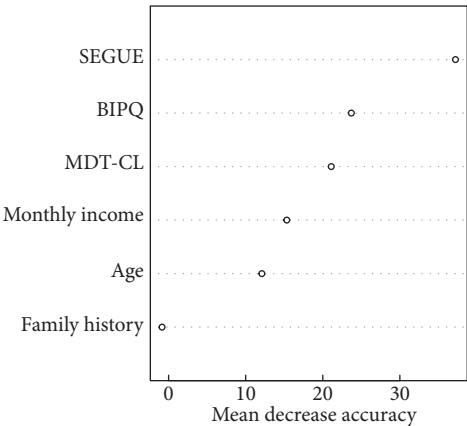


图 2 重要性排序

Fig 2 Importance ranking

BIPQ: The Brief Illness Perception Questionnaire; SEGUE: Set Elicit Give Understand End Framework; MDT-CL: Measuring Different Types of Cognitive Load.

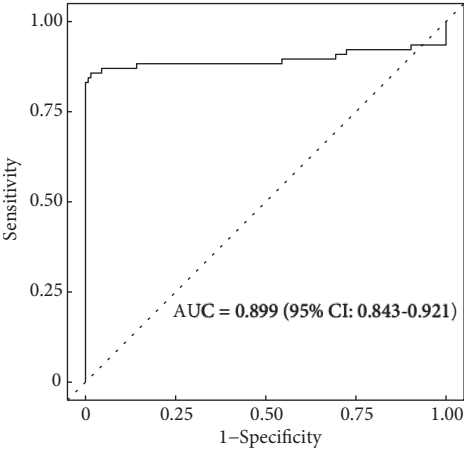


图 3 ROC曲线

Fig 3 ROC curve

3 讨论

3.1 消化道早癌高危患者内镜复查依从性现状及影响因素

本研究显示, 303例消化道早癌高危患者中, 111例 (36.63%)存在复查依从性差的问题。采用多因素logistic

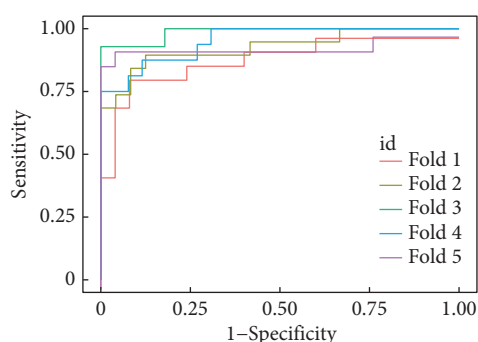


图4 五折交叉验证的随机森林模型ROC曲线

Fig 4 ROC curve of the fivefold cross-validation random forest model

分析得出,年龄、消化道肿瘤家族史与家庭人均月收入均是消化道早癌高危患者内镜复查依从性的影响因素($P<0.05$)。分析原因为,老年人对消化道早癌的危害性认知相对不足,容易低估定期复查的必要性,且一些高危患者缺乏医学知识,对消化道癌症的早期症状不够重视,认为无症状即无病症,则无需检查,导致主动复查意愿低下。加之,老年人往往在健康问题上倾向于采取“自然衰老”的心态,忽略了早期筛查的重要性^[16]。然而,对于有家族史的患者,尤其是直系亲属中曾患有消化道肿瘤者,他们对自己可能患病的风患有更高的认知,且更容易理解早期筛查对早期发现和治疗癌症的重要性,这种对疾病的高度警觉性使其更愿意积极参与定期的内镜检查。杜佳等^[17]指出,家族史的存在往往让患者对消化道癌症产生更强的恐惧感,担心自己也会遭遇类似的疾病,因此,部分患者出于对疾病的恐惧或压力,反而更加积极地进行定期检查,以减少患病风险。ZHANG等^[18]认为,有家族史的消化道早癌高危患者有“自己也可能得病”的心理,因此主动要求定期复查,以确保及早发现潜在的癌症或病变,减少患癌风险。经济压力可能会导致高危患者无法支撑医疗费用,即使意识到复查重要性,但在长期的经济压力下,选择放弃检查。刘畅等^[19]认为,收入较高的患者更愿意花时间和精力关注自身健康状况,这些因素有益于患者进行癌症监测。

3.2 医患沟通、认知负荷、疾病感知与消化道早癌高危患者内镜复查依从性的关系

本研究发现,消化道早癌高危患者内镜复查依从性差与疾病感知、医患沟通呈负相关,与认知负荷呈正相关,且三者均是内镜复查依从性的影响因素。分析原因为,当患者对疾病风险过度感知或存在认知偏差时,易产生焦虑、恐惧等负面情绪,进而回避复查。ZENG等^[20]指出,增强医生交流的策略,对于高血压患者而言有可能改善其药物依从性和血压控制的潜力。此外,当医生与患者的沟通不充分或信息传递不准确时,患者的疾病感知

偏差可能被放大,进而降低依从性^[21]。而疾病本身的复杂性会增加患者认知负荷,使其难以理解“无症状期仍需复查”的逻辑,导致患者因信息过载而放弃依从。LIU等^[22]认为,高水平的医患沟通能帮助医生与患者建立信任,患者更愿意接受疾病信息,修正“复查无用”的错误认知,最终主动配合复查。同时,简化沟通内容,强化关键信息,让患者更能有效了解疾病信息,知道疾病控制与筛查的必要性,减少决策犹豫,提高其依从性^[23]。因此,通过高质量的医患沟通,让消化道早癌高危患者降低认知负荷,使其清晰理解“何时查、为何查”,减少决策阻力,最终促使患者将疾病风险感知转化为持续的复查依从行为。

3.3 随机森林模型分析及验证

随机森林模型对消化道早癌高危患者内镜复查依从性的AUC为0.899(95%CI: 0.843 ~ 0.921),五折交叉验证平均准确率达0.893,表明模型具有良好的区分能力和稳定性。这是因为,随机森林通过自动特征选择,更客观地挖掘数据内在规律,以Gini指数置换检验,直接输出变量重要性排序,明确关键驱动因素,为早期识别高危人群提供了更精准的工具。相比传统logistic回归受限于线性假设,随机森林通过集成多棵决策树,可有效拟合变量间的非线性关联,更客观地挖掘数据内在规律^[24]。此外,模型直接输出特征变量的重要性排序(医患沟通>疾病感知>认知负荷>家庭人均月收入>年龄>消化道肿瘤家族史),为临床干预提供了精准的靶点。并利用五折交叉验证减少过拟合风险,验证了模型在不同数据集上的稳定性和泛化能力。

但本研究仍存在一定局限性:首先,研究样本均取自同一医疗机构,这可能会对结果的外部推广价值产生局限;其次,样本规模较小且分组存在不平衡现象,可能致使针对低频次暴露因素的统计检验效力降低,从而增加假阴性结果出现的风险;尽管通过五折交叉验证证实了模型的内部一致性,但其泛化能力尚未经过多中心数据的验证,且本研究主要用于评估内镜复查短期依从性,对于长期预后关联分析存在一定局限。未来研究可纳入更多潜在的调节变量,延长随访周期进一步验证结论,以提升消化道早癌高危人群的内镜复查依从率。

综上所述,本研究发现疾病感知、医患沟通、认知负荷、家庭人均月收入、年龄、消化道肿瘤家族史是消化道早癌高危患者内镜复查依从性的影响因素,随机森林模型展现出了较优的预测效能。

* * *

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