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THE HOSPITAL DISCHARGE GAME : A GAME THEORY-INSPIRED WORKSHOP TO ENCOURAGE COOPERATION BETWEEN HEALTH AND SOCIAL CARE ORGANISATIONS

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ABSTRACT

Traditionally, health and social care organisations have operated independently, with minimal interaction and poor integration of the various services with which a patient comes into contact. In some cases, 'perverse' systemic incentives have discouraged cooperation and led to a 'silo mentality'. In this paper, we present an interactive workshop game that can be played with those working in and around health and social care. The game places teams in the roles of community and acute hospitals, and asks them to make discharge decisions about patients. However, a 'perverse' incentive is present in the system, and opposing teams are not allowed to communicate, which leads to increasingly 'selfish' decision making. We outline the details of this game, and show how it can be used as a tool to facilitate understanding of the benefits of cross-organisational communication and cooperation. We also present data from an initial pilot of this workshop.

Keywords: Interactive Workshop, Game Theory, Systems Thinking, Health and Social Care

1 INTRODUCTION

NHS organisations face increasing pressures coping with growing demand and declining resources (NHS England, 2013). Patient journeys through entire health and social care systems have traditionally been neglected as the focus of service improvement, which has instead sought to optimise organisations as standalone entities, rather than components of larger systems (Bell et al, 2006). However, more recently organisations have been increasingly encouraged to adopt whole systems thinking when considering how to improve their services, with an increasing focus on moving towards integrated care models (Ham et al, 2011; Naylor et al, 2015). Despite this, many organisations continue to operate as 'silos', perhaps because of a lack of incentive to adopt service improvement measures that benefit the whole system whilst potentially leading to apparent short-term falls in performance for the individual organisation (Naylor et al, 2015; Mannion and Braithwaite, 2012).

In this paper, we present a game that uses principles from Game Theory (von Neumann, 1959), and specifically the Prisoner's Dilemma (Rapoport and Chammah, 1965), in order to starkly convey the pitfalls of making decisions that only benefit an individual organisation within a larger system, particularly where 'perverse' incentives do not encourage cooperation between organisations in a system. We outline the rules of the game, explain how the mechanics of the game lead to certain behaviours being exhibited, and then present results from a pilot of the game, which was run as a workshop for

professionals working across health and social care in South West England. We show how the results from the pilot demonstrate the desired effects of the game, and argue that this game could be used as a tool to promote whole systems thinking within the NHS, amongst both practitioners and policy makers.

2 THE HOSPITAL DISCHARGE GAME

2.1 Rules of the Game

Participants in the workshop are split into two teams – one representing an acute hospital, and one representing a community hospital. Each team should have around 3-5 members. For large workshop groups, multiple pairs of teams can be used. The game is Java-based and installed on one computer for each pair of teams.

The objective of each team is to discharge patients such that they minimise the number of penalty points that they accrue. The winning team is the one at the end of the game with the fewest penalty points. Play is divided into a series of turns, with the acute hospital and community hospital alternating play within each turn. The acute hospital begins the first turn. The team approaches the computer and is presented with a list of patients in their hospital, including an ID for each patient and their state of health (on a scale from 0% to 100%, with 100% representing full health). They are also told how many patients are currently waiting for a bed in their hospital, along with the total number of patients currently in the hospital (both in a bed and waiting for a bed), the total number of beds in the hospital, the number of new patients that have arrived this turn and the number of patients they have discharged this turn. The hospital must then decide which (if any) of their patients they will discharge, and they are encouraged to discuss their decision amongst themselves, taking care to ensure they are not heard by the other team. Once they have made their decision, play passes to the community hospital, who must make the same decision for their hospital. Once they have made their decision, the game moves to the next turn and play passes back to the acute hospital. For every patient for whom a hospital does not have an available bed, the hospital incurs 100 penalty points.

All patients discharged from the acute hospital are immediately sent to the community hospital. All patients discharged from the community hospital are immediately sent home. Patients who have been sent home may be readmitted to the acute hospital. The probability of a patient being readmitted to the acute hospital on any given turn is the inverse of their state of the health (so if their state of health is 60%, they have a 40% chance of being readmitted each turn). The acute hospital incurs a penalty of 100 points for every patient who is readmitted to the hospital. In addition, on each turn a random number of new patients will arrive into the acute hospital, with randomly generated states of health.

The state of health of patients gradually improves whilst they are in hospital. Specifically, each patient in the acute hospital improves by 10% each turn (up to a maximum of 100%), whilst patients in the community hospital improve by 5% each turn (up to a maximum of 100%). However, this information is not disclosed to participants ahead of the game, and they are simply told that patients gradually get better whilst they are in hospital. The state of health of patients at home does not improve, and this is disclosed to participants. Patients cannot die in this game.

The number of turns over which the game is played can be decided by the facilitator, but it is important that participants are not told how many turns the game will last to avoid the potential for endgame strategies to be adopted. It is recommended that each hospital be given at least 10 turns to allow for pressures to build up.

Figure 1 shows a screenshot of the Java-based game. The number of turns, maximum number of new patients that can arrive each turn, the maximum state of health of new patients arriving, the total number of beds in each hospital, the number of patients in each hospital at the start of the game, the per-turn state of health increase in each hospital, the penalty points accrued for not having an available bed and the penalty points accrued by the acute hospital for a readmission are specified by the facilitator before the game begins (Figure 2). These details are not disclosed to the participants ahead of playing the game.

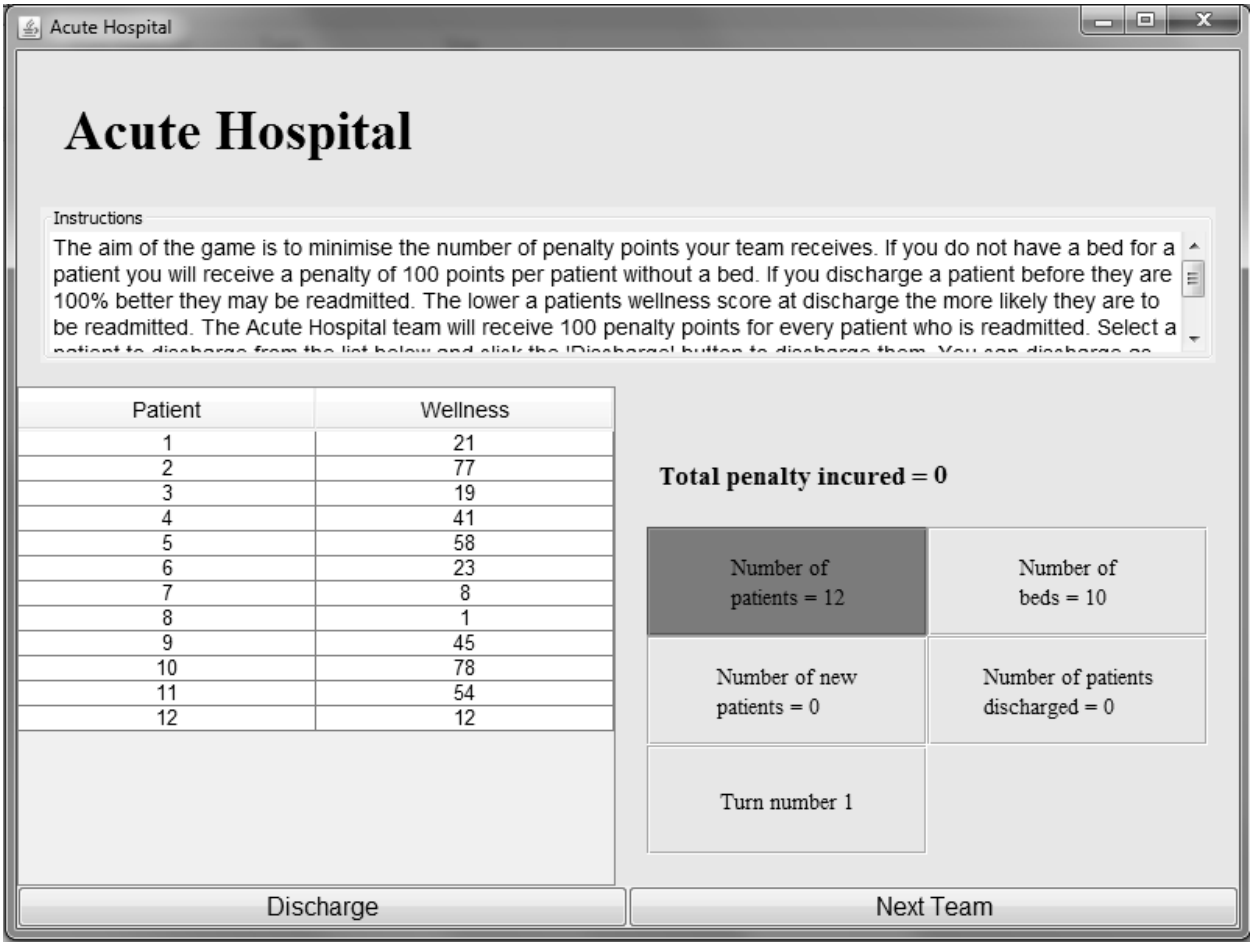

Figure 1 *Screenshot of the Java-based Hospital Discharge Game in Play*

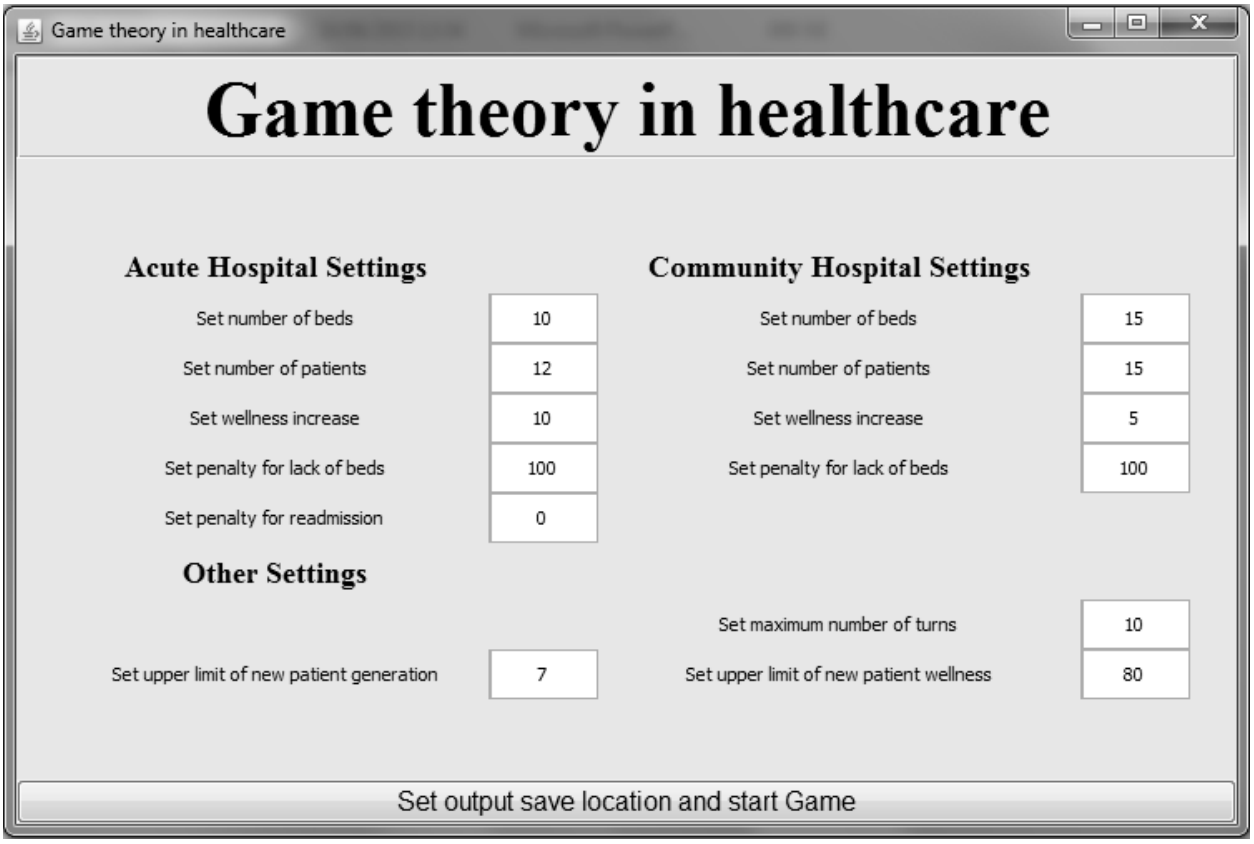

Figure 2 *Screenshot of the initial configuration options for the Java-based Hospital Discharge Game*

2.2 'Perverse' Incentives

Whilst it is never explicitly highlighted to participants, and participants are not allowed to ask questions about the rules prior to playing the game to avoid the risk of highlighting the nature of the system to others, the system has a 'perverse' incentive that encourages conflict and selfish decisions to be made. The performance of each hospital is only judged in terms of the amount of penalty points that are accrued, and penalty points are only accrued for not having any available beds. As such, the optimum strategy should be to discharge all patients at all times, regardless of their state of health, in order to minimise the probability of not having an available bed at any time. The team that 'wins' the game will be the one that adopts this strategy first. This strategy is equivalent to the Prisoner's Dilemma in Game Theory, in which the optimum 'rational' strategy is to make the most selfish decision, in order to maximise your average expected reward (Rapoport and Chammah, 1965).

The 'perverse' incentive is placed in the game in order to encourage teams to behave increasingly 'selfishly', by not considering the impact on the other hospital or on the patient, and to emulate real-world performance measures that only assess limited aspects of single organisations (Pollitt, 1986; Mannion and Braithwaite, 2012). In order to increase the probability of 'selfish' behaviour occurring, the game should be configured such that the flow of patients into the acute hospital quickly becomes overwhelming. If the acute hospital is seeking to minimise their penalty points, they will quickly start increasing the number of patients they discharge. This, in turn, increases the burden on the community hospital, leading to an increased quantity of discharges here too. Consequently, more patients will be sent home in poorer states of health, increasing the probability of readmission to the acute hospital. This leads to a 'snowballing' effect, in which teams become increasingly burdened and increasingly 'selfish' in their decision making.

If only one team behaves selfishly, the other team will incur significant penalty points as they will not be able to provide sufficient beds for the patients entering their hospital.

2.3 The Second Iteration

Once the game has been played, participants should have an opportunity to reflect on what happened during the game. Specifically, they should have an opportunity to discuss what strategies they adopted when playing the game, and whether these strategies changed over the course of the game. The facilitator should then explain the 'perverse' incentive present in the system, the resultant 'optimum' strategy to win, and how this encourages conflict between teams.

Once the participants have understood the outcomes of the first iteration of the game, it is played again. However, in this second iteration of the game, there are several key changes to the rules. First, each pair of teams is now working together to compete against other team pairs (if there was only one pair of teams in the first iteration, teams should be split here to form two pairs of teams). Second, the winning pair of teams is the one with both the lowest penalty points accrued across both hospitals, and the highest average patient state of health at discharge from the community hospital. Third, the acute and community teams within a pair should discuss with each other what decision each hospital should take on each turn.

By changing the rules in this way, teams are actively encouraged to cooperate to meet a common goal – to reduce penalties across both hospitals and maximise patient state of health. This removes the 'perverse' incentive, as each hospital is now rewarded for improving the health of patients and sharing the burden of admissions across the system. Teams working cooperatively are able to discuss the current bed occupancies in each hospital and future discharge plans, allowing informed and integrated decisions to be made. This removes the snowballing effect observed in the first iteration of the game, and leads to shared responsibility between teams, resulting in lower average penalties across both organisations and higher states of health at discharge.

Once the second iteration has been played, the facilitator should again encourage reflection and discussion of how the game was played, particularly focusing on the differences in team behaviour and strategies between the first and second iterations. This may be followed by a discussion on the benefits of cooperation and whole systems thinking, and an introduction to Game Theory and the Prisoner's Dilemma.

3 PILOT RUN OF THE GAME

On 16th June 2015, a pilot session of the Hospital Discharge Game was run as part of the Peninsula Collaboration for Health Operational Research and Development (PenCHORD) Seminar, Showcase and Workshop Series. These events are a capacity building initiative of the NIHR CLAHRC for the South West Peninsula (PenCLAHRC), and are targeted primarily at those working in and around health and social care in the South West of England. The key aim of the events is to increase awareness in the NHS of Operational Research, and how such techniques can be applied to problems in health and social care to inform decision making. As part of this, an afternoon workshop session at each event introduces an aspect, technique or idea from Operational Research using an interactive format. The Hospital Discharge Game was piloted during this session at 16th June event.

3.1 Participants and Game Configuration

There were around 30 participants in the pilot session of the game, the majority of whom worked in the NHS (with the remaining participants representing healthcare researchers). The participants were divided into three pairs of teams, such that each team had around five team members. Each acute hospital had a total of ten beds available to them, whilst each community hospital had a total of 15 beds. At the start of the game, the acute hospital had 12 patients in the hospital (and therefore two immediately without beds), and the community hospital had 15 patients. Patients in the acute hospital improved at a rate of 10% per

turn, compared to community hospital patients who improved by 5% each turn. Penalties for lack of beds were set to be the same for both hospitals – 100 points for each patient without a bed each turn. The acute hospital received an additional penalty of 100 points for every readmission to the hospital. A minimum of one and a maximum of seven new patients would arrive at the acute hospital each turn, presenting with a state of health between 1% and 80%. The game was played for 20 turns for the first iteration, and 10 turns for the second iteration.

3.2 Results from the First Iteration of the Game

In the first iteration of the game, Team Pair 1 incurred 45,600 penalty points in the acute hospital compared with 63,200 penalty points in the community hospital. Team Pair 2 incurred 78,500 penalty points in the acute hospital compared with 5,100 points in the community hospital. Team Pair 3 incurred 85,300 penalty points in the acute hospital compared with 6,300 points in the community hospital.

In both Team Pair 2 and 3, the community hospital dominated the game by adapting to selfish decision making more quickly than the acute hospital. The community hospitals in Team Pairs 2 and 3 discharged a total of 290 and 262 patients respectively, compared to the acute hospitals who discharged 275 and 247 patients respectively. In contrast, the community hospital in Team Pair 1 lost the game, and only discharged 276 patients compared to the acute hospital's 333 discharges.

The average state of health of patients discharged from the community hospital was 48.2% for Team Pair 1, 52.2% for Team Pair 2, and 65.3% for Team Pair 3.

Table 1 provides full details of the total discharges, readmissions, penalties and mean state of health at discharge for each hospital in each team pair in the first iteration of the game.

Table 1 *Total discharges, readmissions, penalties and mean state of health at discharge across the two hospitals in each Team Pair for the first iteration of the game*

Team Pair	Acute Total Penalties	Community Total Penalties	Acute Discharges	Community Discharges	Acute Readmission Penalties	Acute Readmissions	Mean State of Health at Discharge from Acute Hospital	Mean State of Health at Discharge from Community Hospital
1	45600	63200	333	276	26400	264	39.5%	48.2%
2	78500	5100	275	290	26300	263	52.6%	52.2%
3	85300	6300	247	262	22300	223	65.4%	65.3%

3.3 Results from the Second Iteration of the Game

In the second iteration of the game, Team Pair 1 incurred 9,300 penalty points in the acute hospital and 7,000 penalty points in the community hospital. Team Pair 2 incurred 15,800 penalty points in the acute hospital and 1,900 points in the community hospital. Team Pair 3 incurred 15,600 penalty points in the acute hospital and 1,500 points in the community hospital. Overall, the total penalty points accrued across both hospitals fell by 92,500 for Team Pair 1, 65,900 for Team Pair 2, and 74,500 for Team Pair 3. It should be noted that the second iteration only ran for half the length of the first iteration, but even considering this the differences are significant.

The average state of health at discharge from the community hospital increased significantly in the second iteration of the game. Specifically, there was an increase of 51.8% for Team Pair 1, 25.1% for Team Pair 2, and 10.3% for Team Pair 3.

Table 2 provides details of total discharges, readmissions, penalties and mean state of health at discharge for each hospital in each team pair in the second iteration of the game. Table 3 compares total penalties and community hospital mean state of health at discharge across the two iterations of the game.

Table 2 *Total discharges, readmissions, penalties and mean state of health at discharge across the two hospitals in each Team Pair for the second iteration of the game*

Team Pair	Acute Total Penalties	Community Total Penalties	Acute Discharges	Community Discharges	Acute Readmission Penalties	Acute Readmissions	Mean State of Health at Discharge from Acute Hospital	Mean State of Health at Discharge from Community Hospital
1	9300	7000	28	25	0	0	87.7%	100%
2	15800	1900	42	47	3100	31	75.3%	77.3%
3	15600	1500	45	50	3300	33	75.7%	75.6%

Table 3 *Comparison of total penalties and mean state of health at discharge between the first and second iterations*

Team Pair	Total Penalties Across Both Hospitals (First Iteration)	Total Penalties Across Both Hospitals (Second Iteration)	Difference in Total Penalties	Mean State of Health at Discharge from Community Hospital (First Iteration)	Mean State of Health at Discharge from Community Hospital (Second Iteration)	Difference in Mean State of Health
1	108800	16300	-92500	48.2%	100%	+51.8%
2	83600	17700	-65900	52.2%	77.3%	+25.1%
3	91600	17100	-74500	65.3%	75.6%	+10.3%

4 DISCUSSION

In this paper, we have outlined an interactive game that can be played with health and social care professionals in order to improve understanding of the importance of whole systems thinking when making decisions that affect other organisations. The game presents an exaggerated example of a 'perverse' incentive that could discourage cooperation between organisations. Nevertheless, 'perverse' incentives can be found in the way in which some organisations in the NHS are rewarded or penalized (Naylor et al, 2015; Berry et al, 2015; Kar, 2015).

The pilot of this workshop demonstrated the intended effects of the game. During the first iteration, decisions were made under increasing pressure from overwhelming demand for beds and a lack of knowledge of the capacity and decisions of the other hospital in the system. Participants visibly became increasingly frustrated with the escalating number of admissions or readmissions into their hospital, leading to a gradual increase in 'selfish' decisions that did not consider patient wellness or the impact on the other organization. In turn, this led to a 'vicious circle' in which increasing demand was placed on the other organization, causing them to have to discharge more patients early, leading to more readmissions and escalating levels of demand for both services.

In contrast, when playing the second iteration, teams were able to communicate and make joint decisions about their discharges. Both teams were working towards a common goal – low penalties and high levels of wellness for their patients across the *system*. Consequently, teams made decisions that may not have appeared immediately optimal when considering only their service, but which improved the outcomes in the system as a whole. This led to significant increases in patient state of health at discharge, and significant decreases in penalties from beds being blocked.

This game shares some similarities with the Beer Distribution Game (Sterman, 1984), which is a long-standing Operational Research game designed to demonstrate the dangers of lack of communication and individual-level optimisation within a larger system. However, the Beer Distribution Game uses a production line as its example context, which may not immediately find resonance with health and social care professionals and the way in which they view their systems. In contrast, the Hospital Discharge Game presents a pertinent example of a problem within healthcare systems, and one which is likely to be familiar to many working within the NHS. Therefore, the potential for health professionals to understand the direct relevance of the game to their own organisational thinking is arguably more significant. Another game – Friday Night at the ER (http://fridaynightattheer.com/ accessed 5th November 2015) – uses principles from the Beer Game in the context of managing patient flow in a hospital during a 24 hour period to teach principles of systems thinking. However, this game does not contain 'perverse' incentives within the system, meaning that the resultant behavior, outcomes and intended reflection are different to the Hospital Discharge Game.

There has been much effort in recent years to improve collaboration between NHS organisations, and move towards integrated care models that consider the whole system within which patients access care (Ham et al, 2011; Naylor et al, 2015). However, it can often be difficult to move thinking away from the 'silo mentality' that has plagued the health service for many years, not helped by performance measures that often still focus on individual organisation performance (Mannion and Braithwaite, 2012). We propose that this workshop game could be an effective means of conveying a simple message to health and social care professionals – that whole systems thinking, and increased cooperation between organisations, can lead to improved patient outcomes and improved longer-term performance across the system. In addition, this game could be used with policy makers to demonstrate the risks of employing performance measures that only consider the performance of an individual organization, and the potential significant benefits from incentivising cross-organisational service improvement.

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