## SUPPLEMENTARY MATERIAL

| Table of content                                                                 | Page |
|---------------------------------------------------------------------------------|------|
| Public consultation                                                             | 2    |
| Response rate                                                                   | 4    |
| Internal validity                                                                | 4    |
| Demographic data                                                                 | 5    |
| Comparison of demographic characteristic between mTurk and social media respondents | 9    |
| Responses for individual scenarios                                              | 11   |
| Overall responses (across all 5 scenarios)                                      | 13   |
| Effect of demographic parameters on overall responses                           | 14   |
| Autonomy level analysis                                                         | 16   |
| Survey sample                                                                   | 18   |
Public consultation

A cross-sectional mixed qualitative and quantitative survey was performed to appraise the publics’ understanding of and attitudes towards the scenarios proposed to be presented in the iRobot Surgeon Survey. The survey was devised on SurveyMonkey (Momentive Global Inc., San Mateo, CA, USA) observing the guidelines of good practice in conduct and reporting of survey research. The survey was distributed over a two-week period of October 2019 at the Department of Neurosurgery of the senior author’s (H.J.M.) institution and administered in person using a tablet computer (iPad; Apple Inc., Cupertino, California, USA). A total of 11 participants were recruited from inpatients and their relatives, using the following inclusion criteria: 1) adequate capacity to understand and complete the survey 2) willingness to participate. The public consultation survey was organized into three sections for each one of the 5 proposed scenarios. First, the clinical scenario was described, and the available response options were presented. Second, participants were asked to rate how much the scenario was understandable (how much they could understand by reading its description), concerning (how much they would be worried if that scenario would present in real-life settings), and answerable (if the available response options were sufficient to answer the question). Responses were rated using 5-point Likert-scales, from 0 = “not at all” to 4 = “very much” (Table 1). Third, two open-ended questions were asked: 1) “Do you have any concerns about this scenario being presented to the general public? If yes, please state why.”; 2) “Do you have any recommendations on ways to improve the scenario?”. The free text responses were analysed qualitatively and themes were identified and categorised (Table 2).

Table 1: Results from public consultation for each individual scenario

| Scenarios | Understandable | | | Concerning | | | Answerable |
|-----------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|           | Option         | %               | Option          | %               | Option          | %               | Option          | %               |
| 1         | 0(not at all)  | 0%              | 0(not at all)   | 0%              | 0(not at all)   | 45.4%           |                 |                 |
|           | 1              | 0%              | 1               | 0%              | 1               | 36.4%           |                 |                 |
|           | 2              | 0%              | 2               | 18.2%           | 2               | 0%              |                 |                 |
|           | 3              | 27.3%           | 3               | 9.1%            | 3               | 27.3%           |                 |                 |
|           | 4(very much)   | 72.3%           | 4(very much)    | 72.3%           | 4(very much)    | 9.1%            |                 |                 |
| 2         | 0(not at all)  | 0%              | 0(not at all)   | 0%              | 0(not at all)   | 18.2%           |                 |                 |
|           | 1              | 0%              | 1               | 0%              | 1               | 18.2%           |                 |                 |
|           | 2              | 0%              | 2               | 0%              | 2               | 18.2%           |                 |                 |
|           | 3              | 36.4%           | 3               | 36.4%           | 3               | 27.3%           |                 |                 |
|           | 4(very much)   | 63.3%           | 4(very much)    | 63.6%           | 4(very much)    | 18.2%           |                 |                 |
| 3         | 0(not at all)  | 0%              | 0(not at all)   | 0%              | 0(not at all)   | 18.2%           |                 |                 |
|           | 1              | 9.1%            | 1               | 0%              | 1               | 0%              |                 |                 |
|           | 2              | 18.2%           | 2               | 0%              | 2               | 9.1%            |                 |                 |
|           | 3              | 18.2%           | 3               | 9.1%            | 3               | 27.3%           |                 |                 |
### Table 2: Summary of key themes from free text responses

#### Concerns about presenting these scenarios to the public

| Concern                                                                 | No  | %    |
|------------------------------------------------------------------------|-----|------|
| (1) The human element during surgery is not specified in detail        | 6/11| 54.55%|
| (2) The information provided is not sufficient                         | 5/11| 45.45%|
| (3) Some mistakes may happen even without robots                       | 5/11| 45.45%|
| (4) The public mistrust towards robots may influence responses         | 4/11| 36.36%|
| (5) Bad hospital maintenance may be confused with manufacturer errors | 2/11| 18.18%|

#### Recommendations for improving the public understanding

| Recommendation                                                                 | No  | %    |
|--------------------------------------------------------------------------------|-----|------|
| (1) Provide more information on the role of the surgeon                      | 8/11| 72.73%|
| (2) Add the extra response option “jointed responsibility of the surgeon and the robot” | 7/11| 63.64%|
| (3) Provide more general information on robotics and medicine                | 2/11| 18.18%|
Response rate

Duplicates from mTurk were removed. Completed questionnaires were defined as questionnaires with completed attention question at end of questionnaire. Responses were included in final data set if respondent got attention question correct at end of survey.

| Cohort                      | No  | %    |
|-----------------------------|-----|------|
| All responses               | 2673| 100.0|
| Duplicates removed          | 2554| 95.6 |
| Completed questionnaires    | 2293| 85.8 |
| Included data               | 2191| 82.0 |

Internal validity

A total of 90 mTurk respondents completed a questionnaire more than once. This data was used to determine concordance between responses from individual respondents. Concordance was defined as complete agreement across all responses for specific scenario by an individual respondent.

| Scenario     | Concordant (n) | %    |
|--------------|----------------|------|
| Total        | 301            | 66.89%|
| Scenario 1   | 66             | 73.33%|
| Scenario 2   | 68             | 75.56%|
| Scenario 3   | 64             | 71.11%|
| Scenario 4   | 45             | 50.00%|
| Scenario 5   | 58             | 64.44%|
Demographic data

Age

| Age Group      | No of responses | %   |
|----------------|----------------|-----|
| Grand Total    | 2191           | 100.00% |
| 25-34          | 1024           | 46.55%  |
| 35-44          | 440            | 20.08%  |
| 18-24          | 363            | 16.56%  |
| 45-54          | 184            | 8.40%   |
| 55-64          | 135            | 6.16%   |
| 65+            | 49             | 2.24%   |

Gender

| Gender         | No of responses | %   |
|----------------|----------------|-----|
| Grand Total    | 2191           | 100.00% |
| Male           | 1367           | 62.39% |
| Female         | 824            | 37.61% |

Country

| Country                                      | No of responses | %   |
|----------------------------------------------|----------------|-----|
| Grand Total                                  | 2191           | 100.00% |
| United States of America                     | 540            | 24.65% |
| United Kingdom of Great Britain and Northern Ireland | 372            | 16.98% |
| India                                        | 341            | 15.56% |
| Italy                                        | 154            | 7.03% |
| Brazil                                       | 139            | 6.34% |
| Canada                                       | 131            | 5.98% |
| Singapore                                    | 73             | 3.33% |
| Saudi Arabia                                 | 58             | 2.65% |
| Malaysia                                     | 41             | 1.87% |
| Spain                                        | 39             | 1.78% |
| Germany                                      | 32             | 1.46% |
| Country                        | Percentage | Users |
|-------------------------------|------------|-------|
| Egypt                         | 1.41%      | 31    |
| France                        | 0.87%      | 19    |
| Australia                     | 0.78%      | 17    |
| Kenya                         | 0.78%      | 17    |
| Turkey                        | 0.73%      | 16    |
| Netherlands                   | 0.64%      | 14    |
| Hungary                       | 0.41%      | 9     |
| Ireland                       | 0.41%      | 9     |
| Mexico                        | 0.41%      | 9     |
| Switzerland                   | 0.41%      | 9     |
| Bangladesh                    | 0.27%      | 6     |
| Nigeria                       | 0.27%      | 6     |
| Portugal                      | 0.27%      | 6     |
| Colombia                      | 0.23%      | 5     |
| Argentina                     | 0.18%      | 4     |
| Austria                       | 0.18%      | 4     |
| China                         | 0.18%      | 4     |
| Ethiopia                      | 0.18%      | 4     |
| Romania                       | 0.18%      | 4     |
| Venezuela (Bolivarian Republic of) | 0.18% | 4     |
| Afghanistan                   | 0.14%      | 3     |
| Algeria                       | 0.14%      | 3     |
| Belgium                       | 0.14%      | 3     |
| Greece                        | 0.14%      | 3     |
| Jordan                        | 0.14%      | 3     |
| New Zealand                   | 0.14%      | 3     |
| Poland                        | 0.14%      | 3     |
| Andorra                       | 0.09%      | 2     |
| Chile                         | 0.09%      | 2     |
| Finland                       | 0.09%      | 2     |
| Indonesia                     | 0.09%      | 2     |
| Israel                        | 0.09%      | 2     |
| Kuwait                        | 0.09%      | 2     |
| Libya                         | 0.09%      | 2     |
| Norway                        | 0.09%      | 2     |
| Pakistan                      | 0.09%      | 2     |
| South Africa                  | 0.09%      | 2     |
| Trinidad and Tobago           | 0.09%      | 2     |
| Ukraine                       | 0.09%      | 2     |
| United Arab Emirates          | 0.09%      | 2     |
| Albania                       | 0.05%      | 1     |
| Angola                        | 0.05%      | 1     |
| Country                          | Count | %    |
|---------------------------------|-------|------|
| Anguilla                        | 1     | 0.05%|
| Bahamas                         | 1     | 0.05%|
| Barbados                        | 1     | 0.05%|
| Benin                           | 1     | 0.05%|
| Bosnia and Herzegovina          | 1     | 0.05%|
| Cambodia                        | 1     | 0.05%|
| El Salvador                     | 1     | 0.05%|
| Fiji                            | 1     | 0.05%|
| Iceland                         | 1     | 0.05%|
| Iraq                            | 1     | 0.05%|
| Japan                           | 1     | 0.05%|
| Luxembourg                      | 1     | 0.05%|
| Malta                           | 1     | 0.05%|
| Morocco                         | 1     | 0.05%|
| Nepal                           | 1     | 0.05%|
| Oman                            | 1     | 0.05%|
| Russian Federation              | 1     | 0.05%|
| Slovakia                        | 1     | 0.05%|
| Sudan                           | 1     | 0.05%|
| Suriname                        | 1     | 0.05%|
| Thailand                        | 1     | 0.05%|
| The former Yugoslav Republic of Macedonia | 1 | 0.05%|
| Tunisia                         | 1     | 0.05%|
| Uganda                          | 1     | 0.05%|
| Vietnam                         | 1     | 0.05%|

### Occupation

| Row Labels                                      | Count of Start Date | %    |
|-------------------------------------------------|---------------------|------|
| Other                                           | 695                 | 31.72%|
| Healthcare                                      | 618                 | 28.21%|
| Business, finance and management                | 518                 | 23.64%|
| Computing, science and engineering              | 360                 | 16.43%|
## Education

| Highest Educational Qualification                                | No of responses | %       |
|------------------------------------------------------------------|-----------------|---------|
| **Grand Total**                                                  | 2191            | 100.00% |
| Bachelor's Degree                                                | 904             | 41.26%  |
| Master's Degree                                                  | 508             | 23.19%  |
| A-level/IB/Equivalent high-school diploma                        | 369             | 16.84%  |
| Medical Degree                                                   | 284             | 12.96%  |
| PhD                                                              | 126             | 5.75%   |

## Previous Surgery

| Previous Surgery | No of responses | %       |
|------------------|-----------------|---------|
| **Grand Total**  | 2191            | 100.00% |
| Yes              | 1280            | 58.42%  |
| No               | 911             | 41.58%  |

## Social vs mTurk

| Source of response | No of responses | %       |
|--------------------|-----------------|---------|
| **Grand Total**    | 2191            | 100.00% |
| mTurk              | 1232            | 56.23%  |
| Social             | 959             | 43.77%  |
Comparison of demographic characteristic between mTurk and social media respondents

Analysis was performed to examine whether there were significant differences the demographic characteristics of the mTurk (n=1232) and social media (n=959) cohorts. Chi-squared test was used to assess for significance.

**Age**

| Row Labels | mTurk | Social | Total |
|------------|-------|--------|-------|
|            | No    | %      | No    | %      | No    | %      |
| Grand total| 1232  | 56.23% | 959   | 43.77% | 2191  | 100.00%|
| 18-24      | 172   | 7.85%  | 191   | 8.72%  | 363   | 16.57% |
| 25-34      | 605   | 27.61% | 415   | 18.94% | 1020  | 46.55% |
| 35-44      | 277   | 12.64% | 163   | 7.44%  | 440   | 20.08% |
| 45-54      | 102   | 4.66%  | 82    | 3.74%  | 184   | 8.40%  |
| 55-64      | 57    | 2.60%  | 78    | 3.56%  | 135   | 6.16%  |
| 65+        | 19    | 0.87%  | 30    | 1.37%  | 49    | 2.24%  |
| P value    |       |        |       | <0.0001|        |        |

**Gender**

| Row Labels | mTurk | Social | Total |
|------------|-------|--------|-------|
|            | No    | %      | No    | %      | No    | %      |
| Grand total| 1232  | 56.23% | 959   | 43.77% | 2191  | 100.00%|
| Female     | 416   | 18.99% | 408   | 18.62% | 824   | 62.39% |
| Male       | 816   | 37.24% | 551   | 25.15% | 1367  | 37.61% |
| P value    |       |        |       | <0.0001|        |        |
### Occupation

| Row Labels                          | mTurk  | Social | Total  |
|-------------------------------------|--------|--------|--------|
|                                     | No     | %      | No     | %      | No     | %      |
| Grand total                         | 1232   | 56.23% | 959    | 43.77% | 2191   | 100.00%|
| Business, finance and management    | 395    | 18.03% | 123    | 5.61%  | 518    | 23.64% |
| Computing, science and engineering  | 264    | 12.05% | 96     | 4.38%  | 360    | 16.43% |
| Healthcare                          | 193    | 8.81%  | 425    | 19.40% | 618    | 28.21% |
| Other                               | 380    | 17.34% | 315    | 14.38% | 695    | 31.72% |
| **P value**                         |        | <0.0001|        |        |        |        |

### Education

| Row Labels                                          | mTurk  | Social | Total  |
|-----------------------------------------------------|--------|--------|--------|
|                                                     | No     | %      | No     | %      | No     | %      |
| Grand total                                         | 1232   | 56.23% | 959    | 43.77% | 2191   | 100.00%|
| A-level/IB/Equivalent high-school diploma           | 211    | 9.63%  | 158    | 7.21%  | 369    | 16.84% |
| Bachelor’s Degree                                   | 666    | 30.40% | 238    | 10.86% | 904    | 41.26% |
| Master’s Degree                                     | 292    | 13.33% | 216    | 9.86%  | 508    | 23.19% |
| Medical Degree                                      | 41     | 1.87%  | 243    | 11.09% | 284    | 12.96% |
| PhD                                                 | 22     | 1.00%  | 104    | 4.75%  | 126    | 5.75%  |
| **P value**                                         |        | <0.0001|        |        |        |        |

### Previous Surgery

| Row Labels | mTurk  | Social | Total  |
|------------|--------|--------|--------|
|            | No     | %      | No     | %      | No     | %      |
| Grand total| 1232   | 56.23% | 959    | 43.77% | 2191   | 100.00%|
| No         | 423    | 19.31% | 488    | 22.27% | 911    | 41.58% |
| Yes        | 809    | 36.92% | 471    | 21.50% | 1280   | 58.42% |
| **P value** |        | <0.0001|        |        |        |        |
Response for individual scenarios

Responses to each scenario from the total cohort (n=2191)

Scenario 1

A world-leading heart surgeon (Surgeon A) operates remotely on a patient in a different country using a telesurgical system. During the operation, a major blood vessel is cut open. Surgeon A cannot stop the bleeding using the robot. A support surgeon in the operating room (Surgeon B) steps in and controls the bleeding. Despite this, the patient loses blood and is harmed.

| Choices                | No of responses |
|-----------------------|-----------------|
|                       | No. | %     |
| Grand Total           | 2191| 100.00%|
| Surgeon A             | 1482| 67.64%|
| Hospital              | 246 | 11.23%|
| Surgeon B             | 208 | 9.49% |
| Robot manufacturer    | 169 | 7.71% |
| Other                 | 86  | 3.93% |

Scenario 2

A surgeon uses a robotic telescope while operating on a patient. Its purpose is to inform the surgeon about the location of an important blood vessel. The surgeon plans to use this information and their knowledge of anatomy to perform the operation safely. During surgery, the robot malfunctions. It gives the surgeon inaccurate information. The blood vessel is cut and the patient is harmed.

| Choices              | No of responses |
|----------------------|-----------------|
|                       | No. | %     |
| Grand Total          | 2191| 100.00%|
| Robot manufacturer   | 1524| 69.56%|
| Surgeon              | 455 | 20.77%|
| Hospital             | 168 | 7.67% |
| Other                | 44  | 2.01% |

Scenario 3

A patient has an operation where screws are inserted into the bone of their spine by a robot. A surgeon pre-programmes the robot with directions for the screws to be fixed. The robot then carries out the operation independently as the surgeon supervises. After the operation, the patient wakes up and cannot move their legs. A follow-up scan shows a screw has been put into the wrong place, causing spinal injury. An investigation finds the surgeon had correctly programmed the robot, directing the screws away from the spinal cord.
| Choices                | No of responses |
|-----------------------|-----------------|
|                       | No.  | %    |
| **Grand Total**       | 2191 | 100.00% |
| Robot manufacturer    | 1390 | 63.44%  |
| Surgeon               | 530  | 24.19%  |
| Hospital              | 209  | 9.54%   |
| Other                 | 62   | 2.82%   |

**Scenario 4**

A surgeon recommends a hip replacement operation for a patient. A robot carries out the surgery independently and the surgeon, who supervises, does not intervene. The operation is technically successful and follow-up scans show that the hip was repaired as planned. However, the patient is left with worse hip pain which badly affects their quality of life.

| Choices                | No of responses |
|-----------------------|-----------------|
|                       | No.  | %    |
| **Grand Total**       | 2191 | 100.00% |
| Surgeon               | 998  | 45.55%  |
| Other                 | 472  | 21.54%  |
| Hospital              | 421  | 19.21%  |
| Robot manufacturer    | 300  | 13.69%  |

**Scenario 5**

An intelligent robot develops a new surgical technique to treat pancreatic cancer. Research through clinical trials shows the new technique is better than existing treatments. A surgeon refers a patient with newly diagnosed pancreatic cancer for the procedure. During the operation, the robot cannot manage a complication in the surgery and the patient is harmed.

| Choices                | No of responses |
|-----------------------|-----------------|
|                       | No.  | %    |
| **Grand Total**       | 2191 | 100.00% |
| Robot manufacturer    | 803  | 36.65%  |
| Surgeon               | 731  | 33.36%  |
| Hospital              | 510  | 23.28%  |
| Other                 | 147  | 6.71%   |
### Overall responses (across all 5 scenarios)

#### All Data

Aggregate responses across all 5 scenarios from n=2191 respondents providing a total of 10955 individual scenario responses

| Option                  | Q1 | Q2 | Q3 | Q4 | Q5 | Total | %   |
|-------------------------|----|----|----|----|----|-------|-----|
| **Total**               | 2191| 2191| 2191| 2191| 2191| 10955 | 100.00% |
| Surgeon (A+B for Q1)    | 1690| 455 | 530 | 998 | 731 | 4404  | 40.20% |
| Robot Manufacturer      | 169 | 1524| 1390| 300 | 803 | 4186  | 38.21% |
| Hospital                | 246 | 168 | 209 | 421 | 510 | 1554  | 14.19% |
| Other                   | 86  | 44  | 62  | 472 | 147 | 811   | 7.40%  |
Effect of demographic parameters on overall responses

Total responses across the 5 scenarios analysed based upon 7 demographic parameters. Statistical significance tested with Chi-squared test.

Age

| Age group | Hospital | Other | Robot manufacturer | Surgeon |
|-----------|----------|-------|--------------------|---------|
| 18-24     | 268      | 129   | 758                | 660     |
| 25-34     | 748      | 319   | 1927               | 2106    |
| 35-44     | 299      | 169   | 844                | 888     |
| 45-54     | 129      | 95    | 318                | 378     |
| 55-64     | 81       | 74    | 257                | 263     |
| 65+       | 29       | 25    | 82                 | 109     |

P value <0.0001

Gender

| Row Labels | Hospital | Other | Robot manufacturer | Surgeon |
|------------|----------|-------|--------------------|---------|
| Female     | 594      | 368   | 1554               | 1604    |
| Male       | 960      | 443   | 2632               | 2800    |

P value <0.0001

Occupation

| Row Labels              | Hospital | Other | Robot manufacturer | Surgeon |
|-------------------------|----------|-------|--------------------|---------|
| Business, finance and management | 345      | 135   | 1039               | 1071    |
| Computing, science and engineering | 281      | 113   | 681                | 725     |
| Healthcare              | 401      | 293   | 1046               | 1350    |
| Other                   | 527      | 270   | 1420               | 1258    |

P value <0.0001

Education

| Row Labels                               | Hospital | Other | Robot manufacturer | Surgeon |
|------------------------------------------|----------|-------|--------------------|---------|
| A-level/IB/Equivalent high-school diploma | 240      | 145   | 787                | 673     |
| Bachelor’s Degree                        | 699      | 270   | 1771               | 1780    |
| Master’s Degree                          | 364      | 174   | 918                | 1084    |
| P value          | <0.0001 |
|------------------|---------|
| Medical Degree   | 159     | 158    | 494   | 609    |
| PhD              | 92      | 64     | 216   | 258    |

**Previous Surgery**

|          | Hospital | Other | Robot manufacturer | Surgeon |
|----------|----------|-------|--------------------|---------|
| No       | 585      | 342   | 1813               | 1815    |
| Yes      | 969      | 469   | 2373               | 2589    |
| P value  | **0.0015** |       |                    |         |

**Social vs mTurk**

|          | Hospital | Other | Robot manufacturer | Surgeon |
|----------|----------|-------|--------------------|---------|
| mTurk    | 863      | 276   | 2516               | 2505    |
| Social   | 691      | 535   | 1670               | 1899    |
| P value  | <0.0001  |       |                    |         |
Autonomy level analysis

Scenarios were classified based upon the level of robotic autonomy

Level 1

**Human-controlled robotic system**: these systems include robots that are completely controlled by the surgeon who can sometimes be in a different place to the surgery (telesurgical robot). Other robots are integrated within handheld instruments and may, for example, warn the doctor when they are operating close to important parts of the body (handheld robot).

| Option                  | Q1 | Q2 | Total | Percentage |
|-------------------------|----|----|-------|------------|
| **Total**               | 2191 | 2191 | 4382 | 100.00%    |
| Surgeon                 | 1690 | 455  | 2145 | 48.95%     |
| Robot Manufacturer      | 169  | 1524 | 1693 | 38.64%     |
| Hospital                | 246  | 168  | 414  | 9.45%      |
| Other                   | 86   | 44   | 130  | 2.97%      |

Level 2

**Robot-assisted system**: these systems help the surgeon carry out specific tasks. This could be stitching wounds, inserting a needle into the brain, or inserting a screw to fix a broken bone. The surgeon is present and supervises the robot.

| Option                  | Q3 | Percentage |
|-------------------------|----|------------|
| **Total**               | 2191 | 100.00%    |
| Robot Manufacturer      | 1390 | 63.44%     |
| Surgeon                 | 530  | 24.19%     |
| Hospital                | 209  | 9.54%      |
| Other                   | 62   | 2.83%      |
Level 3

**Autonomous robotic system**: this system can conduct entire surgical procedures with minimal or no human supervision.

| Option                  | Q4 | Q5 | Total | Percentage |
|-------------------------|----|----|-------|------------|
| **Total**               | 2191 | 2191 | 4382  | 100.00%    |
| Surgeon                 | 998 | 731 | 1729  | 39.46%     |
| Robot Manufacturer      | 300 | 803 | 1103  | 25.17%     |
| Hospital                | 421 | 510 | 931   | 21.25%     |
| Other                   | 472 | 147 | 619   | 14.13%     |
Survey sample

Demographic information

Which of these age groups do you belong to?
15-30
30-45
45-60
60-75
>75

What is your gender?
Male
Female

In what country do you live?
<full list of nations>

Which choice best describes your occupation?
Medical - Surgeon
Medical – Non-surgical
Other healthcare
Life, Physical, and Social Science Occupations
Sales and Related Occupations
Business and Financial Operations Occupations
Personal Care and Service Occupations
Computer and Mathematical Occupations
Construction and Extraction Occupations
Legal Occupations
Education, Training, and Library Occupations
Farming, Fishing, and Forestry Occupations
Food Preparation and Serving Related Occupations
Protective Service Occupations
Office and Administrative Support Occupations
Building and Grounds Cleaning and Maintenance Occupations
Arts, Design, Entertainment, Sports, and Media Occupations
Installation, Maintenance, and Repair Occupations
Architecture and Engineering Occupations
Community and Social Service Occupations
Management Occupations
Production Occupations
Student
Transportation and Materials Moving Occupations
Not stated above
What is your highest academic qualification?
A-level/IB/Equivalent high-school diploma
Bachelor’s Degree
Master’s Degree
PhD

Have you had surgery in the past?
Yes
No

MTurk respondents only: Please provide your Worker ID number?
Case 1

Level 1: Human-controlled robot system
A world-leading heart surgeon (surgeon A) operates remotely on a patient in a different country using a telesurgical system. During the operation, a major blood vessel is cut open. Surgeon A cannot stop the bleeding using the robot. A support surgeon in the operating room (surgeon B) steps in and controls the bleeding. Despite this, the patient loses blood and is harmed.

Who is primarily responsible in this situation?

- Surgeon A
- Surgeon B
- Robot manufacturer
- Hospital
- Other

Case 2

Level 1: Human-controlled robot system
A surgeon uses a robotic telescope while operating on a patient. Its purpose is to inform the surgeon about the location of an important blood vessel. The surgeon plans to use this information and their knowledge of anatomy to perform the operation safely. During surgery, the robot malfunctions. It gives the surgeon inaccurate information. The blood vessel is cut and the patient is harmed.

Who is primarily responsible in this situation?

- Surgeon
- Robot manufacturer
- Hospital
- Other

Case 3

Level 2: Robot-assisted system
A patient has an operation where screws are inserted into the bone of their spine by a robot. A surgeon pre-programmes the robot with directions for the screws to be fixed. The robot then carries out the operation independently as the surgeon supervises. After the operation, the patient wakes up and cannot move their legs. A follow-up scan shows that a screw has been put into the wrong place, causing spinal injury. An investigation finds the surgeon had correctly programmed the robot, directing the screws away from the spinal cord.

Who is primarily responsible in this situation?

- Surgeon
- Robot manufacturer
- Hospital
- Other
Case 4

**Level 3: Autonomous robot system**
A surgeon recommends a hip replacement operation for a patient. A robot carries out the surgery independently and the surgeon, who supervises, does not intervene. The operation is technically successful and follow-up scans show that the hip was repaired as planned. However, the patient is left with worse hip pain, which badly affects their quality of life.

Who is primarily responsible in this situation?

- Surgeon
- Robot manufacturer
- Hospital
- Other

Case 5

**Level 3: Autonomous robot system**
An intelligent robot develops a new surgical technique to treat pancreatic cancer. Research through clinical trials shows the new technique is better than existing treatments. A surgeon refers a patient with newly diagnosed pancreatic cancer for the procedure. During the operation, the robot cannot manage a complication in the surgery and the patient is harmed.

Who is primarily responsible in this situation?

- Surgeon
- Robot manufacturer
- Hospital
- Other

**How many cases were presented in this survey?**

- 1
- 5
- 10
- 25

Thank you very much for taking part