



Review article

Gender differences in how physicians access and process information

R. Gotlieb^{a,b}, J. Abitbol^{b,c}, J.A. How^{b,d}, I. Ben-Brith^b, H.A. Abenham^{a,d}, S.K. Lau^{b,c}, M. Basik^{a,e}, Z. Rosberger^f, N. Geva^g, W.H. Gotlieb^{a,b,*}, A. Mintz^h

^a Division of Experimental Surgery, Faculty of Medicine, McGill University, Montreal, Quebec, Canada

^b Division of Gynecologic Oncology, Segal Cancer Center, Jewish General Hospital, McGill University, Canada

^c Lady Davis Research Institute, Segal Cancer Center, McGill University, Montreal, Quebec, Canada

^d Department of Obstetrics and Gynecology, Jewish General Hospital, McGill University, Canada

^e Department of General Surgery, McGill University, Montreal, QC H3T 1E2, Canada

^f Psychology Division, Department of Psychiatry, Sir Mortimer B. Davis-Jewish General Hospital, Canada

^g Department of Political Science, Texas A&M University, USA

^h Lauder School of Government, Diplomacy and Strategy, IDC, Israel



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ABSTRACT

There is an absence of information on how physicians make surgical decisions, and on the effect of gender on the processing of information. A novel web based decision-matrix software was designed to trace experimentally the process of decision making in medical situations. The scenarios included a crisis and non-crisis simulation for endometrial cancer surgery. Gynecologic oncologists, fellows, and residents (42 male and 42 female) in Canada participated in this experiment. Overall, male physicians used more heuristics, whereas female physicians were more comprehensive in accessing clinical information ($p < 0.03$), utilized alternative-based acquisition processes in the non-crisis scenario ($p = 0.01$), were less likely to consider procedure-related costs ($p = 0.04$), and overall allocated more time to evaluate the information ($p < 0.01$). Further experiments leading to a better understanding of the cognitive processes involved in medical decision making could influence education and training and impact on patient outcome.

Canada.

1. Introduction

Studies of decisions made by physicians largely focused thus far on physicians' choices. However, there has been dearth of data on how physicians process information en route to decision and whether there are gender effects in the way doctors make medical decisions.

There has been a sweeping growth of female enrolment into medical schools, reaching 60% nowadays, compared to 7% in the 1960's (Canadian Medical Association, 2016; Kletke et al., 1990; Macdonald and Webb, 1966). The project presented in this paper focuses on information acquisition patterns and on gender similarities and differences in processing information.

Studies have shown disparities in clinical interactions between the patient and the physician that were attributable to the gender of either party (Franks and Bertakis, 2003; Hajjaj et al., 2010; Keane et al., 1991; Shay and Lafata, 2015), but research on the decision-making process of

surgeons has been rare.

As cognitive biases have been shown to play an important role in doctors' decisions (Blumenthal-Barby and Krieger, 2014; Groopman, 2010; Shay and Lafata, 2015), an understanding of individual physicians' decision processes via computerized decision process tracing is becoming increasingly relevant. Based on well-established decision matrices used in diplomacy and the military (Mintz, 2004; Mintz and DeRouen, 2010), we developed a web based decision tool to perform an experiment seeking to analyze information acquisition patterns and decisions of physicians and explore gender differences.

2. Material & methods

2.1. Participants

Physician members of the Society of Gynaecologic Oncologists of Canada, the Society of Obstetricians and Gynaecologists of Canada, and resident physicians at Canadian Universities were invited to participate

* Corresponding author at: Division of Gynecologic Oncology, McGill University SMBD Jewish General Hospital, 3755 Chemin de la Cote-Ste-Catherine, Montreal, QC, H3T 1E2, Canada.

E-mail address: walter.gotlieb@mcgill.ca (W.H. Gotlieb).

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in this experiment. Subjects accessed website, www.mdcisions.com, and were presented with medical simulations devised to evaluate decision-making. Subjects provided non-identifying demographic information (age, gender, level and location of medical training, place of employment), and participated in complete anonymity. Non-physicians were excluded. The hospital's research ethics board approved the study and participants provided informed consent for involvement in the simulation.

A statistical power analysis was conducted to determine the appropriate sample size for this experiment. To detect a 10% difference in the time to decision between males and females based on a standard deviation of 15% and a 95% confidence interval, it was found that 84 participants would be required for this experiment.

From June 2015 to February 2016, eighty-four subjects participated in this experiment using the MDCisions™ decision tracing platform: 42 female doctors (19 staff and 23 residents) and 42 male doctors (18 staff and 24 residents). The software traced the path taken by each participant prior to reaching a final decision, as well as her/his decision (see appendix 1).

2.2. Scenarios

Two hypothetical scenarios were presented to each subject (see Appendix 1a, 1b). The scenarios and matrices were created based on three rounds of a modified Delphi method (Okoli and Pawlowski, 2004). In view of the experimental population who included physicians in gynecology, the scenarios were built around cases of patients with endometrial cancer. The first scenario (which will be referred to as the non-crisis scenario) assessed how doctors would acquire information and make decisions on the extent of the removal of lymph nodes (lymph node dissection) needed in early stage endometrial cancer. The second scenario (further referred to as the crisis scenario) evaluated how subjects would attempt to treat a bleeding vessel and create hemostasis following an iatrogenic vascular injury during a minimally invasive procedure for endometrial cancer. An information board (called MDCisions™) displayed a decision matrix consisting of criteria, alternatives, and implications based on relevant peer reviewed literature, to assist subjects in making the decision (appendix 1).

Through computerized process tracing, the MDCisions software enabled us to track information acquisition of the physicians. Each matrix consisted of 5 main components (defined below) that have been validated in the field of decision science, psychology, marketing, and finance (Mintz, 2004; Mintz and DeRouen, 2010; Mintz et al., 1997) (appendix 2):

- 1) Alternatives: choices available to the decision maker (i.e. complete lymphadenectomy, sentinel node dissection).
- 2) Dimensions: criteria (i.e. length of procedure, risk of complications) that the decision maker may consider when evaluating the alternatives.
- 3) Implications: peer reviewed information for an alternative and given dimension (i.e. data on complications for complete lymphadenectomy versus sentinel node dissection).
- 4) Ratings: represent the significance for the subject of the information provided by the implication (0 = not important; 10 = very important).
- 5) Weights indicate the level of importance of each dimension for the subject (i.e. importance of lymphedema) on a visual scale from 0 to 10.
- 6) Subjects were offered to access the implications, rate the implications, and assign importance to the dimensions.

2.3. Simulation

Subjects were invited to first access the simulation website at www.mdcisions.com (available to the reader online for review) and to watch

a 2-min instructional video explaining how to navigate the decision matrix. Following this demonstration, participants accessed the first of two scenarios (non-crisis clinical scenario, appendix 2a) and then accessed the associated decision matrix. Subsequently, participants accessed the second scenario (crisis, appendix 2b) and accessed the corresponding matrix. Participants were welcome to open as many cells of information (implications) as they wished prior to making a final choice. Despite no time limit enforced, participants were told at the onset of the simulation that as with “all real-life decisions, there is a trade-off between the amount of information you consider and the time it takes to make a decision based on that information.”

2.4. Study design

The software was designed with the capability of tracing the path taken by each participant prior to reaching a final decision. More specifically, the sequence in which each subject accessed, ranked, and weighted information on the decision matrix, the total time taken to make the decisions and the final alternative selected, were recorded.

We designed our study as a 2×2 quasi experiment factorial. The first factor (within subject) is the crisis level depicted in the scenario (non-crisis vs. crisis). The second factor and the focus of this investigation is the gender of the physician (female vs. male). Our dependent measures consisted of processing parameters of the decisions: (a) time to decision (assessed as time to simulation completion in minutes); (b) the amount of information acquired prior to making the decision; (c) the method of information acquisition (dimension versus alternative based); (d) the importance of procedure-cost on final decision; and (e) the final choice made. Student *t*-test was utilized and statistical significance was determined to be $p < 0.05$. The average proportion of information used by female and male physicians during their decision-making process was compared. A 2×2 mixed ANOVA procedure was employed to explore the gender effects in the two scenarios.

Decision strategy was defined, following Billing and Scherer (Billings and Scherer, 1988). This measure has been used in numerous studies (Darley and Smith, 1995; Meyers-Levy and Tybout, 1989; Laroche et al., 2000; Seock and Bailey, 2008). It was calculated separately for each scenario and was coded as alternative-based (which is typically more meticulous), compared to dimension-based searches.

3. Results

3.1. Participant demographics

There were 42 females and 42 males in the analysis. 47 trainees (residents) 23 of which were female and 24 males with an average age of 31. There were 37 attending physicians, 19 females and 18 males with an average age of 46. The average age of the entire cohort was 37 years old.

3.2. Overall findings

Significant differences were identified in the way male and female doctors acquired information en route to a decision. The results show the influence of gender on the amount of time it takes them to make a clinical decision, the amount of information they interact with, their decision strategy, and the importance they attribute to the cost of the medical procedure in the non-crisis situation.

a) Time to decision.

Male doctors took less time to perform the decision-making process than female doctors (8.35 vs. 11.03 min respectively, $t(1,82) = 2.72$, $p < 0.006$).

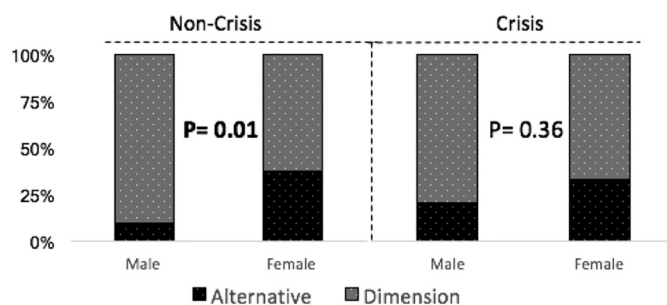


Fig. 1. Alternative versus dimension-based information processing by male and female physicians.

Table 1
Weight associated to cost versus other dimensions.

		M	F	T-Test ^a
Non-Crisis	Cost	3.2	2.1	T(69) = 2.1 p = 0.038
	Other dimensions	7.2	7.04	T(73) = 0.4 p = 0.703
Crisis	Cost	1.9	2.2	T(65) = 0.5 p = 0.634
	Other dimensions	7.6	8.3	T(67) = 1.7 p = 0.098

^a Significance tests between male and female physicians for average weights assigned to cost as well as average of all non-cost variables for both non-crisis and crisis scenarios.

b) Amount of information acquired.

Overall, more information was accessed in the non-crisis scenario (42% vs. 33%, [F (1,74) = 5.25 p < 0.001]). In both crisis and non-crisis, female physicians accessed a significantly higher percentage of information bins (46%) compared to males (28%), [F (1,74) = 5.52 p < 0.03] (Appendix 3).

c) Method of information acquisition (alternative vs dimension based).

Significantly more females utilized the alternative-based information acquisition process in the non-crisis scenario (36% of females compared to 10% of males, p = 0.01), with a similar trend in the crisis scenario (33% of females vs. 21% of males, p = 0.36) (Fig. 1).

d) Importance of procedure-related costs in decision-making.

Female physicians assigned a lower importance to the cost of the medical procedure in determining their final decision in the non-crisis scenario (average weight of 2.1 among females vs. 3.2 among males, p = 0.038). However, in the crisis scenario, there was no significant difference between genders (1.9 among males vs. 2.2 among females, p = 0.634) (Table 1).

Overall, compared with other dimensions, cost was not an important consideration. Among all participants, subjects rated cost significantly less than the average of other dimensions both in the non-crisis scenario (average weight of 2.7 assigned to cost vs. average of 7.1 to non-cost dimensions, p < 0.0001) and the crisis scenario (2.0 vs. 8.0, respectively, p < 0.0001) (appendix 4).

Table 2A
Alternative chosen in the non-crisis scenario (lymph node dissection).

	A Remove only suspiciously enlarged nodes	B Selective lymph node dissection based on intra-operative risk factors	C selective lymph node mapping	D full pelvic and periaortic lymph node dissection	
Male doctors	4 (10%)	6 (14%)	23 (55%)	9 (21%)	42
Female doctors	5 (13%)	5 (13%)	19 (49%)	10 (25%)	39
Total	9	11	42	19	81

e) Final decision.

There were no differences in the non-crisis scenario in the selected final procedure by female and male doctors (Table 2A, p = 0.7), but female and male doctors tended to select different procedures in the crisis scenario (p = 0.07), with more than half of female doctors choosing clipping (alternative C) compared to less than a quarter of male doctors (Table 2B). Male physicians more frequently converted to open procedure (alternative E).

4. Discussion

There is dearth of information and data on decision processes of physicians. Given the shift in the gender composition of physicians over the years, we explored the role of gender on the decision-making process in clinical situations. The physicians utilized a novel software, MDcisions™, that traces the decision-making path. The experiment revealed several significant outcomes in terms of information processing, indicating that male physicians examined less information, while their female counterparts tended to be more comprehensive in searching for information, used more time, and used more alternative based processing, which is typically more meticulous compared to dimension-based searches (Mintz et al., 1997).

This study has some limitations. First, our sample consists only of Canadian physicians. This study also examined a clinical scenario in the field of gynecology, which does not necessarily represent other medical fields. Because this is the first study demonstrating the feasibility of the decision making matrix to evaluate the decision process in health care professionals, it was not designed to evaluate the impact of the decision making processes on patient outcomes, and no recommendations can be made concerning speed of decision making, a more comprehensive approach, or considerations for procedure related costs. Another limitation is the potential of confounders such as age or years of practice. To assess this, correlations between age and the primary dependent variables were tested. There was a weak correlation between age and the total time taken to reach a decision (r = -0.15, p = 0.2), the number of information bins accessed in the non-crisis scenario (r = -0.10, p = 0.4), and the number of bins accessed in the crisis scenario (r = -0.002, p = 1.0). The impact of expertise on decision making is presently being investigated.

Our findings based on medical decision making are similar to online consumer shopping studies, in which females have been found to comprehensively acquire more information and take longer to shop “whereas males appeared to heuristically limit their search” (Laroche et al., 2000; Seock and Bailey, 2008). In marketing, a “Selectivity Model” was developed, demonstrating that males do not process all available information to the extent of females, but rather use more cognitive shortcuts or heuristics (Darley and Smith, 1995; Meyers-Levy and Tybout, 1989). In addition to our findings, female physicians were seen to spend significantly more time with their patients (Franks and Bertakis, 2003; Hajjaj et al., 2010; Keane et al., 1991; Shay and Lafata, 2015), and suggested an association between gender and clinical outcomes (Tsugawa et al., 2016). The shift in gender among physicians affects the clinical decision making process. Further understanding of these differences might allow to refine medical education and residency training, as part of our continuous efforts to improve clinical care.

Table 2B

Alternative chosen in the crisis scenario.

	A suture	B fibrin sealants	C clip	D call for vascular surgery	E conversion to open	
Male doctors	7 (18%)	6 (15%)	9 (23%)	4 (10%)	13 (33%)	39
Female doctors	4 (11%)	3 (8%)	20 (56%)	3 (8%)	6 (17%)	36
Total	11	9	29	7	19	75

Author contribution

R.Gotlieb, concept development, created the software and the simulations, gathered and analyzed the data and wrote the manuscript.

J.Abitbol, helped in concept development, performed statistical analysis, reviewed manuscript.

J.A.How, helped in concept development, gathering information for DELPHI review, setting up simulation, and reviewed the manuscript.

I.Ben-Brith, helped in concept development, setting up website and analytics, and reviewed the manuscript.

H.A.Abenhaim, supervised concept development, aid in recruitment and setting up presentations, reviewed & corrected manuscript.

S.K.Lau, helped in concept development, critically evaluated the data, and reviewed manuscript.

M.Basik, helped in concept development, provided scientific advice, corrected manuscript drafts and reviewed manuscript.

Z.Rosberger, helped in concept development, supervised the psychology aspects of the simulation and data analysis, reviewed & corrected manuscript.

N.Geva, helped in concept development, performed statistical analysis, reviewed manuscript.

W.H.Gotlieb, developed the concept, supervised all steps, recruited participants for simulation, edited manuscript.

Alex Mintz, developed the concept, provided expertise on decision making, collaborated in setting up the experiment, edited manuscript.

Author declaration

None of the authors declare a conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.gore.2018.12.008>.

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