Deborah Plana, PhD, MD Candidate

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EDUCATION

Harvard Medical School (HMS)/MIT MD-PhD Program • Boston, MA

Jun. 2017-May 2024

Candidate for MD in Harvard-MIT Program in Health Sciences and Technology (HST)

Harvard PhD in Systems Biology, with the dissertation: "Clinical Trial Data Science to Advance Precision Oncology"

Completed clinical rotations in Anesthesia, Emergency Medicine, Internal Medicine, Neurology, Ob/Gyn,

Oncodermatology, Pediatrics, Primary Care, Psychiatry, Radiology, Surgical Critical Care, and Surgery

Massachusetts Institute of Technology • Cambridge, MA

Jun. 2013-Jun. 2017

Bachelor of Science in Biological Engineering

GPA 4.9/5.0

Minor in Statistics and Data Science

AWARDS

Ruth L. Kirschstein National Research Service F30 Award • National Cancer Institute	Jun. 2021-May 2024
Harvard Graduate Prize Fellowship • HMS	Mar. 2019
Quantitative Sciences in Drug Development Best Poster • Novartis	Aug. 2018
Presidential Scholar • HMS	Aug. 2017, Aug .2018
Medical Scientist Training Program • National Institutes of Health	Jun. 2017-May 2024
Reddy Family Undergraduate Research Opportunities Fund • MIT	Dec. 2016
Tau Beta Pi Engineering Honor Society • MIT	Sep. 2016
James E. Cunningham (1957) Memorial Scholar • MIT	Dec. 2015
Industrial Advisory Council for Minority Education Student Prize • MIT	Dec. 2015
MIT Biological Engineering Department Barry M. Goldwater Scholarship Nominee • MIT	Nov. 2015
Ilona Karmel Writing Prize • MIT	<i>May 2015</i>
Exceptional Research Opportunities Program Grant • Howard Hughes Medical Institute	Jan. 2015

RESEARCH EXPERIECE

Sorger Laboratory • HMS Laboratory of Systems Pharmacology • Boston, MA HMS/MIT MD-PhD Program

Jan. 2018-Mar. 2022

- Invented a new statistical tool to identify treatment-sensitive tumor subgroups in 'basket trials' of new therapies.
- Discovered that a parametric form (Weibull) describes patient survival data and can estimate the therapeutic efficacy for small patient cohorts.
- Established an online repository of individual participant survival data in oncology: cancertrials.io.
- Identified drug-response biomarkers in ovarian cancer and T-cell lymphoma using patient-derived xenograft (PDX) data.

Lauffenburger Laboratory • MIT Department of Biological Engineering • Cambridge, MA Jan. 2015-Jun. 2017 Undergraduate Research Opportunities Program (UROP) and MGH Summer Research Trainee Program (SRTP)

- Constructed and collected cytokine data from a triculture hydrogel model of endometriosis.
- Used a mixed-effects model of cytokine data to investigate the role of different cell types in endometriosis.
- Developed blood-based CLIA assays for prognosticating patient resistance to targeted therapies.
- Analyzed RNA-Seq and microarray data from melanoma patient tumor tissue and exosome samples to predict patients' response to immune-checkpoint inhibitors.

Beth Israel Deaconess Medical Center Faculty Hour • Boston, MA Faculty Hour Team Member

Jan. 2014-Mar. 2014

- Collected, analyzed, and presented data on patients' clinical conditions and waiting times.
- Assisted in writing official hospital protocols, such as guidelines on the care of post-anesthesia care unit patients.

WORK EXPERIENCE

Longitude Capital • Research Fellow • Boston, MA

Aug. 2020-Feb. 2021

- Sourced and evaluated early-stage companies for biotechnology investment team.
- Investigated therapeutic areas of interest and created presentation materials to summarize research findings.

LEADERSHIP AND TEACHING

Greater Boston Pandemic Fabrication Team • Co-Founder, Coordinator • Harvard-MIT

Mar. 2020-Jan. 2022

- Coordinated team of ~100 scientists, clinicians, and engineers in responding to medical supply shortages during the COVID-19 pandemic, with resulting products used in Boston-area hospitals.
- Guided preparation and publication of multiple open-source research articles on the creation, reuse, and clinical testing of personal protective equipment during a crisis, available at panfab.org.

Medical School Admissions Committee for Harvard-MIT HST • Member • HMS

Jul. 2019-Mar. 2021

• Reviewed applications, conducted interviews, contributed to discussions at subcommittee meetings, and submitted interview reports for medical school applicants.

Principles and Practices of Drug Development • Teaching Assistant • HMS and MIT

Aug. 2020-Dec. 2020

• Created and presented course materials on pharmacology fundamentals, preclinical drug discovery, clinical trials, drug manufacturing, FDA regulation, and financing of new therapeutics.

HST MD Student Diversity Ambassadors Group • Founding Member • HMS

Mar. 2018-Dec. 2020

• Collaborated with diversity initiatives at HMS and MIT for prospective student outreach and recruitment.

Crimson Care Collaborative • Co-Director • HMS

Mar. 2018-Mar. 2019

- Directed quality improvement efforts across seven clinical sites in the Greater Boston Area.
- Implemented projects to register patients to vote and reduce clinic no-show rates.
- Managed about 300 volunteers consisting of medical, dental, and undergraduate students.

Fields, Forces and Flows (2.793/6.023/20.330) • Teaching Assistant • MIT

Jan. 2017-May 2017

- Taught weekly recitations and office hours. Organized review sessions, graded exams, and moderated Piazza forum.
- Course topics taught included electric fields, fluid flows, transport phenomena and applications to biological systems.
- Received 7.0/7.0 instructor rating.

Latino Cultural Center (LCC) • President • MIT

May 2016-May 2017

• Official representative of about 150 students to the MIT administration and outside organizations.

Rune Literary Magazine • Editor-In-Chief • MIT

May 2015-May 2016

• Organized membership of over 30 students. Ensured magazine printing, publicity, funding, and distribution.

PEER-REVIEWED PUBLICATIONS AND PREPRINTS

- 1. Zhou, I. *, **Plana, D.** *, & Palmer, A. C. (2023). *Tumor-specific activity of precision medicines in the NCI-MATCH trial* [Preprint]. *These authors contributed equally.
- 2. **Plana, D.**, Fell, G., Alexander, B. M., Palmer, A. C., & Sorger, P. K. (2022). *Cancer patient survival can be parametrized to improve trial precision and reveal time-dependent therapeutic effects.* Nature Communications, 13(1), 873.
- 3. **Plana, D.**, Palmer, A. C., & Sorger, P. K. (2022). *Independent Drug Action in Combination Therapy: Implications for Precision Oncology*. Cancer Discovery, 12(3), 606–624.
- 4. **Plana, D.**, Shung, D. L., Grimshaw, A. A., Saraf, A., Sung, J. J. Y., & Kann, B. H. (2022). *Randomized Clinical Trials of Machine Learning Interventions in Health Care: A Systematic Review.* JAMA Network Open, 5(9), e2233946.
- 5. Hwangbo, H., Patterson, S., Dai, A., **Plana, D.,** & Palmer, A. C. (2022). Additivity predicts the efficacy of most approved combination therapies for advanced cancer [Preprint].
- 6. Ye, Z., Qian, J. M., Hosny, A., Zeleznik, R., **Plana, D.**, Likitlersuang, J., Zhang, Z., Mak, R. H., Aerts, H. J. W. L., & Kann, B. H. (2022). *Deep Learning–based Detection of Intravenous Contrast Enhancement on CT Scans*. Radiology: Artificial Intelligence, 4(3), e210285.

- 7. **Plana, D.***, Tian, E.*, Cramer, A. K.*, Yang, H.*, Carmack, M. M., Sinha, M. S., Bourgeois, F. T., Yu, S. H., Masse, P., Boyer, J., Kim, M., Mo, J., LeBoeuf, N. R., Li, J., & Sorger, P. K. (2021). *Assessing the quality of nontraditional N95 filtering face-piece respirators available during the COVID-19 pandemic*. BMC Infectious Diseases, 21(1), 712. *These authors contributed equally.
- 8. Cramer, A. K.*, **Plana, D.***, Yang, H.*, Carmack, M. M., Tian, E., Sinha, M. S., Krikorian, D., Turner, D., Mo, J., Li, J., Gupta, R., Manning, H., Bourgeois, F. T., Yu, S. H., Sorger, P. K., & LeBoeuf, N. R. (2021). *Analysis of SteraMist ionized hydrogen peroxide technology in the sterilization of N95 respirators and other PPE*. Scientific Reports, 11(1), 2051. *These authors contributed equally.
- 9. Antonini, M.-J.*, **Plana, D.***, Srinivasan, S.*, Atta, L., Achanta, A., Yang, H., Cramer, A. K., Freake, J., Sinha, M. S., Yu, S. H., LeBoeuf, N. R., Linville-Engler, B., & Sorger, P. K. (2021). *A Crisis-Responsive Framework for Medical Device Development Applied to the COVID-19 Pandemic*. Frontiers in Digital Health, 3, 617106. *These authors contributed equally.
- 10. Kothakonda, A.*, Atta, L.*, **Plana, D.***, Ward, F. *, Davis, C., Cramer, A., Moran, R., Freake, J., Tian, E., Mazor, O., Gorelik, P., Van, C., Hansen, C., Yang, H., Li, Y., Sinha, M. S., Li, J., Yu, S. H., LeBoeuf, N. R., & Sorger, P. K. (2021). *De Novo Powered Air-Purifying Respirator Design and Fabrication for Pandemic Response*. Frontiers in Bioengineering and Biotechnology, 9, 725. *These authors contributed equally.
- 11. McAvoy, M.*, Bui, A.-T. N.*, Hansen, C.*, **Plana, D.***, Said, J. T., Yu, Z., Yang, H., Freake, J., Van, C., Krikorian, D., Cramer, A., Smith, L., Jiang, L., Lee, K. J., Li, S. J., Beller, B., Huggins, K., Short, M. P., Yu, S. H., ... LeBoeuf, N. R. (2021). 3D Printed frames to enable reuse and improve the fit of N95 and KN95 respirators. BMC Biomedical Engineering, 3(1), 10. *These authors contributed equally.
- 12. Kassamali, B., Yu, Z., Davis, C., Carmack, M., Bui, A.-T. N., Said, J. T., **Plana, D.**, Yang, H., Sorger, P., LeBoeuf, N. R., & LaChance, A. H. (2021). *Conversion of Existing UVB Phototherapy Units to UVC Germicidal Chambers for N95 Decontamination: Lessons Learned.* Photobiomodulation, Photomedicine, and Laser Surgery, 39(2), 83–85.
- 13. Palmer, A. C.*, **Plana, D.***, Gao, H.*, Korn, J. M., Yang, G., Green, J., Zhang, X., Velazquez, R., McLaughlin, M. E., Ruddy, D. A., Kowal, C., Muszynski, J., Bullock, C., Rivera, S., Rakiec, D. P., Elliott, G., Fordjour, P., Meyer, R., Loo, A., ... Sorger, P. K. (2020). A Proof of Concept for Biomarker-Guided Targeted Therapy against Ovarian Cancer Based on Patient-Derived Tumor Xenografts. Cancer Research, 80(19), 4278–4287. *These authors contributed equally
- 14. Palmer, A. C.*, **Plana, D.***, & Sorger, P. K. (2020). *Comparing the Efficacy of Cancer Therapies between Subgroups in Basket Trials*. Cell Systems, 11(5), 449-460.e2. *These authors contributed equally.
- 15. Mostaghimi, A.*, Antonini, M.-J.*, **Plana, D.***, Anderson, P. D., Beller, B., Boyer, E. W., Fannin, A., Freake, J., Oakley, R., Sinha, M. S., Smith, L., Van, C., Yang, H., Sorger, P. K., LeBoeuf, N. R., & Yu, S. H. (2020). *Regulatory and Safety Considerations in Deploying a Locally Fabricated, Reusable Face Shield in a Hospital Responding to the COVID-19 Pandemic*. Med, 1(1), 139-151.e4. *These authors contributed equally.
- 16. Tyan, K., Levin, A., Avalos-Pacheco, A., **Plana, D.**, Rand, E. A., Yang, H., Maliszewski, L. E., Chylek, L. A., Atta, L., Tye, M. A., Carmack, M. M., Oglesby, N. S., Burgin, S., Yu, S. H., LeBoeuf, N. R., & Kemp, J. M. (2020). *Considerations for the Selection and Use of Disinfectants Against SARS-CoV-2 in a Health Care Setting*. Open Forum Infectious Diseases, 7(ofaa396).
- 17. Shi, A., Kasumova, G. G., Michaud, W. A., Cintolo-Gonzalez, J., Díaz-Martínez, M., Ohmura, J., Mehta, A., Chien, I., Frederick, D. T., Cohen, S., **Plana, D.**, Johnson, D., Flaherty, K. T., Sullivan, R. J., Kellis, M., & Boland, G. M. (2020). *Plasma-derived extracellular vesicle analysis and deconvolution enable prediction and tracking of melanoma checkpoint blockade outcome*. Science Advances, 6(46), eabb3461.
- 18. Koch, R., Christie, A. L., Crombie, J. L., Palmer, A. C., **Plana, D.**, Shigemori, K., Morrow, S. N., Van Scoyk, A., Wu, W., Brem, E. A., Secrist, J. P., Drew, L., Schuller, A. G., Cidado, J., Letai, A., & Weinstock, D. M. (2019). *Biomarker-driven strategy for MCL1 inhibition in T-cell lymphomas*. Blood, 133(6), 566–575.
- 19. Schrier, S. B., Hill, A. S., **Plana, D.**, & Lauffenburger, D. A. (2016). *Synergistic Communication between CD4+T Cells and Monocytes Impacts the Cytokine Environment*. Scientific Reports, 6(1), 34942.

ABSTRACTS, FEDERAL COMMENTS, AND DIGITAL PUBLICATIONS

- 1. Hwangbo, H., Patterson, S., Dai, A., **Plana, D.**, & Palmer, A. C. (2023). *Abstract 5718: Additivity predicts the clinical efficacy of most approved combination therapies for advanced cancer*. Cancer Research, 83(7_Supplement), 5718–5718.
- 2. Plana, D. (2022). Data science can help us run better cancer clinical trials. Mathematical Oncology Blog.
- 3. Ye, Z., Likitlersuang, J., Zeng, J., **Plana, D.**, Mak, R. H., Aerts, H., Haibe-Kains, B., Margalit, D. N., Schoenfeld, J. D., Tishler, R. B., & Kann, B. H. (2022). *Deep Learning for Automated Outcome Prediction in Oropharyngeal*

- Cancer from Tumor and Lymph Node Imaging Data. International Journal of Radiation Oncology Biology Physics, 114(3), e325.
- 4. Ojo, A., Johnson, S., Erfani, P., Guo, R., Garmilla, A., Saini, A., Benitez, B., Salinas, K. E., **Plana, D.**, Pena Perez, A., Guzman, J., So-Armah, C., & Gottlieb, B. (2022). *A high-touch outreach model to re-engage patients in mammogram screening*. Journal of Clinical Oncology, 40(16_suppl), e18555–e18555.
- 5. Johnson, S., Ojo, A., Erfani, P., Guo, R., Garmilla, A., Saini, A., Benitez, B., Salinas, K. E., **Plana, D.**, Perez, A. P., Guzman, J., So-Armah, C., & Gottlieb, B. (2022). *Re-engaging patients in breast cancer screening through a scalable, high-touch care model.* Journal of General Internal Medicine, S553–S553.
- 6. Peterson, J. S., **Plana, D.**, Bitterman, D. S., Johnson, S. B., & Kann, B. H. (2021). *Growth in eligibility criteria content and failure to accrue among National Cancer Institute (NCI)-affiliated clinical trials.* Journal of Clinical Oncology, 39(15 suppl), 1515–1515.
- 7. **Plana, D.**, Arfe, A., & Sinha, M. S. (2020). FDA-2020-D-1106-0139, Re: FDA Guidance on Conduct of Clinical Trials of Medical Products during COVID-19 Pandemic; Guidance for Industry, Investigators, and Institutional Review Boards. Regulations.gov.
- 8. **Plana, D.**, Arfè, A., & Sinha, M. S. (2020). *Re-Envisioning Clinical Trials During The COVID-19 Pandemic*. Health Affairs Blog.
- 9. Gupta, A., **Plana, D.**, Antonini, M.J., Cramer, A., McAvoy, M., Atta, L. *HST students share their reflections on responding to Covid-19*. (2020). Harvard-MIT Health Sciences and Technology News.
- 10. Shi, A., Cintolo-Gonzalez, J. A., Chien, I., Frederick, D. T., Alpatov, R., Michaud, W., **Plana, D.**, Panka, D., Corcoran, R., Flaherty, K., Sullivan, R., Kellis, M., & Boland, G. (2018). *Abstract B25: Exosomal transcriptomic signatures tracks and predicts response to checkpoint blockade immunotherapy*. Systems Immuno-Oncology.
- 11. Kasumova, G. G., Kim, M. S., Shi, A., Chein, I., Frederick, D. T., Alpatov, R., Michaud, W. A., **Plana, D.**, Panka, D. J., Corcoran, R. B., Flaherty, K. T., & Sullivan, R. J. (2018). *Society of Surgical Oncology 71st Annual Cancer Symposium: Exosomal PD-L1 Protein Expression Correlates with Targeted Therapy Resistance in Melanoma*. Annals of Surgical Oncology, 25(S1), 1–230.
- 12. Shi, A., Kasumova, G., Chien, I., Cintolo-Gonzalez, J., Frederick, D. T., Alpatov, R., Michaud, W. A., **Plana, D.**, Corcoran, R., Flaherty, K., Sullivan, R., Kellis, M., & Boland, G. (2018). *Abstract 4282: Deconvolution of plasmaderived exosomes for tracking and prediction of immunotherapy across multiple tissues*. Bioinformatics and Systems Biology, 4282–4282.
- 13. Kasumova, G. G., Shi, A., Cintolo-Gonzalez, J. A., Chein, I., Frederick, D. T., Alpatov, R., Michaud, W. A., **Plana, D.**, Panka, D. J., Corcoran, R. B., Flaherty, K. T., Sullivan, R. J., Kellis, M., & Boland, G. M. (2018). *Abstract A35: BRAF inhibition increases exosomal PD-L1 protein expression in melanoma*. Checkpoints and Immunomodulation.
- 14. Cohen, S., Cintolo-Gonzalez, J. A., **Plana, D.**, Sullivan, R., & Boland, G. (2017). Society of Surgical Oncology 70th Annual Cancer Symposium: Mixed Responder Cohort of Metastatic Melanoma Patients Treated with Anti Programmed Cell Death-1. Annals of Surgical Oncology, 24(S1), 1–202.
- 15. Cintolo-Gonzalez, J. A., Cohen, S., Michaud, W. A., **Plana, D.**, Panka, D. J., Sullivan, R., & Boland, G. (2017). Society of Surgical Oncology 70th Annual Cancer Symposium: Use of Circulating Microvesicles, Exosomes, as a Biomarker to Track Response to Immunotherapy. Annals of Surgical Oncology, 24(S1), 1–202.

ORAL PRESENTATIONS

- 1. **Plana, D.** *Highlights from the Bigelow: Residency Intake.* MGH Department of Medicine Noon Conference. Boston, MA. April 2023.
- 2. **Plana, D.** *Biological Engineering as a Foundation for a Career in Medical Research.* 20.001: MIT Introduction to Professional Success and Leadership in Biological Engineering. Cambridge, MA. November 2022.
- 3. **Plana, D.**, Palmer, A.C., Sorger, P.K. Advancing the design and interpretation of cancer clinical trials through systematic data mining and analysis. HMS Ludwig Cancer Center. Virtual. June 2021.
- 4. **Plana, D.** *Making Precise Estimates of Drug Efficacy from Small Amounts of Patient Data.* Tumor Therapeutics and Resistance Session; Junior Investigator Meeting for the NCI Cancer Systems Biology Consortium, Physical Sciences-Oncology Network, and the Big Data Scientist Training Enhancement Program. Virtual. August 2020.
- 5. **Plana, D.** Introduction to PanFab: Mobilizing a volunteer response to COVID-19 (Speaker); Resiliency and Trust: Local, regional, and national response to PPE shortages (Panelist). Harvard-MIT Center for Regulatory Science Pandemic Response: Resilience and Recovery in the Era of COVID-19. Virtual. June 2020.
- 6. **Plana, D.** Parametric fitting of over 100,000 individual patient events from clinical trials in oncology. Harvard-MIT Center for Regulatory Science Doctoral Student Symposium. Boston, MA. February 2020.
- 7. **Plana, D.** *Of mice and (small numbers of) men: Improving estimates of drug efficacy in oncology.* Harvard Systems Biology Department Pizza Talk. Boston, MA. October 2019.
- 8. **Plana, D.** *Parametric fitting of clinical trial data in oncology*. Harvard Institute for Therapeutic Sciences Symposium. Boston, MA. October 2019.

9. **Plana, D.** *Using blood-based assays and RNA data to predict melanoma patient response to therapy.* Summer Research Trainee Program at the Massachusetts General Hospital. Boston, MA. June 2016.

POSTER PRESENTATIONS

- 1. **Plana, D.**, Fell, G., Alexander, B. M., Palmer, A. C., & Sorger, P. K. *Cancer patient survival can be accurately parameterized, improving trial precision and revealing time-dependent therapeutic effects.* Pacific Symposium on Biocomputing (PSB). Big Island, HI. January 2022.
- 2. **Plana, D.**, Fell, G., Alexander, B. M., Palmer, A. C., & Sorger, P. K. *Re-analysis and sharing of clinical trial data to advance precision oncology.* 2021 Cancer Systems Biology Consortium Annual Investigator Meeting. Virtual. September 2021.
- 3. **Plana, D.**, Fell, G., Alexander, B. M., Palmer, A. C., & Sorger, P. K. *Cancer patient survival can be accurately parameterized, revealing time-dependent therapeutic effects and doubling the precision of small trials*. Keystone Symposia, Precision Oncology: Translating Discovery to the Clinic. Virtual. June 2021.
- 4. **Plana, D.**, Palmer, A. C., Sorger, P.K. *Making Precise Estimates of Drug Efficacy from Small Amounts of Patient Data*. NCI Center for Cancer Systems Pharmacology Annual Investigators Meeting. Virtual. September 2020.
- 5. **Plana, D.**, Palmer, A. C., Sorger, P.K. *Predicting patient response to cancer combination therapies from clinical trial data*. Novartis-Academia Conference on Quantitative Sciences in Drug Development. Cambridge, MA. August 2018.
- 6. **Plana, D.**, Hill, A., Cook, C., Griffith, L., Lauffenburger, D. *Characterizing a 3-D hydrogel model of the human endometrium and its interactions with immunological factors using mixed effects modeling*. Biomedical Engineering Society Conference. Minneapolis, MN. October 2016.
- 7. Cintolo-Gonzalez, J., Michaud, W., Cohen, S., **Plana, D.**, Panka, D., Sullivan, R., Boland, G. *Use of Circulating Microvesicles, Exosomes, as a Biomarker to Track Disease Burden in Melanoma*. Massachusetts General Hospital Clinical Research Day. Boston, MA. October 2016.
- 8. **Plana, D.**, Wang, S., Cepko, C. Characterization of retinal cell subpopulations expressing distinct Otx2 enhancers. Howard Hughes Medical Institute Exceptional Research Opportunities Program Meeting. Chevy Chase, MD. May 2016
- 9. **Plana, D.**, Hill, A., Cook, C., Griffith, L., Lauffenburger, D. *Creating a 3-D hydrogel model of the human endometrium and its interactions with immunological factors*. New England Science Symposium. Cambridge, MA. April 2016.
- 10. **Plana, D.**, Cocchi, Sundar, Pleumann, Grzybinski, Shaefi, Brogna, Sisti, Butler, Small, Cain, Muret-Wagstaff, Foley, Talmor, Ma, Whyte, Kleinman, Simon. *Early Identification and Care of the Critically Ill Post-Operative Patient*. Beth Israel Deaconess Medical Center Silverman Symposium. Boston, MA. April 2015.

PROFESSIONAL ACTIVITIES

Ad hoc referee: BMJ Open, Frontiers in Medicine

Poster judge: 22nd Annual New England Science Symposium

Memberships: American Association for Cancer Research, American Society of Clinical Oncology, Massachusetts Medical Society, Harvard Center for Cancer Systems Pharmacology Executive Committee, Harvard-MIT Center for Regulatory Science, HMS Medical Student COVID-19 Curriculum Committee

TECHNICAL SKILLS

Programming and data analysis: Mathematica, MATLAB, Python, R

Image editing: Adobe Creative Suite (including Illustrator, Photoshop, InDesign)

LANGUAGE SKILLS

English: Native/Bilingual proficiency.

Spanish: Native/Bilingual proficiency. Certified to provide clinical care in Spanish as a Qualified Bilingual Staff by ALTA language services.