Medical Ethics: Use of Artificial Intelligence in Medical Decision Making

Rabbi Mordechai Torczyner – torczyner@torontotorah.com

Our agenda

Artificial Intelligence (AI) is becoming increasingly important in many fields, such as radiology, dermatology and pathology. However, these technological advances come with concerns both ethical and practical. How is patient data handled in the training of an AI? Are patients informed of the risks inherent in AI? Are there proper checks on computer programs as they advance in complexity? And what does all of this mean for clinical practice?

Evaluation link	https://www.surveymonkey.com/r/HBZJ883
Past medical sessions	https://torontotorah.com/nusbaum
Patient capacity and consent (abridged, 2012)	https://www.yutorah.org/lectures/lecture.cfm/783340/
Medical malpractice (2013)	https://www.yutorah.org/lectures/lecture.cfm/801124/
Vaccination and risk-taking (2016)	https://www.yutorah.org/lectures/lecture.cfm/865788/
Autonomy and decision-making (2017)	https://www.yutorah.org/lectures/lecture.cfm/871283/

Yaron Ben-Zakkai, *What is the place of Decision Supported Technologies in Medical Decisions?* (2018)
https://journalofethics.ama-assn.org/search?search=artificial%20intelligence

Vignettes

1> Susan, an experienced oncologist, trains in the use of Deep Path, a program that examines CT scans and diagnoses tumors. Susan wants to incorporate Deep Path's recommendations into her counsel for patients, but she knows that many patients lack the sophistication to understand the positives and negatives of using Deep Path. What must she tell patients, in order to ensure that their acceptance of recommendations constitutes "informed consent"?

2> Susan uses Deep Path in her practice for five years, examining the program's recommendations and finding them largely reliable. But one day, Susan learns that a patient's tumour was badly misdiagnosed by the Artificial Intelligence, resulting in inappropriate treatment and, eventually, death. The patient's family wants to sue Susan for malpractice. Who should be held responsible for Deep Path's error?

3> After her experience with Deep Path's error, Sarah becomes more sensitive to her own doubts about some of Deep Path's advice. Faced with Richard, an elderly patient in fragile health for whom Deep Path recommends surgery, Sarah believes that the better immediate approach would be radiation. Richard defers to Sarah's judgment. What should Sarah do?

4> SubJudge is an Artificial Intelligence designed to analyze an incapacitated patient's biography and social media trail and predict the treatment path the patient would have chosen. Jonathan, a family physician, routinely consults SubJudge for incapacitated patients, and he finds that substitute decision makers generally concur with the SubJudge counsel. Jonathan is now taking care of Sarah, an unconscious 92-year old Holocaust survivor with Stage 4 lung cancer, from an observant Jewish family. Based on Sarah's religious community and the healthcare decisions made by elderly members of that community within a radius of 10 miles, SubJudge decides that Sarah would prefer aggressive treatment of the tumor. However, Sarah's children believe that she is exhausted and would prefer to allow her life to end. What should Jonathan do?

5> It's 2050, and Dermatron has just been released. For a small fee (covered by OHIP), this AI-driven kiosk scans skin discolourations, presents diagnoses and recommend courses of treatment. David, a Torah-observant Jew with a suspicious spot on his skin, wonders: would Judaism prefer that he see a human physician or Dermatron?

Brief background on use of AI in medical decisions

1. Davenport, Kalakoka, *The Potential for Artificial Intelligence in Healthcare, The Future Healthcare Journal*, Jun '19
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6616181/

Rule-based expert systems - Expert systems based on collections of 'if-then' rules were the dominant technology for AI in the 1980s and were widely used commercially in that and later periods… Expert systems require human experts and knowledge engineers to construct a series of rules in a particular knowledge domain. They work well up to a point and

are easy to understand. However, when the number of rules is large (usually over several thousand) and the rules begin to conflict with each other, they tend to break down. Moreover, if the knowledge domain changes, changing the rules can be difficult and time-consuming…

Basic Machine Learning - The great majority of machine learning and precision medicine applications require a training dataset for which the outcome variable (e.g. onset of disease) is known; this is called supervised learning….

Neural Network and Deep Learning - The most complex forms of machine learning involve deep learning, or neural network models with many levels of features or variables that predict outcomes. There may be thousands of hidden features in such models, which are uncovered by the faster processing of today's graphics processing units and cloud architectures.

2. Harish, Morgado, Stern, Das, *Artificial Intelligence and Clinical Decision Making: The New Nature of Medical Uncertainty*, Journal of Academic Medicine , Jan. '21

AI proponents believe that diagnosis is hindered by humans' analytic capabilities and expect AI to refine the analytic process. This early optimism has perhaps been most significantly realized in areas of medicine dominated by imaging. In a 2017 article in the journal *Nature*, a multidisciplinary group from Stanford University developed a convolutional neural network that performed comparably to 21 board-certified dermatologists on a recognition task designed to differentiate cancers from benign seborrheic keratoses and nevi. A similar algorithm has since been developed that was able to outperform dermatologists in identifying malignant melanomas and properly segregating these cancers from benign lesions. In neurology, Siddhartha Mukherjee has written about the ability of AI to identify early signs of stroke on computed tomography scans, which could have profound implications for early intervention and consequently improving patient outcomes. Finally, a recent study from China described a natural language processing system (i.e., a long short-term memory network, a type of deep learning approach) that integrated multifaceted clinical data from 1.3 million pediatric electronic health records to diagnose a wide range of childhood diseases across multiple organ systems; the performance of this system was comparable to that of experienced physicians.

3. Basu, Sinha, Ong, Basu, *Artificial Intelligence: How is It Changing Medical Sciences and Its Future?*, Indian Journal of Dermatology Sep-Oct '20 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7640807/

Case #1: Informed consent

4. Jonathan F. Will, *A Brief Historical and Theoretical Perspective*, Chest 139:6 pg. 1493

While physicians did develop a more consistent practice of obtaining patient consent in the early 20th century, the medical literature indicates that the practice was fueled more by a desire to respond to lawsuits than by a moral imperative to respect patient autonomy. In a 1911 article, physician George W. Gay suggested that "careful and explicit explanations of the nature of serious cases, together with the complications liable to arise and their probable termination,… be given to the patient … for our own protection."…

In *Schloendorff v Society of New York Hospitals*, Justice Cardozo planted the seed for what would become the informed consent doctrine when he wrote, "Every human being of adult years and sound mind has a right to determine what shall be done with his own body; and a surgeon who performs an operation without his patient's consent commits an assault, for which he is liable in damages."

5. CPSO Policy #4-05 (https://www.cpso.on.ca/uploadedFiles/policies/policies/policyitems/Consent.pdf)

Respect for the autonomy and personal dignity of the patient is central to the provision of ethically sound patient care. Through the translation of these ethical principles to law, the Supreme Court of Canada has confirmed the fundamental right of the individual to decide which medical interventions will be accepted and which will not.

6. Rambam (12th century Egypt), Mishneh Torah, Hilchot Rotzeiach uShemirat haNefesh 11:4-5

וכן כל מכשול שיש בו סכנת נפשות מצות עשה להסירו ולהשמר ממנו ולהזהר בדבר יפה יפה שנ' (דברים ד' ט') השמר לך ושמור נפשך, ואם לא הסיר, והניח המכשולות המביאין לידי סכנה, ביטל מצות עשה ועבר על "לא תשים דמים".

הרבה דברים אסרו חכמים מפני שיש בהם סכנת נפשות וכל העובר עליהן ואמר הריני מסכן בעצמי ומה לאחרים עלי בכך או איני מקפיד על כך מכין אותו מכת מרדות.

So, too, there is a commandment to remove any stumbling block which endangers lives, and to guard from it, and to be very careful with this, as Devarim 4:9 says, "Guard yourself, and guard your life." And if one does not remove it, and one leaves dangerous stumbling blocks, he fails to fulfill a commandment, and he violates "Do not place blood." The sages prohibited many activities because they endanger lives. Regarding anyone who transgresses, and who says, "I will endanger myself, and what business is it of others?" or "I don't care", we issue lashes of rebellion for him.

7. Talmud, Yoma 83a

אמר רבי ינאי חולה אומר צריך ורופא אומר אינו צריך שומעין לחולה מאי טעמא +משלי יד+ לב יודע מרת נפשו פשיטא מהו דתימא רופא קים ליה טפי קא משמע לן

Rabbi Yannai said: If a patient says he needs [food] and the doctor says he does not, we listen to the patient; Proverbs 14 says, "The heart knows the bitterness of its spirit." But this is obvious! I'd have thought we would say the doctor knows better.

8. Ramban (13th century Spain), Torat ha'Adam, Sakkanah 6

בפרק החובל (פ"ה ב') תנא דבי ר' ישמעאל ורפא ירפא מכאן שניתנה רשות לרופא לרפאות. פי' שמא יאמר הרופא מה לי בצער הזה שמא אטעה ונמצאתי הורג נפשות בשוגג לפיכך נתנה לו תורה רשות לרפאות.

The Talmud records, "They taught in the yeshiva of Rabbi Yishmael: The Torah says, 'He shall surely heal.' From here we see that permission is given to doctors to heal." This means the following: lest a doctor say, "What do I need with this pain? I might err and kill accidentally," the Torah permitted him to heal.

9. "HaRav haPoseik" (20th century Israel), Assia III pg. 323

גם במקום סכנה אי אפשר לעשות נתוח מסוכן או אפילו לקטוע יד או רגל בלי הסכמת החולה, אף אם הרפואה היא בטוחה.

Also, in a case of danger one may not perform a dangerous surgery, or even amputate a hand or foot, without the patient's agreement – even if the cure is certain.

10. Talmud, Bava Metzia 112a

"ואליו הוא נשא את נפשו" - מפני מה עלה זה בכבש ונתלה באילן ומסר את עצמו למיתה - לא על שכרו?

"For this he puts his life on the line (Devarim 24:15)" – Why did this person climb the ramp, become suspended from the tree, and give his life over to death? Was it not for his wages?

11. Talmud, Yevamot 72a

א"ר פפא הלכך יומא דעיבא ויומא דשותא לא מהלינן ביה ולא מסוכרינן ביה והאידנא דדשו בה רבים שומר פתאים ד'.

Rav Pappa said: Therefore, we neither circumcise nor let blood on a cloudy day, or a day when the south wind blows. But now, when the masses trample this, we invoke Tehillim 116:6, "G-d guards the fools."

12. Dr. Christopher Meyers, *Autonomy and Critical Care Decision-Making,* Bioethics 18:2 (2004) pp. 111-112

This socialisation into heteronomy would be problematic enough were there no other autonomy-threatening conditions in medical decision-making. But of course, there are. Beyond the obvious threats of immature age, mental illness and trauma-induced incapacitation, healthcare also brings reduced competency due to disease, fear, power asymmetries, physician bias, physician denial, family conflict, pressures related to economic or managed care considerations, the complexities of medical decisions, and the bureaucratic structures of medical institutions.

13. Dr. Christopher Meyers, *Autonomy and Critical Care Decision-Making,* Bioethics 18:2 (2004) pg. 110

In my experience, many clinicians see the assent standard as being sufficient for autonomous consent. So long as the patient has expressed a 'willingness to accept the proposed care', she has autonomously chosen. Surely, though, this is false. Assent requires merely that the patient *agree to* the recommendations of others, whereas autonomous consent requires a rich evaluation of information, of the full range of options, and of whether likely outcomes
are consistent with life plans, along with the intentional selection of preferred alternatives. With assent, the patient *gives permission*; with consent, the patient *chooses*. With assent, the patient *accedes* to treatment; with consent, the patient *takes ownership* of or *identifies* with the choice made.

14. Amann, Blasimme, Vayena, Frey, Madai, *Explainability for artificial intelligence in healthcare: a multidisciplinary perspective*, Medical Informatics and Decision Making, Nov '20

https://bmcmedinformdecismak.biomedcentral.com/articles/10.1186/s12911-020-01332-6

From the development point-of-view, explainability will regularly be helpful for developers to sanity check their AI models beyond mere performance. For example, it is highly beneficial to rule out that the prediction performance is based on meta-data rather than the data itself. A famous non-medical example was the classification task to discern between huskies and wolves, where the prediction was solely driven by the identification of a snowy background rather than real differences between huskies and wolves. This phenomenon is also called a "Clever Hans" phenomenon. Clever Hans phenomena are also found in medicine. An example is the model developed by researchers from Mount Sinai hospital which performed very well in distinguishing high-risk patients from non-high-risk patients based on x-ray imaging. However, when the tool was applied outside of Mount Sinai, the performance plummeted. As it turned out the AI model did not learn clinically relevant information from the images. In analogy to the snowy background in the example introduced above, the prediction was based on hardware related meta-data tied to the specific x-ray machine that was used to image the high-risk ICU patients exclusively at Mount Sinai. Thus, the system was able to distinguish only which machine was used for imaging and not the risk of the patients.

15. Ramban (13th century Spain), Torat ha'Adam, Shaar haMeichush, Inyan haSakkanah

ואיכא מאן דאמר מדקתני "ע"פ בקיאין" ש"מ יחיד מומחה ומוחזק בבקיאות, ורופאים שאינן חכמים ומומחין כל כך [נגדו], שהולכים אחר בקיאות. ואינו נראה, שלא שמענו בסנהדרין שנלך אחר רוב חכמה אלא אחר רוב מנין... אבל הכא שומעין לחכם, והשני אינו ראוי להיות נשאל בפני מי שגדול ממנו בחכמה ובטל הוא. מיהו אחד במקום שנים, כיון שכולן רופאים ויודעים במלאכה זו אין דבריו של יחיד במקום שנים, מ"מ במופלג מהם בחכמה חוששין לדבריו להחמיר אפילו במקום רבים, אבל להקל כדין היחיד.

And there is a view that since [the Talmud] says "[we feed him] at the word of experts," that means an individual who is expert and established as knowledgeable, and doctors who are not as wise and expert [oppose him], and we follow knowledge. This does not appear correct, for we have not heard regarding the Sanhedrin that we follow the majority of wisdom, but the majority in number… But here we listen to the wise, and the next-wise should not be asked in front of one who is greater in wisdom. He is as though he wasn't there. But where it is one versus two, since all of them are doctors, knowing the craft, then the individual does not stand before the two. But if he is much greater than them in wisdom, we are concerned for his words to be strict even against the majority, but to be lenient we follow the individual.

16. "HaRav haPoseik" (20th century Israel), Assia III pg. 324

מועילה גם הסכמה מכללא, כי מסתבר שהחולה סומך על הרופאים. אך בנוגע לניתוח או בדיקה קשה יש צורך בהסכמה מפורשת ולא די בהסכמה מכללא... אין הרופא חייב להסביר לחולה את מהות הטיפול, סיכוניו ותוצאותיו.

General agreement is also effective, for it is logical that the patient would rely on the doctors. But regarding surgery or a difficult test, there is a need for explicit agreement, and not just general agreement… The doctor is not required to explain to the patient the nature of the treatment, its risks and effects.

Case #2: Liability for malpractice

17. J.K.C. Kingston, *Artificial Intelligence and Legal Liability*

Perpetrator-via-another. If an offence is committed by a mentally deficient person, a child or an animal, then the perpetrator is held to be an innocent agent because they lack the mental capacity to form a *mens rea* (this is true even for strict liability offences). However, if the innocent agent was instructed by another person (for example, if the owner of a dog instructed his dog to attack somebody), then the instructor is held criminally liable (see [4] for US case law).

According to this model, AI programs could be held to be an innocent agent, with either the software programmer or the user being held to be the perpetrator-via-another.

Natural-probable-consequence. In this model, part of the AI program which was intended for good purposes is activated inappropriately and performs a criminal action. Hallevy gives an example (quoted from [5]) in which a Japanese employee of a motorcycle factory was killed by an artificially intelligent robot working near him. The robot erroneously identified the employee as a threat to its mission, and calculated that the most efficient way to eliminate this threat was by pushing him into an adjacent operating machine. Using its very powerful hydraulic arm, the robot smashed the surprised worker into the machine, killing him instantly, and then resumed its duties…

Direct liability. This model attributes both *actus reus* and *mens rea* to an AI system.

It is relatively simple to attribute an *actus reus* to an AI system. If a system takes an action that results in a criminal act, or fails to take an action when there is a duty to act, then the *actus reus* of an offence has occurred.

Assigning a *mens rea* is much harder, and so it is here that the three levels of *mens rea* become important. For strict liability offences, where no intent to commit an offence is required, it may indeed be possible to hold AI programs criminally liable. Considering the example of self-driving cars, speeding is a strict liability offence; so according to Hallevy, if a self-driving car was found to be breaking the speed limit for the road it is on, the law may well assign criminal liability to the AI program that was driving the car at that time.

18. Rabbi Yosef Karo (16th century Turkey/Israel), Shulchan Aruch Choshen Mishpat 418:7

השולח את הבעירה ביד חרש, שוטה וקטן, פטור מדיני אדם וחייב בדיני שמים. במה דברים אמורים? כשמסר להם גחלת וליבוה... שדרך הגחלת להכבות מאליה קודם שתעבור ותדליק. אבל אם מסר להם שלהבת, חייב, שהרי מעשיו גרמו.

One who sends a fire in the hand of a *cheresh*, *shoteh* or minor, is exempt by human law, and liable by heavenly law. When is this true? When one gave them a coal and they increased it… for a coal naturally is extinguished on its own before it can travel and ignite elsewhere. But if he gave them a flame, he is liable, for his deeds caused it.

19. Talmud, Bava Kama 99b-100a

המראה דינר לשולחני ונמצא רע, תני חדא: אומן פטור, הדיוט חייב, ותניא אידך: בין אומן בין הדיוט חייב. אמר רב פפא: כי תניא אומן פטור - כגון דנכו ואיסור, דלא צריכי למיגמר כלל. אלא במאי טעו? טעו בסיכתא חדתא, דההיא שעתא דנפק מתותי סיכתא... ריש לקיש אחוי ליה דינרא לרבי אלעזר, אמר: מעליא הוא, אמר ליה: חזי דעלך קא סמכינא. א"ל: כי סמכת עלי מאי למימרא? דאי משתכח בישא בעינא לאיחלופי לך, והא את הוא דאמרת: רבי מאיר הוא דדאין דינא דגרמי, מאי לאו ולא סבירא לן כוותיה! א"ל: לא, ר' מאיר וסבירא לן כוותיה.

If one shows a coin to a moneychanger [who approves it] and then it is rejected:
- One source teaches that an expert would be exempt, but a non-expert would be liable;
- Another source teaches that any moneychanger would be liable.

Rav Pappa said: The view that exempts an expert refers to someone like Danko and Issur, who lacked no knowledge, and erred only with a newly minted coin…

Reish Lakish showed a coin to Rabbi Elazar [who was not expert], who approved it. Reish Lakish said, "See, I depend on you!" Rabbi Elazar replied, "What does that mean? If you wish to be able to exchange it in the event that it is found to be bad, haven't you said that liability would be within the view of Rabbi Meir, who punishes for *garmi*, implying that we don't agree with Rabbi Meir?" Reish Lakish said, "No; it is Rabbi Meir, and we agree with Rabbi Meir."

20. Tosefta, Bava Kama 6:17

רופא אומן שריפה ברשות בית דין והזיק פטור מדיני אדם וחייב בדיני שמים

An expert doctor who treats with court authorization and causes harm is exempt in human law, and liable in heavenly law.

21. Tosefta, Gittin 3:8

כהנים שפגלו במקדש שוגגין פטורין מזידין חייבין מפני תיקון העולם. שלוח בית דין שהכה ברשות בית דין והזיק בשוגג פטור, במזיד חייב מפני תיקון העולם. רופא אומן שריפא ברשות בית דין והזיק בשוגג פטור במזיד חייב מפני תיקון העולם.

Kohanim who accidentally disqualify offerings are exempt; if they do it intentionally they are liable; for *tikun olam*.

Court agents who strike with court authorization and harm accidentally are exempt; if they do it intentionally they are liable; for *tikun olam*.

An expert doctor who treats with court authorization and harms accidentally is exempt; if he does it intentionally he is liable; for *tikun olam*.

22. Rabbi Moshe ben Nachman (Nachmanides), Torat ha'Adam, Sakkanah 6

בפרק החובל (פ"ה ב') תנא דבי ר' ישמעאל ורפא ירפא מכאן שניתנה רשות לרופא לרפאות. פי' שמא יאמר הרופא מה לי בצער הזה שמא אטעה ונמצאתי הורג נפשות בשוגג לפיכך נתנה לו תורה רשות לרפאות. וקשיא לי הא דתניא בתוספתא (ב"ק פ"ט) רופא אומן שרפא ברשות ב"ד והזיק ה"ז גולה, אלמא עונש שוגג יש בדבר! ויש לומר הכי, הרופא כדיין מצווה לדון, ואם טעה בלא הודע אין עליו עונש כלל... ואעפ"כ אם טעה ונודע לב"ד שטעה משלם...

The Talmud records, "They taught in the yeshiva of Rabbi Yishmael: The Torah says, 'He shall surely heal.' From here we see that permission is given to doctors to heal." This means the following: lest a doctor say, "What do I need with this pain? I might err and kill accidentally," the Torah permitted him to heal.

I am troubled; a Tosefta teaches, "An expert doctor who treats with court authorization and harms is exiled," so one is punished for error! Perhaps one could say that a doctor is like a judge, who is required to judge. If he errs and does not know it, he has no penalty… But if he errs and then it becomes known to the court, he pays…

23. Rabbi Yehoshua Falk, Perishah commentary to Tur Yoreh Deah 336:7

ואם לא טעה ועשה הרפואה כהוגן ומת פטור ג"כ מדיני שמים שהוא לא המית אותו אלא ד' יתברך רצה במיתתו.

And if he does not err, and he treats properly, and the patient dies, he is exempt even in the heavenly court. He did not kill him; Hashem desired his death.

24. Tosefta, Bava Kama 9:11

רופא אומן שריפא ברשות בית דין והזיק פטור יתר מן הראוי לו הרי זה חייב

An expert doctor who treats with court authorization and harms is exempt. One who wounds more than necessary is liable.

25. Rabbi Moshe Feinstein, Igrot Moshe Even haEzer 4:31

תלוי זה לפי חכמתו והמחאתו ברפואה של הגברא ושל הרפואה ובאופן עיונו בחולה זה שהיה במתינות ובעיון רב בין בעצם חליו ובין בכחות של החולה אם אפשר לעשות לו הניתוח... ואם היה בבהילות הוא כפשיעה אף שלפי שנדמה לו לא היה דבר הצריך עיון ביותר...

This depends on his wisdom and medical expertise, and the medication's tested success, and his examination of the patient with patience and great analysis in terms of the disease as well as the patient's ability to endure surgery… If it was hasty, that is like carelessness, even if he felt no great analysis was needed…

26. Rabbi Zalman Nechemiah Goldberg, *Rashlanut Refuit*, Techumin 19

מסברה נראה שהחייב הוא הרופא המומחה שציווה לנתח או רשם את התרופה, ולא הרופא שניתח או האחות שנתנה את התרופה בפיו של החולה. יש לדמות את הרופא המצווה למזיק בגרמי, כיון שעל ידי אמירתו ברי שייעשה היזק.

Logically, it appears that the expert doctor who orders surgery or who prescribes medicine is liable, and not the actual surgeon or the nurse who puts the medication in the patient's mouth. One may compare the prescribing doctor to one who harms with *garmi*, since the harm will be done at his command.

Case #3: Clinician disagreeing with the AI

27. Harish, Morgado, Stern, Das, *Artificial Intelligence and Clinical Decision Making: The New Nature of Medical Uncertainty*, Journal of Academic Medicine Jan '21

Notably, Watson's "thinking" process did not mirror how a human *Jeopardy* contestant processes questions. While both humans and Watson take confidence-driven approaches, only Watson explicitly incorporated confidence as a quantifiable and objective metric. Watson had to proceed in this manner because, unlike humans, it associates all potentially related concepts from raw data with each question. Humans, on the other hand, have an immediate instinct for whether they know the correct answer…

By the end of its 3-game *Jeopardy* run, Watson had defeated its human competitors by a considerable margin.[25] While this result was impressive, Watson's most memorable moment for some came during the final round when it responded "Toronto" to a question about American cities. In this instance, Watson's probabilistic answering design prevented it from excluding any solutions with total certainty, leading to an incorrect (albeit low-confidence) conclusion that the audience knew was obviously incorrect.

28. Challen, Denny, Pitt, Gompels, Edwards, Tsaneva-Atanasova, *Artificial intelligence, bias and clinical safety*, BMJ Quality & Safety '19 https://qualitysafety.bmj.com/content/28/3/231

As humans, clinicians are susceptible to a range of cognitive biases which influence their ability to make accurate decisions. Particularly relevant is 'confirmation bias' in which clinicians give excessive significance to evidence which supports their presumed diagnosis and ignore evidence which refutes it. Automation bias describes the phenomenon

whereby clinicians accept the guidance of an automated system and cease searching for confirmatory evidence (e.g., see Tsai *et al*), perhaps transferring responsibility for decision-making onto the machine—an effect reportedly strongest when a machine advises that a case is normal. Automation complacency is a related concept in which people using imperfect DSS are least likely to catch errors if they are using a system which has been generally reliable, they are loaded with multiple concurrent tasks and they are at the end of their shift.

29. Rabbi Moshe Feinstein (20th century USA), Igrot Moshe Choshen Mishpat 2:69:2

להרוג את העובר יהיה אסור עד שתהיה האומדנא להרופאים גדולה קרוב לודאי שתמות האם, דמאחר דהוא מצד שנחשב רודף צריך שיהיה כעין ודאי שהוא רודף.

Killing a fetus is prohibited until the doctors have great reason, close to certainty, that the mother will die. Since the permission is due to the fetus's status as a pursuer, it must be near-certain that he is a pursuer.

30. Rambam (12th century Egypt), Mishneh Torah, Hilchot Sanhedrin 24:3

ומנין לדיין שהוא יודע בדין שהוא מרומה שלא יאמר אחתכנו ויהיה הקולר תלוי בצוארי העדים, תלמוד לומר "מדבר שקר תרחק." כיצד יעשה? ידרוש בו ויחקור הרבה בדרישה ובחקירה של דיני נפשות...

How do we know that a judge who knows a verdict is based on trickery should not say, "I will issue the verdict, and the burden lies with the witnesses?" The Torah says, "Distance yourself from falsehood." What should he do? Analyze and investigate a lot, with the modes of analysis appropriate for capital cases…

31. David L Sackett, *Evidence Based Medicine: what it is and what it isn't*, BMJ 1996

Evidence based medicine is not "cookbook" medicine. Because it requires a bottom up approach that integrates the best external evidence with individual clinical expertise and patients' choice, it cannot result in slavish, cookbook approaches to individual patient care. External clinical evidence can inform, but can never replace, individual clinical expertise, and it is this expertise that decides whether the external evidence applies to the individual patient at all and, if so, how it should be integrated into a clinical decision. Similarly, any external guideline must be integrated with individual clinical expertise in deciding whether and how it matches the patient's clinical state, predicament, and preferences, and thus whether it should be applied. Clinicians who fear top down cookbooks will find the advocates of evidence based medicine joining them at the barricades.

32. Talmud, Sotah 22a

קרא ושנה ולא שימש ת"ח ר' אלעזר אומר הרי זה עם הארץ ר' שמואל בר נחמני אמר הרי זה בור ר' ינאי אומר ה"ז כותי רב אחא בר יעקב אומר הרי זה מגוש

One who has read and studied but not apprenticed with Torah scholars – Rabbi Eliezer says: This is an *am ha'aretz*. Rabbi Shemuel bar Nachmeni said: This is a boor. Rabbi Yannai said: This is a *kuti*. Rav Acha bar Yaakov said: This is a trickster.

33. Challen, Denny, Pitt, Gompels, Edwards, Tsaneva-Atanasova, *Artificial intelligence, bias and clinical safety*, BMJ Quality & Safety '19 https://qualitysafety.bmj.com/content/28/3/231

In the comparison between ML systems and expert dermatologists performed by Esteva *et al*, both humans and machines find it difficult to discriminate between benign and malignant melanocytic lesions, but humans 'err on the side of caution' and over-diagnose malignancy. The same pattern was not observed for relatively benign conditions. While this decreases a clinician's apparent accuracy, this behaviour alteration in the face of a potentially serious outcome is critical for safety, and something that the ML system has to replicate. ML systems applied to clinical care should be trained not just with the end result (e.g., malignant or benign), but also with the cost of both potential missed diagnoses (false negatives) and over-diagnosis (false positives)

34. Sefer haChinuch (13th century Spain), Mitzvah 78

בחירת רוב זה לפי הדומה הוא בששני הכיתות החולקות יודעות בחכמת התורה בשוה... בהשות החכמה או בקרוב הודיעתנו התורה שריבוי הדעות יסכימו לעולם אל האמת יותר מן המיעוט.

Apparently, choosing the majority is when the two dissenting groups are equal in their Torah knowledge… When they are of equal or similar knowledge, the Torah informs us that the majority will always agree to the truth, over the minority.

35. Mishnah, Eduyot 1:5

ולמה מזכירין דברי היחיד בין המרובין הואיל ואין הלכה אלא כדברי המרובין שאם יראה בית דין את דברי היחיד ויסמוך עליו, שאין בית דין יכול לבטל דברי בית דין חברו עד שיהיה גדול ממנו בחכמה ובמנין היה גדול ממנו בחכמה אבל לא במנין במנין אבל לא בחכמה אינו יכול לבטל דבריו עד שיהיה גדול ממנו בחכמה ובמנין:

Then why do we mention the words of an individual alongside the majority, if the law only follows the majority? In case a rabbinical court sees the view of the individual and relies on it. [This will be considered a substantive view.] For a rabbinical court [that disagrees] cannot cancel the words of another rabbinical court unless it is greater in wisdom and in number [of followers]. If it is greater in wisdom but not numbers, or in numbers but not in wisdom, it cannot cancel their words, until it is greater in wisdom and number.

36. Talmud, Berachot 64a

רב יוסף סיני ורבה עוקר הרים אצטריכא להו שעתא שלחו להתם סיני ועוקר הרים איזה מהם קודם שלחו להו סיני קודם שהכל צריכין למרי חטיא

Rav Yosef was known as "Sinai", and Rabbah as "The Uprooter of Mountains". They were needed [to lead the study hall]. They asked, "Who goes first – Sinai or the Uprooter of Mountains?" The response was sent to them, "Sinai is first, for all need the one with the grain."

37. Yaron Ben-Zakkai, *What is the place of Decision Supported Technologies in Medical Decisions?* (2018)

לאור האמור, נראה לענ"ד, שבמקרה של פער בין עובדות הנגלות לנגד עיני הגורם הרפואי מחד בעוד שמאידך הטכנולוגיה תומכת ההחלטה מציגה אבחנה ודרכי טיפול אחרות, על הגורם הרפואי לנהוג לפי המלצת הטכנולוגיה תומכת ההחלטה גם כשהיא סותרת אפשרות להחלטה על בסיס מידע הנגלה לנגד עיניו. על הגורם הרפואי להעלות נושאים השנויים במחלוקת בפני גורמי מקצוע נוספים.

Based on what has been said, it appears, in my humble opinion, that where there is a gap between the facts before the eyes of the medical clinician on one side, while on the other the decision support technology presents a different diagnosis and treatment option, the medical clinician should act according to the recommendation of the decision support technology, even when it contradicts the option of deciding based on the information revealed before his eyes. The medical clinician should raise the disputed issues before additional medical professionals.

Case #4: AI vs Family in Substituted Judgment

38. Lamanna, Byrne, *Should Artificial Intelligence Augment Medical Decision Making? The Case of an Autonomy Algorithm*, AMA Journal of Ethics '18

A significant proportion of elderly and psychiatric patients do not have the capacity to make health care decisions. We suggest that machine learning technologies could be harnessed to integrate data mined from electronic health records (EHRs) and social media in order to estimate the confidence of the prediction that a patient would consent to a given treatment. We call this process, which takes data about patients as input and derives a confidence estimate for a particular patient's predicted health care-related decision as an output, the *autonomy algorithm*. We suggest that the proposed algorithm would result in more accurate predictions than existing methods, which are resource intensive and consider only small patient cohorts. This algorithm could become a valuable tool in medical decision-making processes, augmenting the capacity of all people to make health care decisions in difficult situations.

39. Speak-Up Ontario, Questions About the Substitute Decision Maker
https://www.makingmywishesknown.ca/questions-about-the-substitute-decision-maker/

When your substitute decision maker has to step in and make decisions for you, he or she is required to honour and apply the wishes, values and beliefs that you communicated when you were still mentally capable.

If your wishes are not known, your SDM is required to act in your "best interests"…

40. Rabbi Moshe Feinstein (20th century USA), Igrot Moshe Choshen Mishpat 2:74:2, 5

ב: ברובא דרובא הא יש להחולה קרובים ואף אב ואם ואחים וכדומה העוסקים ברפואת החולה שעליהם יותר מוטל גם בדינא

ה: ובאם החולה הוא תינוק או אף גדול שאינו יודע להחליט רשאין אביו ואמו וכל המשפחה להחליט, והרשות שיש להם משום דרוב חולים סומכין על דעת האב והאם ואף על המשפחה כאחים ואחיות ובניהם שרוצים מה שיותר טוב להחולה ולבני ביתו, וכשליכא קרובים ודאי יש לסמוך על דעת הב"ד שבעיר.

2: In most cases the patient has relatives, even father and mother and brothers and the like, who are involved in his treatment, for it is legally their responsibility to a greater extent.

5: If the patient is a baby, or an adult who cannot decide, his parents and the whole family may decide. This permission stems from the fact that most patients depend upon their parents' opinion and even upon the family, like brothers and sisters and children, who want what is best for the patient and his family. When there are no relatives, it is certainly better to depend upon the view of the local court.

41. Rabbi Shlomo Zalman Auerbach (20th century Israel), Shulchan Shlomo, Erkei Refuah I pg. 75

אם החולה הוא במצב של חוסר הכרה שאי אפשר לדבר על כך עם החולה, אפשר שיכולים גם לסמוך על בני המשפחה אשר יודעים ברור שהם חפצים מאוד בטובתו של החולה ויכולים לאמוד את דעתו של החולה ורצונו במצב כזה אם להסכים או לא.

If the patient lacks capacity, so that one cannot discuss this with the patient, perhaps one may rely on the family members who we know, clearly, desire very much the best interests of the patient, and they can gauge the patient's views and desire in such a situation, whether to agree [to the treatment] or not.

Case #5: AI or Doctor?
42. Mishnah, Avot 1:16

רבן גמליאל אומר עשה לך רב והסתלק מן הספק...

Rabban Gamliel said: Make a teacher for yourself, and absent yourself from doubt...

43. Talmud, Ketuvot 60b

אמר אביי האי מילתא דאמור רבנן "אפילו ביעתא בכותחא לא לישרי איניש במקום רביה," לא משום דמיחזי כאפקירותא אלא משום דלא מסתייעא מילתא למימרא, דהא אנא הוה גמירנא ליה להא דרב ושמואל אפי' הכי לא מסתייעא לי מילתא למימר.

Abbaye said: When the sages say, "One should not even permit an egg in yogurt in his Rebbe's location," it isn't because [permitting it] would appear like hubris, but because one will not have assistance in saying it. For I learned that issue of Rav and Shemuel, and yet I did not have assistance in saying it.

44. Talmud, Sanhedrin 93b

"ידע נגן" שיודע לישאל, "גבור" שיודע להשיב, "איש מלחמה" שיודע לישא וליתן במלחמתה של תורה, "ונבון דבר" שמבין דבר מתוך דבר, "איש תואר" שמראה פנים בהלכה, "וד' עמו" שהלכה כמותו בכל מקום.

"Knows how to play" – He knows how to ask/comprehend questions;
"Mighty" – He knows how to respond;
"Warrior" – He knows how to engage in the battle of Torah;
"Understanding" – He comprehends one thing from another;
"A man of appearance" – He can bring proofs to his position in Jewish law;
"And Gd is with him" – The law always follows his view.

45. Rabbi Hershel Schachter, *How to Choose a Rabbi*
https://www.torahweb.org/torah/2011/parsha/rsch_mishpatim.html
The Talmud notes that one reason we follow the opinions of *Beis* Hillel is because they were more humble than *Beis* Shamai. The Talmud doesn't state that *Beis* Shamai were arrogant, rather that *Beis* Hillel were humble. What does humility have to do with *psak halacha*? Perhaps the humble person ought to be granted a *middos* award, but why ought the reward be that his opinion is accepted *halacha lmaaseh*?
The answer apparently is that the *navi* Yeshaya (57:15) tells us that *Hakadosh Baruch Hu* chooses to be with the humble people. Therefore, the *anav* stands a better chance of having that divine assistance to be *mechavein l'amita shel Torah*. When following the instruction of the *mishna* in *Avos* to choose a rov to follow in matters of *halacha* we must try to choose an intelligent, learned, honest rov who also posses *yiras shomayim* and humility. These last two qualities are essential to be more secure in the knowledge that the particular *talmid chacham* who is issuing the *psak* will be granted *siyata dishmaya* not to err.

46. Talmud, Avodah Zarah 55a

יסורין בשעה שמשגרין אותן על האדם משביעין אותן שלא תלכו אלא ביום פלוני ולא תצאו אלא ביום פלוני ובשעה פלונית ועל ידי פלוני ועל ידי סם פלוני.

When suffering is sent upon a person, it is sworn: Do not go other than on this day, and do not leave other than on that day, and at that time, and via that person, and via that medicine.

47. Rabbi Yosef Karo (16th century Turkey/Israel), Shulchan Aruch Yoreh Deah 336:1

נתנה התורה רשות לרופא לרפאות. ומצוה היא. ובכלל פיקוח נפש הוא. ואם מונע עצמו, הרי זה שופך דמים ואפילו יש לו מי שירפאנו, שלא מן הכל אדם זוכה להתרפאות

The Torah gave permission to the doctor to heal, and this is a mitzvah and included in the general mitzvah of saving lives. One who restrains himself is spilling blood even if he has someone to heal him, for one may not merit to be healed by just anyone.