Individual Rationality and Participation in Large Scale, Multi-hospital Kidney Exchange

[Extended Abstract]*

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ABSTRACT

As multi-hospital kidney exchange clearinghouses have grown, the set of players has grown from patients and surgeons to include hospitals. Hospitals have the option of enrolling only their hard-to-match patient-donor pairs, while conducting easily arranged exchanges internally. This behavior has already started to be observed.

We show that the cost of making it individually rational for hospitals to participate fully is low in almost every large exchange pool (although the worst-case cost is very high), while the cost of failing to guarantee individually rational allocations could be large, in terms of lost transplants. We also identify an incentive compatible mechanism.

Categories and Subject Descriptors: J.4 Computer Applications: Social and Behavioral Sciences – Economics.

General Terms: Algorithms, Economics, Theory.

Keywords: Matching, Market Design.

1. EXTENDED ABSTRACT

When kidney exchange was just beginning, most exchanges were conducted in single hospitals, or in closely connected networks of hospitals like the fourteen New England transplant centers organized by the New England Program for Kidney Exchange (Roth, Sönmez, and Ünver (2005)). But today exchanges often involve multiple hospitals that may have relatively little repeated interaction outside of kidney exchange. In this paper (Ashlagi and Roth(2011)) we study the problem of providing hospitals the incentive to participate fully, in order to achieve the gains that kidney exchange on a large scale makes possible.

Hospitals participate in a multi-center exchange by reporting a list of incompatible patient-donor pairs to a central clearinghouse, and a matching mechanism chooses which exchanges to carry out. Hospitals may report only a partial list of their incompatible pairs and conduct among their own patients internal exchanges. We assume that hospitals wish to maximize the number of their own patients that are matched.

As kidney exchange clearinghouses try to maximize the (weighted) number of transplants without attention to whether those transplants are internal to a hospital, it may not be even individually rational for a hospital to contribute those pairs it can match internally. For example, consider a hospital a with two pairs, $a1$ and $a2$, that it can match internally. Suppose it enters those two pairs in a centralized exchange. It may be that the weighted number of transplants is maximized by including $a1$ in an exchange but not $a2$, in which case only one of hospital a's patients will be transplanted, when it could have performed two transplants on its own.

In our model each hospital has a set of incompatible pairs (of constant size), and all incompatible pairs induce a "compatibility" graph. We first study the loss of transplants from requiring the allocation to be individually rational (guarantee each hospital the number of pairs it can internally match) rather than just efficient. We first show that the loss can be large in the deterministic case. Next we consider large random compatibility graphs and extend Erdos-Renyi results, to show both what efficient matches look like, and also construct an individual rational allocation (under some regularity condition on the size of the hospital) that is almost efficient.

We further use random compatibility graphs to show that there exists an incentive compatible mechanism that is almost efficient. Specifically we construct an almost efficient mechanism that (under a slightly stronger regularity condition on the hospital size) makes truth-telling an approximated Bayes-Nash equilibrium.[1]

REFERENCES

[1] I. Ashlagi and A. E. Roth. Individual rationality and participation in large scale, multi-hospital kidney exchange. Working paper, 2011.

[2] A. E. Roth, T. Sönmez, and M. U. Ünver. A kidney exchange clearinghouse in New England. *American Economic Review Papers and Proceedings*, 95(2): 376–380, 2005.

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*A full version of this paper is available at `http://web.mit.edu/iashlagi/www/papers/LargeScaleKidneyExchange_1_13.pdf`.

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[1]An $\epsilon(n)$-Bayes-Nash equilibrium, where $\epsilon(n) = o(1)$ and n is the number of hospitals.