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Applying a modified care delivery value chain for procurement strategy development (the case of anti-HIV/AIDS institutions)

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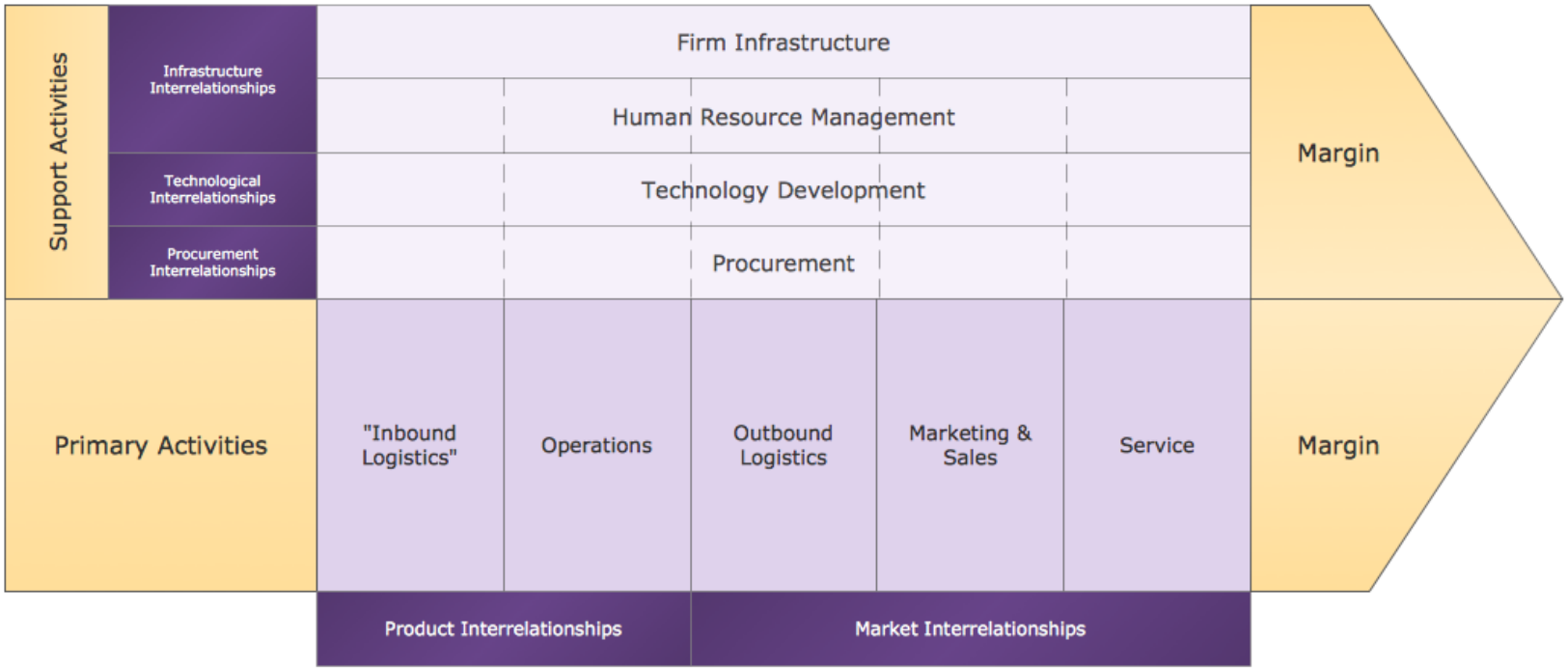
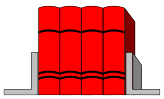
M. Porter's value chain (VC) methodology



- Splits firm's activities into the primary and supporting ones
- Directly points out the (universal) lists of primary and supporting activities
- Describes the sequential accumulation of value for the consumer and firm's costs in the production of goods / services in the process of passing them through the chain links
- Determines firm's success as the excess of the created value over the accumulated costs
- Indicates that firm's Strengths and Weaknesses can be identified as sources of its advantages/disadvantages in the execution of the chain links



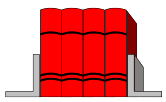
Porter M. 1985. *Competitive Advantage*.

The VC Contribution into the Procurement Strategy Planning (the case of centralized procurement system)

Procurement Department's Supporting Activities	Supplies transportation Data access Services procurement: utilities, security, feeding, etc	Consumables Energy Repair	Transportation services Computer Services	Media Agency Services Travel&Subsistence	Spare Parts Transportation Travel&Subsistence
Links of Value Chain	**Inbound Logistics**	**Operations**	**Outbound Logistics**	**Marketing and Sales**	**Service**
Primary Activities (in SBU)	Inbound material handling Inbound Inspection Parts Picking&Delivery	Component fabrication Assembly Fine tuning &testing Facilities operations Maintenance	Order Processing Shipping	Advertising Promotion Sales Force	Service Reps Spare Parts Systems

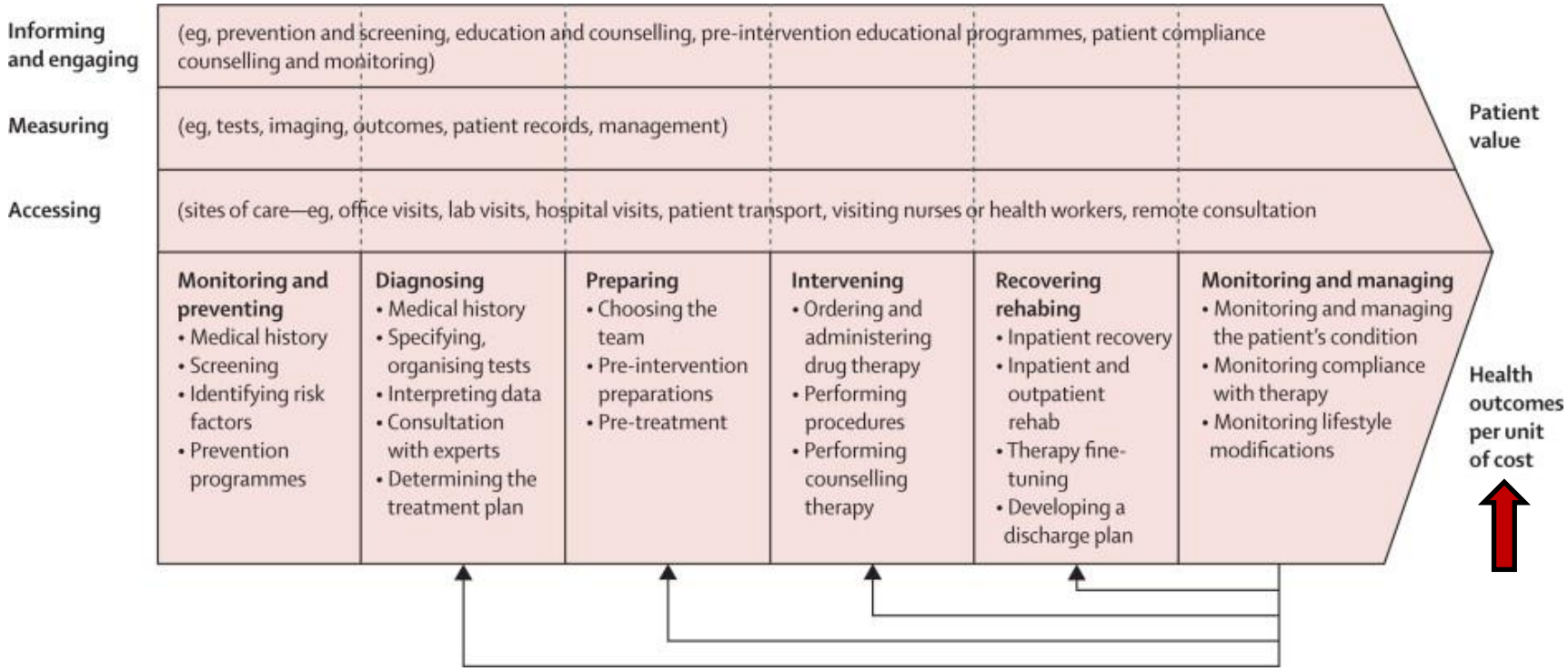
From the Abstract Procurement to the Hospital One

Integrated practice unit (**IPU**) is a dedicated multidisciplinary team that is organized around the needs of patients with a **specific medical condition** over **the full cycle of care**.



Porter M., Nabi J., Lee T. (2021) Value Chain Management to Implement Post–COVID-19 Health Care Strategy: The COVID-19 Crisis Has Created Areas of Innovation That Should Be Embraced by Health Care Leaders. NEJM Catalyst.

M. Porter's Care Delivery Value Chain (CDVC) for the typical IPU

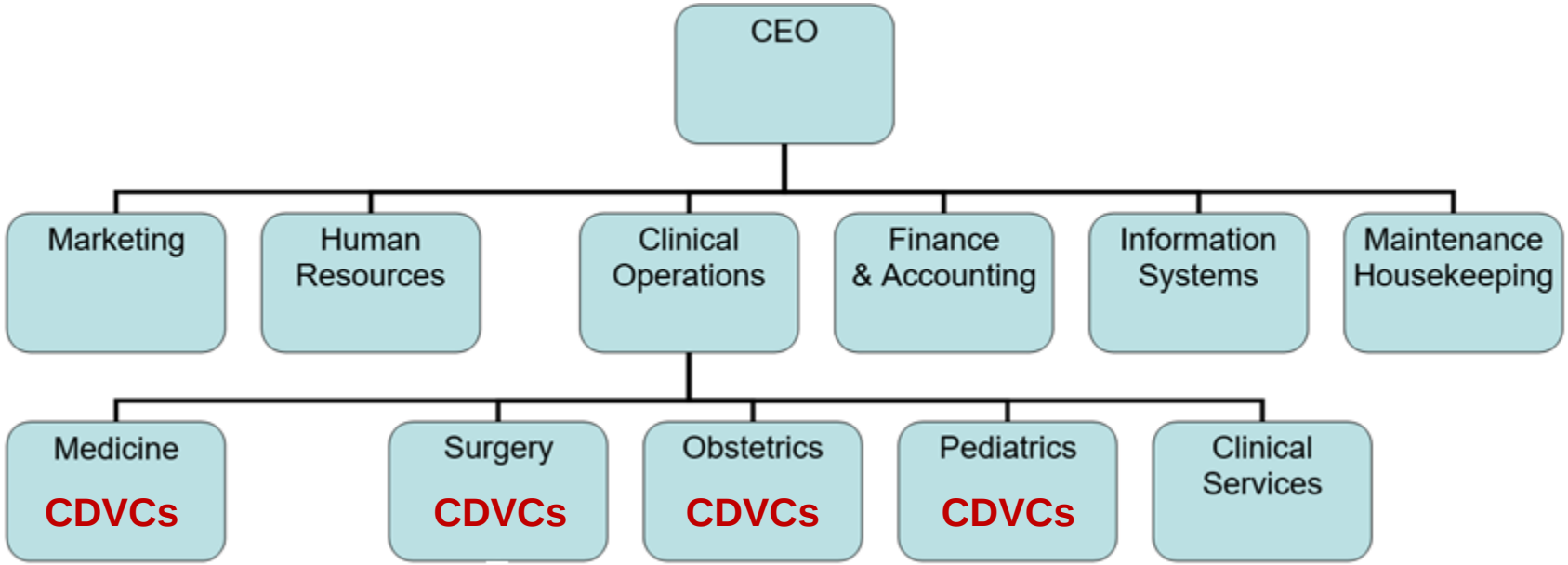


- At the bottom of the CDVC, each link in the chain is a mix of departmental, other hospital entities and, if any, outsourced health care activities
- CDVC structures the value generated by the activities listed at the CDVC bottom within the value components located at the top: ensuring access to medical services, measuring patient health indicators, informing the patient
- The IPU efficiency is measured by means Health Outcomes – to – Costs ratio

Porter M., Teisberg E. (2006) Redefining Health Care: Creating Value-Based Competition on Results. Harvard Business Review Press; 1st Edition.

The Research Object identification

The CDVC applying for strategic planning: main problem



Hospital ≈ IPU

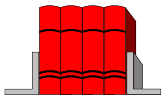
1. AIDS prevention and control Centers (AIDS Centers)
2. TB Dispensaries, Hospitals (or Centers)
3. Perinatal Centers
4. Sanatoriums
5. Anti-COVID-19 mono Hospitals…

CDVC for HIV/AIDS Care: Porter et al. (2009)

Patient's value compounds						
Informing **What do patients need to be educated about**	Lifestyle counseling Self management	Lifestyle counseling Explan. of the diag-nosis and the implic. Explaining the course of HIV and prognosis	Lifestyle counseling Explanation of the diagnosis and the implications	Explanation of medication Instructions and Side-Effects	Medication compliance	Managing Complications Explanation of the co-morbid diagnos. And the implicat. End-of Life Couns.
Measuring **What measures need to be collected**	HIV Testing Screen for TB and, if indicated, Simultaneously Screen for Sexually Transmitted Infections (Chla-mydia, Gonnohrea) Collect baseline demographics	HIV testing for others at risk HIV Staging Clinical examination, CD4+ count, and other labs Testing for common co-morbidities	CD4+ Count Monitoring (Continuous Staging) Continuous Assessment of Co-Morbidities Regular Clinical Examinations to Assess for Disease Progression Socioeconomic and Nutrition Assessment	CD4+ Count Monitoring (Conti-nuous Staging) Monthly Primary Care Assessment HIV Testing for Others at Risk Laboratory Evalu-ation for Medication Initiation	HIV Staging and Medication Response Highly Frequency Primary Care Assessmen Assessing/Managing Complications of Therapy HIV testing for others at risk (bi-annually) Laboratory Evaluation	HIV Staging and Medication Response Monthly Primary Care Assessment Laboratory Evaluation
Accessing **Where do patient care activities take place**	Meeting patients in high-risk settings Primary Care Clinics Testing Centers	Primary Care Clinics Laboratories (on-site at primary clinic) Testing Centers	Primary Care Clinics Support Groups Laboratories (on-site at primary clinic) Pharmacy Food Centers Home Visits	Primary Care Clinics Support Groups Laboratories (on-site at primary clinic) Pharmacy Community Health Workers/Home Visits	Primary Care Clinics Support Groups Laboratories (on-site at primary clinic) Pharmacy Community Health Workers/Home Visits	Primary Care Clin. Support Groups Pharmacy Community Health Workers/Home Vis Hospitals & Hos-pice Facilities Food Centers
Care delivery **What activities are performed at each stage?**	Prevention and Screening	Diagnosing and Staging (if + in screening stage)	Pre Anti-Retroviral Medical and Psychosocial Management	Intervening / ARV-Initiation	Continuous Disease Management	Management of Complications and Clinical Deteriorat.
	Identifying high risk individuals Testing at-risk individuals Promoting appropriat risk reduction strateg Modifying behave-oral risk factors Connecting patients with primary care system Creating a medical record	Formal diagnosis and staging Determine method of transmission and others at potential risk Determine TB, syphilis, and status of other sexually transmit diseases Create manag. plan, including scheduling of follow-up visits	Formulate a treatment plan Initiate therapies that can delay onset Limit co-morbidities that affect progression of disease Improve patient awareness of disease progression, prognosis, and transmis. Connect patient to care team, including community health work	Initiate comprehensive antiretroviral therapy and assess medication readiness Prepare patient for disease progression and side-effects of associated treatment Manage secondary infections and associated illnesses	Managing effects of associated illnesses Determine supporting nutritional modifications Preparing patient for end-of-life management Primary care and healthmaintenance	Identifying clinical and laboratory deterioration Initiating 2-line, 3-line drug therapies Managing acute illness and opport. infection (through aggressive outpat. manage-ment or hospitaliz. Managing side effects of treatment Provide addit. Com

Value chain methodology: further development suggestions

- Relevant merging of VC and CDVC links (for example, adding to CDVC inbound logistics)
- Adding a fourth component of value: Patient's well-being
- Concentrating all healthcare activities in the bottom-part of CDVC
- Filling in the top-part of CDVC with contributions to patient value components
- Chain 'Chessmatization' or 'Excelization'



Ivanov A., Gilenko E., Batueva E. (2021). On some approaches to increasing performance and cost-efficiency of Russian regional AIDS centers. Russian Journal of Management, 19(1), 35–66.

Modified value chain model for an AIDS Center: selected activities

Columns		A	B	C	D	Rows
Components of value for patients	Informing		Using the optimal informing channel (10) Improving information quality (8)	Objective information of stage of the disease (7)		1
	Measuring	Improving the quality of diagnostics (9)	Determining the presence of HIV infection (5, 6, 9)	Extensive health screening (7)		2
	Accessing patient care elements	Ensuring that the demand for medicines will be met (5, 8)	Facilitate access to diagnostics (9)	Opening access to the dispensary care (6, 7) Opening access to the dispensary care (8)	Obtaining medicine (8)	3
	Patient's well-being	Improving the quality of drugs (10)	Informing on the absence of HIV infection	Informing on the easy stage of HIV infection, if any (5)	Use of medicine (8) Obtaining psycho-logical assistance (5)	4
Value chain links		Inbound logistics	Monitoring / Preventing	Diagnosing	Intervening	
Performing activities		Forecasting the need for consumables and medicines	Mandatory medical examination	Identification of HIV infection: ELISA/CLIA	Infectious disease doctors' and other specialists' appointments	5
		Preparation of a state assignment	Voluntary medical examination	Dispensary registration	Laboratory and instrumental research methods	6
		Drawing up an annual procurement schedule	Organization and implementation of preventive measures	Detection of the stage of the disease: appointments of medical specialists, usage of instrumental research method	Organization of education for patients	7
		Preparation of an application to MHRF for provision of medicines	Preparation and distribution of information materials	Issuance of an opinion on the presence of HIV infection	Distribution of medicines	8
		Purchases of consumables	Medical examinations in the course of off-clinic events	Determining the presence of HIV infection Establishing the stage of the disease		9
		Purchases of medicines	Marketing efforts to establish channels with target groups			10

The main problems of the Russian Public Procurement System

Determinants of inefficiency	Comments
English Auction with the single criterion (Price) as the main Procurement Method	The Russian Public Procurement System is tightly aimed to counteract to the necessary conditions of corruption: • Public Buyer's Discretionary Power • Rent extraction behavior • Weakness of the Institutions
Corruption	• Bureaucratic Corruption • Efficient Corruption • Quasi-Corruption • Totalitarian Corruption Andrei Ivanov (2016) Quasi-corruption in Public Procurement: the case of Russian Federation. – In "Corruption, Economic Growth and Globalization", Routledge Studies in the Modern World Economy.
Collusion	The dynamic English Auction is the worst method in the presence of collusion The absence of anti-collusion legislative mechanisms (Guide to Enactment of the UNCITRAL Model Law on Public Procurement: collusion mentioned 43 times)

Ex-post counteraction to corruption: sufficient conditions of suppliers' collusion

The Model Notations and main Assumptions

- The English Auction is applied
- PD – the percentage of ICP (initial contract price, P_0) decreasing in the auction
- There are N risk-neutral bidders $B_1, \ldots, B_N$ selected to take part in the auction;
- Their economic costs of delivering goods: $c_i \le P_0$ (i=1, .., N);
- P_{fi} – the price up to which the *bona fide* i^{th} supplier participates in the auction: $P_{fi} \ge c_i$,
- The corresponding suppliers' price reservations (the maximum percentage of ICP decreasing) are:

$$PR_i = \frac{P_0 - P_{fi}}{P_0} \times 100 > 0, \quad i = 1, 2, \ldots, N;$$

The Auction's Dramatis personae

Public Buyer

ETP — **Electronic Trade Platform**

Suppliers

How an English Auction works in Russia

ETP

Solicitation to tender, ICP

ETP

Bids

First Part: What will be supplied
Second Part: Who will supply

ETP

First Parts of Bids

ETP

N Accepted Suppliers

ETP

Auction

Each time price goes down at $\Delta=0{,}5\times k$, $k\in[1, 10]$

ETP

Second Part of last bidder Bid and some others

Contract

The Collusion identification in the Auctions with a small price reduction

Let's assume that:

- there are two bidders (Winner and Looser),
- their price reservations are PR_W, PR_L,
- there is no bidding ring (all bidders are *bona fide*).

The Collusion identification in the Auction with PD=0

#	Hospital	Auction date	ICP (rub)				ICP decrease (%)
				submitted bids	approved bids	decreased price in the auction	
1	3	09.12.2021	7 318 642.56	5	2	0	0

According Russian PPL contract goes to the supplier who first register on the auction.

Theorem 1. If $N > 1$ and nobody decreases a price in the auction, there is a collusion.

The Looser:
(1) spent resources (money/time) to prepare for participation in the auction;
(2) had information that it was impossible to win the contract without an ICP decrease;
(3) actually, didn't bid.

→ The assumption of bidders *bona fides* was wrong. Collusion can be considered proven.

The Collusion identification in the Auction with PD=0.5

#	Out-patient hospital	Auction date	Initial Contract Price (ICP)	The number of Suppliers that			ICP decrease (%)	Bid submission time (min)
				submitted bids	were accepted as auction's participants	decreased price in the auction		
2	4	01.04.2021	26294437.79	3	2	1	0.5	3:00

PD=0.5 ⇨ Winner bid – 0.5 ⇨ **PR_L = 0.5**

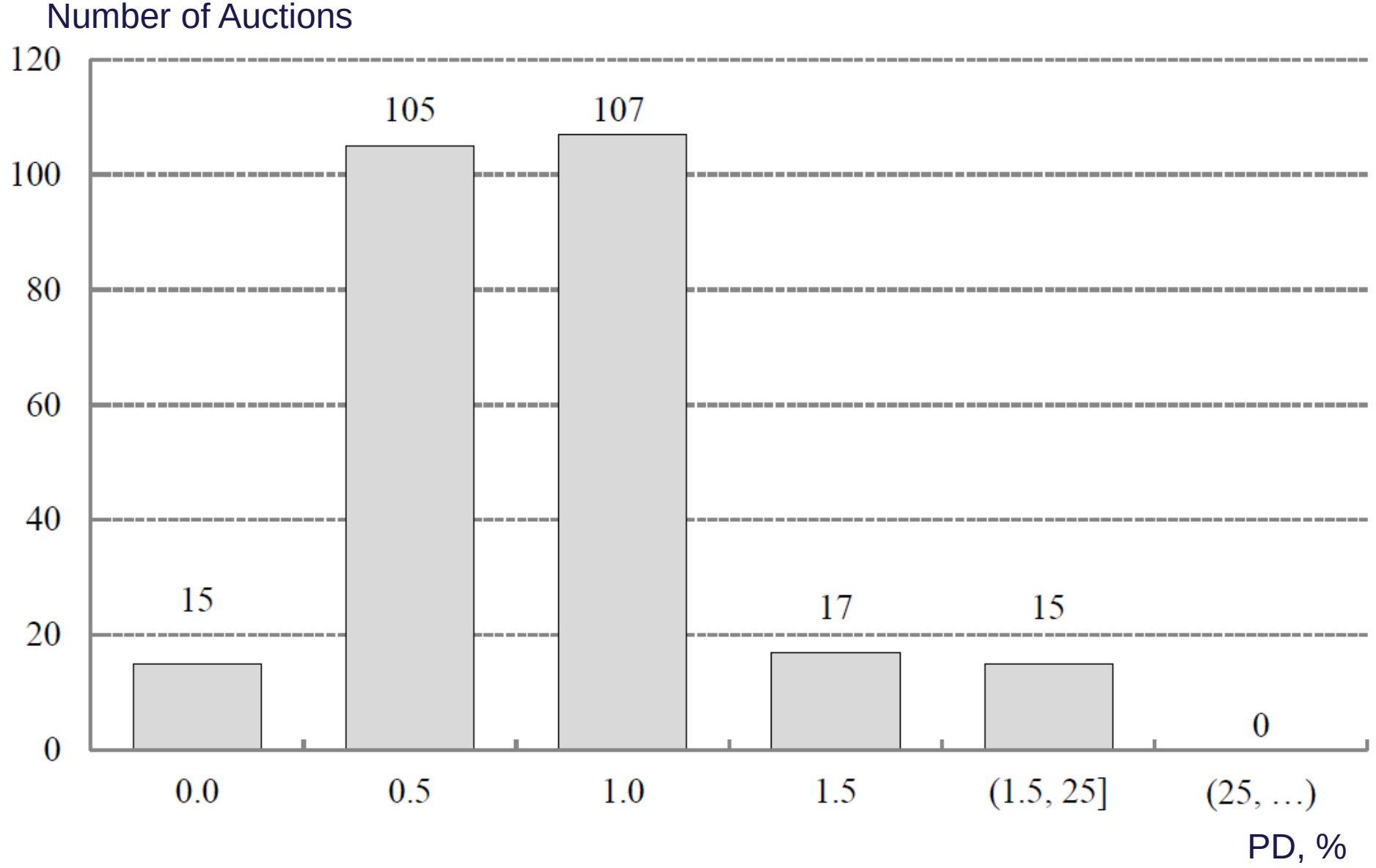
Lemma. The *bona fide* bidder with a PR=0.5 submits a bid at the very beginning of the auction.

The Looser:
(1) spent resources (money/time) to prepare for participation in the auction;
(2) knows that it is impossible to win a contract if the other supplier submit a bid first;
→ The bidder must submit a bid at the very beginning of the auction.

Theorem 2. If PD=0.5, and winner bid has not been submitted at the very beginning of the auction, there is a collusion.

Theorem 1 and Theorem 2 are the collusion sufficient conditions for the cases PD=0 and PD=0.5 (collusion sufficient conditions for the cases PD=1 and PD=1.5 are also formulated and proved).

Federal Antitrust Service: base of hospitals' collusive tenders



Validation: How to make it easier for the FAS
The collusion sufficient conditions applying

Collusion identification: some cases (collusion in red)

aucID	TimeFirstBid	TimeLastBid	icpReduc	nAllowed	nParticip
0372200119818000237			0	3	0
0372200140119000060			0	6	0
0372200131719000134	34	34	0,5	5	1
0372200133115000243	7	**7**	0,5	2	1
0372200140118000048	51	51	0,5	3	1
0372200072318000012	75	111	1	2	2
0372200000116000288	25	**50**	1	2	2
0372200074116000213	**10**	115	1	3	2
0372200074116000202	51	155	1	2	2
0372200000118000054	272	355	1,5	2	2
0372200047715000325	**41**	272	1,5	2	2
0372200047715000388	115	237	1,5	2	2

Collusion identification: total

PD	Total in the database	Online collusion identification (the sufficient collusion conditions are true)
0	15	15 / 100%
0.5	105	91 / 87%
1	107	92 /86%
1.5	15	14 / 93%

Additional Slides

Ex-post counteraction to collusion in AIDS institutions procurement: classification models

The Selection Procedure

Procurement procedures	Number
Procurement data of all Russian HIV/AIDS institutions over the period 2017-2020	38 567
Of them are selected auctions that at the same time: fell into the category “English price electronic reverse auction”; had at least 2 approved participants (as we needed auctions with competition); were held at the Sberbank ETP (as this ETP publicly provides the full information on the auctions in a user-friendly form).	3 096
Of them	
marked as collusion-positive (collusion sufficient conditions are true)	223
marked as collusion-negative (the others)	2873

Variables and their descriptive statistics

Variable	Description, measurement units	Rationale of use	HIV/AIDS data (n=3 096)			
			min	median	mean	max
collusion	Binary variable (BV): =1 for the auctions with identified collusion; =0 otherwise (will be omitted below)	Outcome variable	0	0	0.072	1
ICP	Initial contract price; Continuous variable (CV); RU1000	Higher ICP may provide more incentives to collude.	2.1	317.5	2618.1	710625.7
appCollat	Size of collateral for the application submission (% of the ICP, in the range 0%–5% as set by law, CV	The larger is the size of the collateral, the more incentives to win the auction, thus, to collude.	0.003	7.73	45.77	21318.8
combined	BV: =1 for the auctions run for several buyers simultaneously;	Combined auctions imply bigger purchases, thus, higher ICPs and more incentives to collude.	0	0	0.15	1
federalDistrict	A set of BVs, each corresponding to one of the eight Russian federal districts	Auctions in different federal districts may be differ-rently prone to collusion due to some regional peculiarities.	x	x	x	x
n1hour	The number of auction applications submitted within 1 hour (not necessarily the same hour)	An indirect indicator of coordination of actions.	0	0	1.16	24.0
nApproved	The number of auction applications approved by the first parts	The more approved applications, the more participants in the auction, thus, less possibilities to collude.	2.0	3.0	3.84	33.0
purchaseType	A set of BVs, each corresponding to one of types of medical products being bought: (1) medicines; (2) materials used for medical purposes; (3) medical equipment; (4) medical consumables; (5) other (food provision, security services, etc.)	Auctions for different types of medical products may be differently prone to collusion due to market peculiarities.	x	x	x	x
limitSmall	A legislative limitation: procurement only from SME. BV: =1 if the limitation was applied for the auction,	Auctions with such artificially limited competition may be more likely to have suppliers' collusion	0.0	0.0	0.36	1.0
protection	It implies a 15% handicap for national pro-ducers as compared to foreign producers. BV: =1 if the limitation was applied for the auction,	Auctions with such artificially limited competition may be more likely to have suppliers' collusion	0.0	1.0	0.52	1.0

Models and their quality

Four machine learning algorithms – Random Forest, Gradient Boosting, SVM, and Linear Regression – were used in calculations.

Classification metrics

Precision = TP / (TP + FP); Sensitivity (Recall) = TP / (TP + FN); Specificity = TN / (TN + FP);

F1-score = 2*Precision*Recall / (Precision + Recall); Balanced Accuracy = (Sensitivity + Specificity)/2;

where

TP – true positive (the correctly predicted positive class outcome of the model),

TN – true negative (the correctly predicted negative class outcome of the model),

FP – false positive (the incorrectly predicted positive class outcome of the model),

FN – false negative (the incorrectly predicted negative class outcome of the model).

The corresponding models were optimized via randomized search over their hyper-parameters and validated using a 5-fold cross-validation with respect to the F1-score metric.

Averaged values of classification metrics for the HIV/AIDS dataset

Classification metrics	Random Forest	Gradient Boosting	SVM	Linear regression
Recall	0.973	0.955	0.826	0.900
Precision	0.200	0.204	0.140	0.163
F1-score	0.332	0.337	0.238	0.275
Balanced accuracy	0.836	0.828	0.716	0.771