ABSTRACT

Introduction A strong pipeline of creative ideas and individuals is critical if we are to tackle the complex healthcare challenges we will face in the 21st century. The field of creativity is severely underinvestigated in the context of surgery, and it is of interest to explore the level and nature of creativity in surgeons, across various specialties and backgrounds. Identifying the areas of surgery with strong and weak levels of creativity, as well as the predictors of high creativity among surgeons, may aid in the selection and training of future surgeons.

Methods and analysis A convenience sample of surgeons from the Department of Surgery and McMaster University will be used for the recruitment of participants. The Abbreviated Torrance Test for Adults, a three-part test of divergent thinking ability, will be administered to measure the level and nature of creativity among surgeons. Descriptive analyses and multiple linear regression models are planned to synthesise the results of the survey and identify predictors of divergent thinking ability among surgeons.

Ethics and dissemination Ethics approval from the Hamilton Integrated Research Ethics Board was obtained. No harm is expected due to participation in this study. The results of this survey will be published in a peer-reviewed journal and disseminated through conferences and presentations at the regional, national and international levels.

INTRODUCTION

Background Defined as the creation and implementation of new processes, products, services or methods resulting in significant improvements in outcomes, efficiency, effectiveness or quality, innovation will be essential to address the unique and complex healthcare challenges we will face in the 21st century. Antimicrobial resistance, emerging infectious diseases and the treatment of neurodegenerative diseases are just a few of the unique challenges in modern healthcare requiring innovative solutions. Innovation has played a particularly important role in the evolution of the field of surgery: advancements in MRI and minimally invasive technologies have revolutionised the way we treat patients in the operating room. However, new techniques, interventions, tools and approaches are required to adapt to the ever-changing landscape in the operating room.

The field of surgery has been deliberately constrained by guidelines and structure. While this ensures a consistent level of care across the healthcare system, this may have led to an undervaluing of the importance of creativity in surgery. The surgery departments of the future will require open-minded surgeons with strong creative thinking ability, capable and daring enough to think outside of the box, even pushing against the guide rails of conventional wisdom when required. What surgery needs is an evidence-based blend of creativity, clinical experience and sound research.

The ideation of novel solutions precedes any implementation of innovative products or interventions. Thus, creativity, the process which generates novel and useful outcomes (such as ideas, products, methods or expressions), is the currency by which we will acquire the innovative solutions required in surgery. The measurement of creative ability is, therefore, a useful tool for the selection and training of surgeons. Due to the complexity and multidimensional nature
of the construct of creativity, divergent thinking is typically used as a measure of creative ability and predictor of future creative achievement, as it contains known factors associated with creative ability, namely fluency, flexibility and originality. Therefore, the use of divergent thinking tests, such as the Torrance Test of Creative Thinking (TCTT) and the Alternate Uses Task, is common in experimental research. These tests are useful tools in the study of creativity and will facilitate the exploration and assessment of the creative ability and creative potential of prospective and current surgeons.

The field of creativity in surgery is severely underinvestigated. Previous studies around individual and team creative ability have been published, however, there is a complete dearth of evidence on creativity in surgeons. An awareness and understanding of the level and nature of the creativity of surgeons, across specialties and at all levels of the expertise hierarchy, is the first step towards tackling this issue and building a highly competent and creative pipeline of surgeons. Using a validated and tested tool for the measurement of divergent thinking, we plan to fill this gap and explore the level and nature of creativity in surgeons in the McMaster University Department of Surgery.

**Aim**

The objectives of this survey are to explore: (1) divergent thinking ability in surgeons, (2) sociodemographic, lifestyle and professional factors associated with higher levels of divergent thinking ability and (3) creative self-efficacy among surgeons.

**METHODS AND ANALYSIS**

**Sampling technique and recruitment**

We will perform convenience sampling to identify and recruit potential participants: we will contact programme directors and coordinators at the 11 divisions (ie, vascular, urology, thoracic, plastic, paediatric; otolaryngology, orthopaedic, ophthalmology, neurosurgery, cardiac, general) of the Department of Surgery at McMaster University to identify surgical trainees and attendees within their divisions. Prospective surgeons will be provided with a synopsis of the study objectives, the benefits/harms associated with the study, requirements for participation and a consent form. Priority will be placed on ensuring diversity in age, gender, level of training, ethnicity/background and surgical specialty.

Surgeons who agree to participate will be scheduled to complete our survey, which will be administered on a rolling basis and can be administered to an individual or group settings. The planned start date for our study is 30 January 2023, and the anticipated date of completion is 31 August 2023.

**Measurement**

On the day of testing, we will meet the participants at the scheduled time and location. After the consent form is signed, a participant characteristics form will be completed by the surgeon, without any personal unique identifiers. Information collected will include age, institutional affiliation, sexual identity, surgical discipline/specialty, years of surgical training, relationship/family status, creative self-efficacy (the belief that one has the ability to produce creative outcomes), background/ethnicity, undergraduate degree (type and major), average number of hours spent alone per week, average number of hours of worked per week, the presence of creative acquaintances, friends or coworkers, average time spent reflecting/thinking per week, artistic pursuits/hobbies outside of work, research output (# of published peer-reviewed papers), leadership roles (ie, holding of a leadership position, eg, as a division head or clinical director) and the perception of whether one’s work bolsters creative potential. Several of these characteristics (listed in data analyses section) will be used in the regression model as predictors of divergent thinking ability.

The tool that we will use to measure divergent thinking ability is the Abbreviated Torrance Test for Adults (ATTA) test, a shortened form of the TCTT. The ATTA was validated in a population of undergraduate and graduate-level students from the Netherlands and measures 4 norm-referenced creative abilities (fluency—the ability to produce quantities of ideas relevant to the task instruction; originality—the ability to produce uncommon ideas or ideas that are new or unique; elaboration—the ability to embellish ideas with details; flexibility—the ability to process information or objects in different ways, given the same stimulus) as well as 15 indicators of creativity. The test consists of three activities: one verbal task involving the generation of responses to a question, and two figural tasks involving drawing to complete incomplete figures. Each task is time-limited by 3 min and is proctored by an administrator familiar with the testing protocol. In addition, creative self-efficacy will be measured using a 7-point Likert scale; creative self-efficacy has been correlated with measures of creativity.

On completion of the test, we will assess participant responses independently according to the ATTA guidelines. Given the high level of reliability for the ATTA test (Kuder-Richardson 20=0.84–0.95), a single reviewer trained in ATTA scoring will perform all survey assessments. A pilot of five ATTA tests will be performed in duplicate to assess inter-rater reliability.

**Sample size calculation**

To estimate the sample size required to estimate the mean of the scaled creativity score in surgeons on the ATTA, we used the following formula:

\[ n = \left( \frac{1.96 \times SD}{Margin\ of\ Error} \right)^2 \]

The ATTA’s SD of the scaled scores was 7.87 and has a range of plausible scores between 44 and 76. We created a sample size table using Microsoft Excel to explore possible sample sizes: with an SD of 7.87 and a margin of error of 2, we calculated we would require 59.48, or 60 participants to estimate the mean scaled creativity score in surgeons. We
Data analysis plan
We have planned descriptive statistical calculations (ie, mean, median, SD, range) and a multiple linear regression analysis after the completion of data collection and test scoring. We will perform a tabulation of participant characteristics overall and by specialty, and descriptive results of ATTA scores by specialty will be graphically displayed. We will report the estimate for creativity as a mean ATTA score with a 95% CI (median with IQR if not normally distributed). We will use multiple regression to determine associations between the ATTA scores and key characteristics including age, sex, years of surgical training, creative self-efficacy, undergraduate degree, hours spent alone/week, hours worked/week and research output; the results will be reported as an estimate of the association, with the corresponding 95% CI and associated p value. We will perform an assessment of model assumptions and goodness-of-fit by examining the residuals, as well as a sensitivity analysis treating surgical specialty as a random effect to account for potential clustering or similarity of scores among participants with the surgical specialty. For each independent variable in the regression, at least 10 observations will be required for inclusion into the model; if this threshold is not met, the levels of each independent variable will be collapsed if possible, or excluded. All statistical analyses will be conducted using SPSS V.26.0. The statistical analysis plan is summarised in online supplemental table 1.

Patient and public involvement statement
None. All participants will receive their respective survey results upon completion of grading.

ETHICS AND DISSEMINATION

Ethical and safety considerations
Ethics approval was obtained from the Hamilton Integrated Research Ethics Board (project #15178). Participation in the study is not likely to result in any harm or discomfort from/associated with the administration or results of the test. However, participants may feel anxious, distressed or nervous over the timed nature of the test. Participant confidentiality will be upheld throughout the study process. All data will be presented in aggregate at the overall level or level of division (if ≥5 surgeons are in the division). During data collection, analysis and publication, personal identifiers will not be displayed or used in any way. Data will be stored on a password-protected hard drive on a computer that only the research team will have access to. Participation is voluntary, and participants retain the right to withdraw their participation and data at any time.

Dissemination plan
The results of this study will be submitted for publication in a peer-reviewed journal. The primary investigator (AT) will present the results of this study at regional, national and international conferences to communicate the results as well as promote the importance of creativity in medicine. We will make efforts to initiate dialogue with relevant stakeholders (surgeons, universities, hospital administrations and governments) to discuss findings, brainstorm future research questions and translate the results of the survey into actionable items. Comparisons to other published studies of divergent thinking will provide insight into how the level of divergent thinking compares to other professions and populations.

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Contributors AT and MB conceived the research question. AT performed the literature review informing the background of this protocol. The study design and statistical analysis plan were designed by AT, with consultation and feedback from MB, JWB and RS. AT led the writing of this protocol manuscript, with support and editing from MB and JWB. The final version of the protocol has been reviewed and approved by all authors. All authors agreed to be held accountable for the aspects of the work.

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Disclaimer The funders had no role in the design of this protocol and will have no role in the conduct of the study, nor the collection, analysis, interpretation, and publication of the study results.

Competing interests MB is the chair of the Department of Surgery at McMaster University.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, or reporting, or dissemination plans of this research.

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