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Introduction

The poor health status of Canada's northern and indigenous populations continues to gain considerable interest in the literature. Markedly disproportionate utilization rates of secondary and tertiary services by First Nations people suggest access barriers for primary care. Current policy regarding solutions center on the belief that the specific healthcare needs of indigenous people can only be met through facilitating care for aboriginal communities by the aboriginals themselves.

Political mobilization by aboriginal groups in the 1960's led to the tabling of the 1979 federal Indian Health Policy. One broad objective was clear in this act: "the goal of Federal Indian Health Policy is to achieve an increasing level of health in Indian communities, generated and maintained by the Indian communities themselves." The subsequent 1989 Health Transfer Policy provided the legislative template to transfer control of some pre-existing services to aboriginal self-administration at the community, zone and regional levels.

A 2005 evaluation of the 20 year old Health Transfer Policy (HTP) pointed to marked variation in funding levels within and among regions and raised concerns regarding equity in aboriginal healthcare funding allocation. Additionally, this evaluation found that funding levels reflected the historic cost of pre transfer service delivery and perpetuated inequities present in the system. The HTP evaluation recommended a per capita formula which reflects needs, population growth and changes in service delivery costs. It was noted, however, that a funding formula was embedded into the HTP yet the variances in per capita allocation suggested that somehow this formula failed to impact results. Instead, the resultant care delivery form has been described as a "patchwork" by the evaluators and "a confusing mix of federal, provincial and territorial programs and services as well as services provided directly by some Aboriginal communities" by the Romanow Commission.

It well reflected in the literature that per capita funding is likely to provide the most equitable solution for the healthcare of our indigenous people. With evidence of the inability of a formula to be implemented in current policy, the authors of this proposal turned to economic and game theory to gain an understanding of the governing dynamics in policy implementation which have led to the current "confusing mix." Our analysis uncovered fundamental implementation problems embedded in the HTP which predictably led to the current fragmentation.

We then addressed equity concepts to uncover rationale for the current policy, program content and develop solutions beyond a suggested 'needs based' approach. While intuitively appealing, allocation according to needs suffers from a number of pitfalls such as appropriately defining 'needs,' compiling the body of information to document them and develop care costs, and finally passing through the filter of political decision making. Efforts to produce cost effective resource allocation according to societal defined needs have fared poorly (the Oregon Experiment) to be suitable for implementation. Recent reports on resource allocation in Canadian healthcare demonstrate that the true picture for budget decisions is a political process whereby parties seek to improve funding allocations from the historical state.

Given a budget constraint, we used game theory techniques to reflect the reality of the healthcare resource allocation problem, a competition among interested parties for limited dollars. Analysis using this method can lead to equitable funding solutions for aboriginal people, amenable to practical implementation. Our analysis builds a fundamental framework and presents additional research approaches to gather the necessary evidence to support decision making to implement equitable funding levels. While a body of literature exists on this technique, to date, there has been no reported evidence of moving this approach beyond the theoretical model. While focusing on aboriginal care delivery systems, we feel adaptation of this approach lends to other regions and populations seeking fair approaches to budgeting for healthcare.

Background: The Current Template for Resource Allocation- The Health Transfer Policy

The 1986 Health Transfer Policy was designed with three original objectives:

1. To enable Indian Bands to design health programs, establish services and allocate funds according to community health priorities.

2. To strengthen and enhance the accountability of Indian Bands to Band members. And,

3. To ensure public health and safety is maintained through adherence to mandatory programs (National Health and Welfare & Treasury Board of Canada 1989).

Health Canada First Nations and Inuit Health (FNIH) was to remain responsible for fourth level service provision including policy, planning and allocations, advice, monitoring and benchmark planning. A "turning off the lights" policy to substantially reduce the size of FNIH to a smaller office for policy and contract administration was a key objective of the HTP in transferring control of healthcare to indigenous groups themselves. The HTP is applicable to 603 First Nations and Inuit communities representing 790,000 aboriginal people located south of the 60th parallel. It currently provides funds through First Nations and Inuit Health (FNIH) for three types of health programs and services:

1. Public or community health programs;

2. National initiatives directed at specific health and health related issues such as the Aboriginal Diabetes Initiative, the Headstart program and the National Native Alcohol and Drug Abuse Program; and

3. Individual funding to provide support for prescription drugs, dental and vision care and medical transport.

Of these programs, public and community health programs as well as some individual funds such as medical transport were considered 'transferable' under the HTP. National initiatives remained under managerial control of FNIH in most circumstances, with some programs available to native groups on a competitive proposal basis. Involvement in these national initiatives requires separate contribution agreement (CA) contracts to be signed by native groups with FNIH.

Two types of opportunities were provided to native communities who wished to assume responsibility for the administration and provision of some primary healthcare services:

1. Transfer- This option provided the opportunity to assume all transferable programs in place at the time of signing a 3 to 5 year consolidated contribution agreement (CCA) by the community with FNIH, eliminating the need for individual reports for each specific transferred program. As a requirement to fulfill prior to signing a CCA, communities were required to undertake a 21 month planning process to produce a

Community Health Plan. Some flexibility in funding was built in to the CCA with the ability to move funds among programs and the capacity to carry over surpluses through fiscal years.

2. Integrated- This approach required less onerous planning by communities while still allowing transfer of eligible programs under a CCA. The trade-off in foregoing extensive planning was inflexibility in the CCAs, not allowing movement of funds between programs, nor carry over of budget surpluses.

Nearly all First Nations have access to some services delivered in a facility on-reserve. As of 2003, it has been reported by FNIH that 78% of eligible aboriginal communities have entered into agreements under the HTP "to exercise more direct control over their community based health services." At the root of implementation of the Health Transfer Policy are these contractual agreements (contribution agreements and CCAs) between the funder, FNIH, and the recipient aboriginal group. Through Consolidated Contribution Agreements (CCAs) finances are released from the First Nations and Inuit Health to aboriginal communities through advances and monthly payments and the submission of quarterly financial reports.

In addition to CCAs, a variety of contribution agreements serve as vehicles for the administration and management of non-transferable First Nations and Inuit community health programs and services. These CAs vary in terms of level of control, flexibility, authority, reporting requirements and accountability and nature of the specific program(s) and initiatives.

Dissatisfaction and complaints regarding insufficient financial resources through this method are frequently expressed by Aboriginal groups funded to provide the service. A major administrative burden exists due to the sheer number of contracts in place at any time with varying lengths and quantities as well as reporting requirements to support the numerous programs on reserve. One First Nations reserve we have consulted for revealed over 20 such contracts in place at any given time to fund their health services. Such experience is echoed by findings of the Evaluation of the Health Transfer Policy (Lavoie et al 2006). The estimated number of reports for one province in Canada, British Columbia, was 5,813, submitted by First Nations communities to FNIH in 2002-03 to satisfy reporting requirements under the HTP. Due to the reporting volume, the ability to collate this information into useful data for policy and decision making is limited; instead the focus is on adherence to budgets rather than performance outcomes.

A sample study of 30 First Nations communities showed wide variation in the level of per capita funding provided by FNIH, ranging from $430 to $1,418. Furthermore, the level of funding was found not to be proportionate to the number of programs transferred to aboriginal administration. Thirdly, this study demonstrated that communities which transferred early have fewer resources than others which transferred more recently. Such findings raise the question of equity; as well, one wonders how such disparate levels in funding actually arose given a formula embedded in the HTP.

After twenty years of the Health Transfer Policy, the lights are far from turned off at FNIH. Recent financial statements from Treasury Board demonstrate 53.8% of the federal aboriginal care budget remains under control of First Nations and Inuit Health. A number of factors are given to explain this departure from the original HTP objectives. Core national programs representing large portions of the budget such as the Maternal Child Health and Aboriginal Diabetes Initiative were retained for administration by FNIH to ensure national implementation. Criticisms by the 1997 Report of the Auditor General questioned "the appropriateness of transferring responsibilities to Aboriginal communities because they are not directly accountable to Parliament for how these funds are used and there are no requirements in place to assess whether the organizations receiving the funds are able to manage them appropriately." Meeting such accountability needs has resulted in an additional administrative burden for FNIH to report on the various programs.

The Aboriginal Healthcare Game

Conventionally, healthcare resource allocation models, including those based on needs, assume a benevolent decision maker seeking to maximize equity, efficiency or both subject to budget constraints. In the Health Transfer Policy design, the assumption was made that transfer of resources to aboriginal administration would occur with FNIH agreeing to dramatically downsize in accordance with the political decision made. Such an assumption was made despite international evidence to the contrary regarding bureaucratic motives and decision making. A large body of literature exists which demonstrates the tendency of government bureaucracies to retain and maximize influence, often undermining policies which create activities outside their direct control.

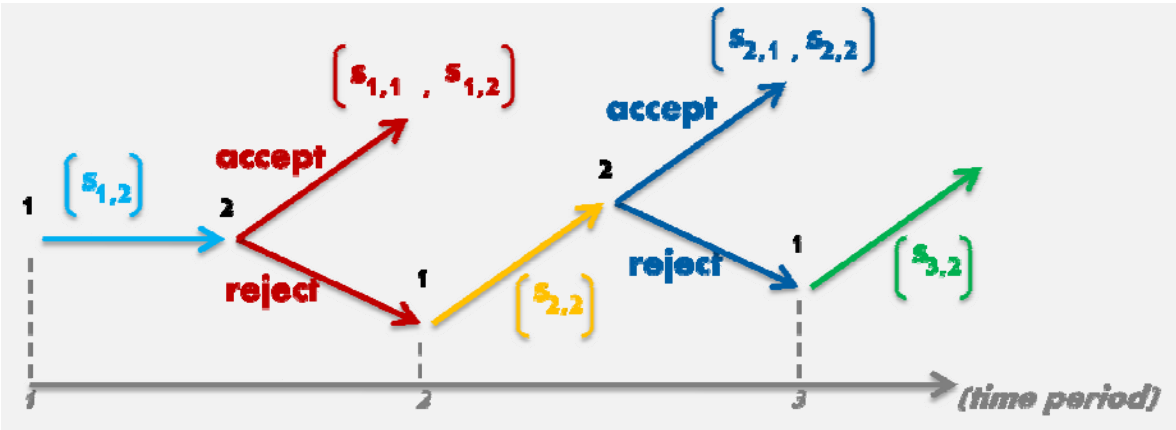
Certainly, the threat to FNIH's role through the HTP was significant. In effect, the larger the proportion of funds transferred to aboriginals, the less resources could be retained by FNIH to pay for its infrastructure and personnel. The resource allocation decision through the HTP then became a bargaining game between FNIH and aboriginal groups seeking to maximize their share of the budget. An additional strategic component in this game is on the self-determination agenda for aboriginals. The importance for indigenous health and culture in assuming control of their health system is apparent in the Health Transfer Policy and the literature surrounding aboriginal health. Romanow noted "This transfer of control is sometimes seen as an intermediate step toward self-government." Transfer of programs then became a 'win' unto itself for aboriginals.

Game and decision theory methods are well employed in resource allocation problems which require incorporation of the strategies of the parties involved, rather than assuming benevolence. For implementation of the HTP, negotiations took place between FNIH and individual communities following community health planning to agree on a contract (CCA) to transfer programs and funding to aboriginal communities. To model this, a two person sequential bargaining game reflects the process:

Player 1 is FNIH; player 2 is a hypothetical representative aboriginal community.

This game is played over time periods t = 1, 2, 3……. The total budget is W. The objective for both parties then is to maximize their share of W. The share taken by aboriginals, $s_{t,2}$, corresponds to funds received by natives for transferred programs at time t, with FNIHB then retaining ($W - s_{t,2}$).

The game starts with player 1, FNIH, making an offer to player 2, natives, of $s_{1,2}$ in exchange for taking on certain services. Player 2 can either accept or reject the offer. If the offer is accepted, the game ends, otherwise player 1 can make an additional offer to player 2.



For this simple model, assume W = N + T

where N = cost of non-transferable programs and

T = cost of transferable programs

Rational strategy sets for the two players are then:

Player 1: Offer $s_{t,2} \leq T$

Player 2: Accept if $s_{t,2} \geq T$

The payoffs at the equilibrium point then are obviously:

$s_{t,1} = W - T$

$s_{t,2} = T$

Clearly, FNIH's maximal position is to offer to transfer services with no corresponding funds. The aboriginals, in order to surpass the disagreement point, must accept, at minimum, funding to at least pay for services already provided. The equilibrium point is then historic cost, consistent with findings from the HTP Evaluation. Given the small size of communities involved in the HTP (majority < 1000 people), one would expect costing of historic service provision to be a fairly simple matter.

To more fully explore the realities of the bargaining game, 'flexibility' on the part of aboriginals to decide upon a varied numbers of programs for transfer is incorporated into the game. To reflect choice, it can be expressed that:

$T = \sum \text{ŧ}_j$ and $N = \sum \eta_k$ where ŧ_j represents j transferable programs and η_k represents k non-transferable programs.

In this bargaining game:

Strategy profiles for FNIH:

(i) Self survival (it is noted that self survival appeared linked with FNIHB's ability to offer new, national level programs as well as provide a monitoring role and advice)
(ii) Ensure financial accountability to the Minister of Health and Treasury Board
(iii) Promote the HTP in accordance with legislation. (It is noted that 'promotion' was all that was required by FNIH by the HTP, as it would be aboriginal parties who would make the final decision to transfer.)

Strategy profiles for aboriginal communities:

(i) Self determination (as reflected in the literature, it is clear that aboriginal groups believe that improved health outcomes were only possible if they had control over their own health delivery. It has also been implied that health transfer may have been part of a larger quest for sovereignty.) Meet or exceed current health service program delivery.

In the two person game model, the initial offer by player 1, FNIH, then becomes more complex: $s_{1,2} = x\ \text{ŧ}_j + y\ \eta_k$ where x represents a variable number of ŧ_j transferable programs, and y represents a variable number of η_k non-transferable programs.

While reporting requirements are implicitly associated with all programs, the importance of this aspect of the offering is noteworthy. With transferable programs under direct aboriginal control, one would expect reporting requirements for these programs to be much greater for natives compared to non-transferable (administered and

managed by the federal department, FNIH would then be directly responsible for financial reporting and accountability to the Ministry).

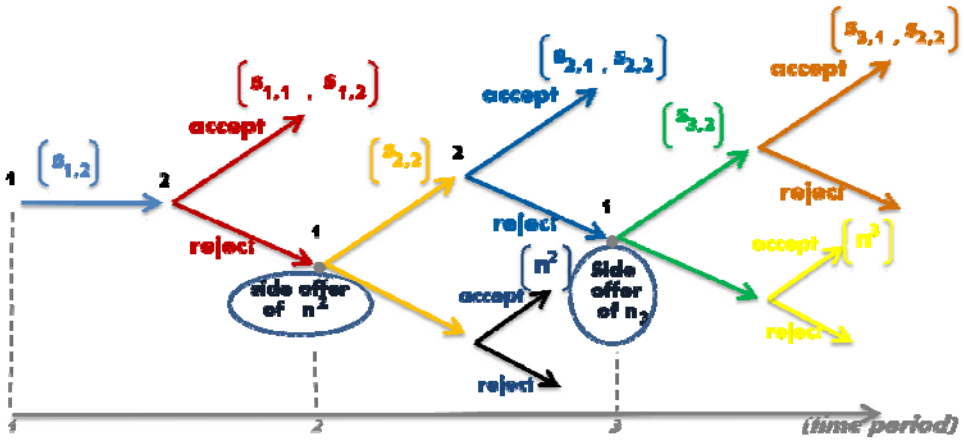
However such was not the case. Reporting for transferable programs was simplified under 3 to 5 year consolidated contribution agreements requiring quarterly reporting by natives to FNIH. Elements of resource accounting, particularly the ability to carry over end of year surpluses and flexibility in moving funds among programs, were incorporated in the CCA as well as the longer term of the contract. CAs, on the other hand, were more in keeping with a cash accounting paradigm with no flexibility for inter program movement of funds and return of all surpluses to FNIH at the end of the fiscal year. Thus transferred programs had less reporting burden associated through the new CCA and this advantage was used by FNIH to motivate native communities to move into the transfer environment.

It is noted in the literature that reporting requirements for all programs became much greater following the 1997 Report of the Auditor General of Canada. Flexibility in the number of non-transferable offered by FNIH arose from the fact that many of these programs were designed to be proposal driven and competitive. Additionally, it is noted that many of the national initiatives were implementable by FNIH at the association and organizational level of aboriginal people. Thus, non-transferable funds could always be spent elsewhere by FNIH if not entirely at the community level.

This expanded model incorporating findings from the literature makes clear a number of findings on analysis. It becomes quite apparent that FNIH was now able to offer a broad spectrum of offerings to individual communities. Attached to each transferred program t_j were consolidated reporting requirements and flexibility, creating a significant incentive for aboriginals to accept transfer of programs. This resultant tendency to accept programs transfer led to a threat to FNIH's survival as a large government department. Assuring a continued share of the budget would be supported through any increase in reporting requirements on the part of natives, further promoted by the growth of non-transferable programs, giving rise to FNIH's need to hire an increased number of staff to act in a stewardship and monitoring role.

FNIH's ability to administer funds on a proposal driven basis, led to a number of side-games created within the bargaining game. Communities accepting or rejecting transfer could still nonetheless potentially benefit from proposal driven, non-transferable programs offerings through the bargaining sequence.

The expanded two person sequential bargaining game is represented below:



It becomes clear from this figure that the greater spectrum of offerings available to FNIH created the potential to lead to a longer sequence of negotiations, now characterized by multiple sub games representing the various non-

transferable initiatives. This growth of sub games satisfied FNIH's motivation for self survival, as each sub-game initiative fell under federal jurisdiction requiring further departmental administration. With a decision to attach less onerous reporting requirements by aboriginals for transferable programs, FNIHBc compensated for its loss in direct budget administration through non-transferable program offerings. The tendency of this game then is to cause increased proliferation of initiatives (which would still satisfy aboriginal desires for health improvement) in a more protracted course of transfer negotiations. Such sub game proliferation could then be characterized by observers as confusing, fragmented and a patchwork.

It is important to recall that the Health Transfer Policy applies to 603 communities representing 790,000 aboriginal people. While some communities joined health services administratively as part of transfer agreements, negotiations were held at the local community level with FNIH. Thus, the previous diagram could be summed over hundreds of transferred communities to depict the results of the resource allocation scheme for the aggregate population. It is clear that such an illustration would appear maximally fragmented, with little adherence to a formula and at best, historical expenditures being the financial benchmark.

In this analysis, less onerous reporting requirements for transferred programs is a significant incentive for natives to transfer in the allocation game. It may be postulated that a decreased burden of reporting would overshadow bargaining by natives for higher budgets. As well, self determination has been demonstrated to be a strong strategy element. The latitude available to FNIH in negotiations at the community level created diminished potential for fair bargaining by natives in transfer, historical cost levels of funding, as well as tremendous fragmentation for the aggregate. Given the community level, implementation of the HTP in this manner could have been defended on the basis of addressing the specific 'needs' of varied communities within the aboriginal nation. However, the governing dynamics of local level negotiation predictably produced funding allocation at historical levels. As such, the nature of the bargaining game would predict any application of a formula based capitation approach would likely fail, given the strategy sets of both players with the equilibrium point being that of historical costs.

Theoretical Framework

Assuming a population based approach with a common financial reporting paradigm, solutions incorporating equity can then be entertained through further analysis of the two person sequential bargaining game. Culyer and Wagstaff (1992) and Clark (1995) offer useful game theoretic approaches to contend with equity and efficiency in healthcare resource allocation. The basic model is constructed to divide a budget between two patients. Division schemes can then be developed to satisfy certain normative properties.

For this research paper, patient 1 could represent the general Canadian public and patient 2, the aboriginal population. A gap in health status is apparent from the literature review. Health status levels for the two patients can be depicted as h_1 and h_2, with initial health status levels s_1 and s_2.

These levels satisfy:

$s_1 < \infty$ and $s_2 < \infty$ and $s_1 > s_2$ at the disagreement point (s_1, s_2)

The respondent health improvement for patient i based on expenditure H_i can be represented by a production function $f_i(H_i)$ and thus health levels are

$h_1 = s_1 + f_1(H_1)$ and $h_2 = s_2 + f_2(H_2)$

From literature and analysis, it is apparent that the cost of delivering healthcare interventions to aboriginals is burdened with additional administrative and delivery costs and therefore one expects:

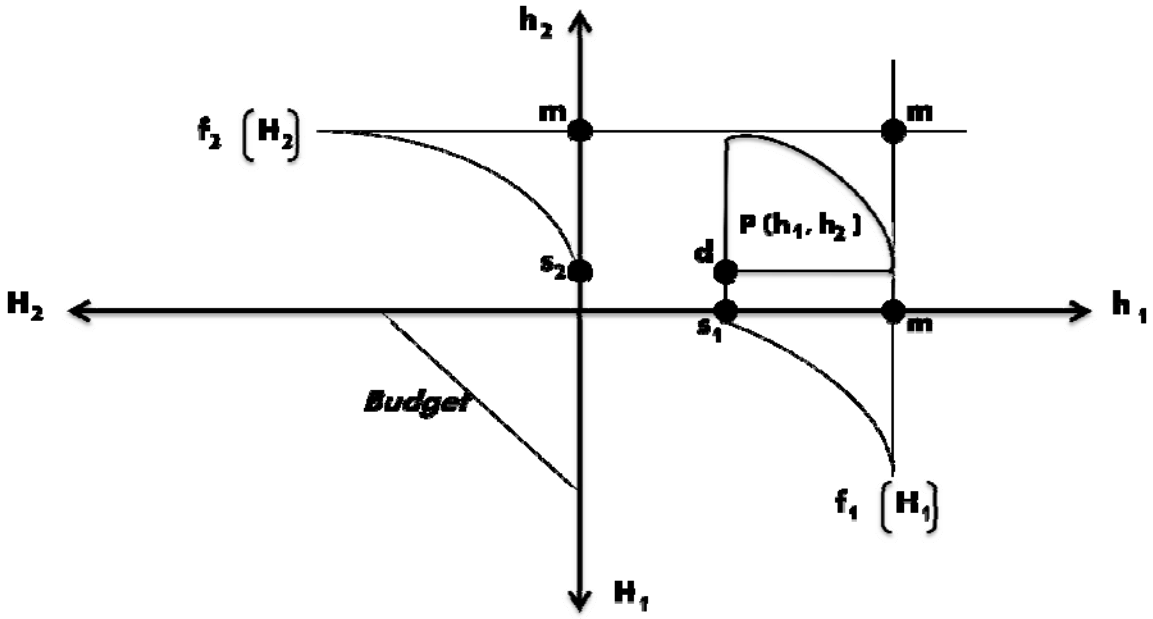
$f_1(H) > f_2(H)$

The general Canadian population health system is associated with an administrative cost of 16.7%. Aboriginal administrative costs are proposed in this application to be calculated to determine the impact on the production function, rather than assume equal outcomes for equal financial expenditures.

The egalitarian concept of Culyer and Wagstaff (1992) is used in this model, which implies the utilities for both players are then equivalent to their health status.

Given a healthcare budget $W \geq H_1 + H_2$, the set of possible outcomes in health status is given by: $P(h_1, h_2) = \{(h_1, h_2) : W \geq H_1 + H_2, h_1 \geq s_1, h_2 \geq s_2\}$

It is clear that for $W > 0$, there will be at least one (h_1, h_2) € Ŭ preferred by both patients to (s_1, s_2) and hence the elements of a static two person bargaining game are present. With $s_1 \neq s_2$ and $f_2(H_i) = 0.6\, f_1(H_i)$, it is clear that for budget W there is an asymmetric, closed set of possible outcomes. The diagram of Clark (1995) is adapted to this game to depict solution sets. A logarithmic health production function is assumed in accordance with the literature.



The problem then remains to determine the budget division to produce equitable health outcomes $h_1$and h_2 within the set of possible outcomes in health status, shown as $P(h_1, h_2)$ above. The outer curved edge of $P(h_1, h_2)$ represents the 'Pareto frontier' which are those set of outcomes produced through maximal budget expenditure W. A key element in solving for the budget division is recognition that the set of possible solutions is asymmetric due to differences in initial health status and production functions. A solution rule that performs well under asymmetries is that of Kalai and Smorodinsky. The normative properties of this rule are:

The Kalai Smorodinsky (KS) rule is independent of linear transformations which means that the solution is scalable across varied budget amounts.

Every convex bargaining game B has a KS utility allocation, and the KS solution set is non empty and consists of Pareto optimal bargaining outcomes. This implies that the optimal solution exists on the Pareto frontier.

If B is a convex and symmetric bargaining game, the KS and Nash solutions coincide. (The Nash solution solves for maximal efficiency through calculation of the product $h_1 \times h_2$ determined at the point of maximal slope of the Pareto

frontier. This solution works well for symmetrical P(h_1, h_2) sets, but has been theoretically shown to perpetuate inequities in the case of asymmetrical sets.)

The KS solution is derived through solving for the intersection of the KS line and the Pareto frontier of the solution set. The KS line is the ray from the disagreement point

(s_1, s_2) and the maxima point (μ_1, μ_2) where in this game,

$\mu_1 = \max h_1$ where (h_1 € Ŭ) and $\mu_2 = \max h_2$ where (h_2 € Ŭ)

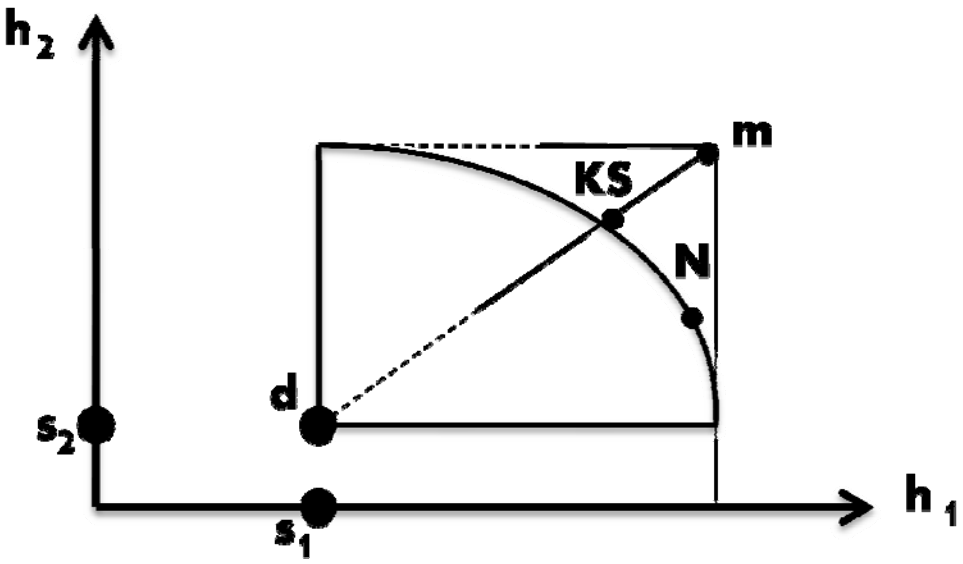
It follows that

$\mu_1 = s_1 + f_1(\Delta W)$ and $\mu_2 = s_2 + f_2(\Delta W)$

Whereby the KS solution is then uniquely defined by

$(\mu_2 - s_2)/(\mu_1 - s_1) = (h_2^k - s_2)/(h_1^k - s_1)$ where (h_1^k, h_2^k) lies on the Pareto frontier.

Diagrammatically, this solution is represented below:



The equity principle incorporated in the solution is apparent: it follows that from this solution, the amount of improved health that each player receives over and above the initial health states is proportional to the capacity of each patient to benefit from treatment given the budget constraint. Additionally, since the initial health states s_1 and s_2 are incorporated in the solution, needs, particularly expressed as a gap in health status in this solution are a driving factor in this resource allocation formula.

Conclusions and Approaches to 'Change the Game'

The theoretical framework outlined provides a highly innovative approach to determine 'what is fair' in calculating resource allocation formulae for northern healthcare. The eventual solution using this method represents a

powerful approach to assist policy and decision makers in allocating the resources necessary for aboriginal people's health, a critical determinant in ongoing capacity building initiatives.

The authors of this application recognize, however, that despite the appeal of this approach, this work remains theoretical and represents a novel perspective to healthcare resource allocation. Additionally, we recognize that application of this approach would require major policy level decisions. As such, robust proof its application and development of practical solutions requires additional innovative research. We suggest the following next steps to move this discussion forward:

1. Validate the theoretical framework and assumptions through a wide literature review and comparison against other techniques. It is accepted that the solution outlined herein may need further refinement through verification of the properties of the solution set. While the example solution set show a smooth contour, the reality of the Pareto frontier will need further theoretical modeling and use of higher order mathematical techniques than the geometric approach depicted.

2. Experimentation and research in methods to define the scope of application:

While 'health status' measures are available through the Quality Adjusted Life Years (QALYs) literature, suitability for application in this method requires investigation. It is also noted that the QALYs literature continues to contend with numerous difficulties in application of societal values and ethics. This will require further review and the pursuit of other methods. The scope of application will depend on the validity of such variables and other measurement criteria may be needed. Testing of such measures will be done within the KS solution model outlined.

Equally, methods to calculate the health production function remain unreported in the literature. Initial assumptions are neutral with respect to ethnicity and gender and will require validation through a comprehensive literature review. The hypothesis, that differing production functions between two populations are due to administrative overhead costs and cost of delivery to remote locations, needs testing at the theoretical and methodological level.

3. Explore and develop innovative ways of data collection and analysis, structure, integration and transfer of knowledge gained through this approach. Once the validity and scope of the application is defined, it will be necessary to determine methods to actually gain valid data to develop the solution. Once this is performed, it will also be required to frame the material in a fashion which can be adopted by decision makers and the regions communities at large. The ability to present research findings in a readily comprehensible form represents a challenge to be overcome through this phase of research.

While such an approach remains relatively novel, we are hopeful that this approach to fairly allocate resources to people much in need will bear further consideration by all parties involved.

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