A crosswalk from medical bioethics to Forensic Bioethics

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1. Background

Forensic science is the application of science to the law and the investigation of crime. Responses to ethical dilemmas faced by or occurring in crime laboratories are primarily guided by rules defined in codes of conduct provided by employers. These employers are primarily law enforcement based. Accredited forensic laboratories follow well developed quality programs for corrective actions, however these are generally directed towards scientific and technical issues rather than providing proactive ethical guidance. There is a distinct lack of the development of a philosophical basis for ethical decision making besides following these rules. The result is a narrow basis for guidance of policy and foundation for the recognition of ethical dilemmas and decision making by forensic scientists. As there is currently no single overarching organization in the United States providing oversight to forensic laboratories, insight provided through the comparison to medical bioethics would benefit from multiple standpoints including philosophy, policy and implementation. The result is the opportunity for development of an ethical framework specifically tailored to forensic science and its unique ethical challenges. The goal is to develop a context rich ethical approach which will permit forensic scientists to fully understand ethical issues. This understanding will permit dynamic recognition of a myriad of ethical issues and situations that may or may not fit rules neatly. By use of the word dynamic, the scientist is flexible and positive, enabled to make sound ethical decisions on the fly, rather than read through and interpret static rules. With this more robust framework, forensic scientists will better think, reflect, and make better informed decisions in the issues they face on a daily basis.

There are tremendous parallels between the fields of forensics and medicine, where forensic science could benefit by a comparison and contrast with medical ethics. Both forensics and medicine are applied science to individual case circumstances, frequently guided by a combination of biologically and chemically based testing, education, experience and training. Each depend on technology and high levels of expertise, where ethical systems and behavior are paramount. There are examples of consolidated ethical standards which are mandatory requirements for accreditation, such as the Guiding Principles of Professional Responsibility for Forensic Service Providers and Forensic Personnel [1]. While forensic science came into being in the early 1900’s, its growth has been limited through restricted resources and application to solving of specific crimes, versus healthcare, which affects all individuals directly. For the purposes of this article, forensic science is defined as the profession practiced by scientists within accredited multidiscipline crime laboratories analyzing criminal cases for...
investigative purposes. Everyone is personally impacted by the healthcare profession at multiple points in their lifetime, including a minimum of once per year assuming regular doctor office visits. This contrasts against a much lower indirect contact rate with crime labs through law enforcement, as a victim, witness or suspect in a criminal offense. Forensic science as discussed here, therefore, is a much narrower field.

Forensics can benefit tremendously by taking advantage of the evolution and practice of medical bioethics, progressing through a comparison of current practice in each. The sincerest form of flat-tery is imitation, hence borrowing the best application of established principles of bioethics can move the ethics of forensic science forward on a well-established foundation provided by the practice of medicine. A forensic specific ethical framework promotes improved ethical acuity and dexterity than simply following a staid set of rules and regulations. This means better understanding of the rationale behind the rules provides for more sound and flexible decision making which will better apply to a variety of situations. Difficult decisions should be based on sound ethical reflection rather than simply following rules and policies. The result of better understanding is more than improved behavior and compliance; it guides and produces laws and procedures that are aligned for ethical coherence.

Individuals who commit violent crimes inflict tremendous grievous emotional and physical harm on their victims and their families. While they express their own individualism and autonomy, they infringe on the rights of others, commonly practicing recidivism. Recidivism is the commission of repetitious and frequently increasingly violent infractions on new victims. To illustrate this cost, the damage in a case of sexual assault is estimated at over $111,000 [2]. The existing cycle of recidivism represents a growing opportunity for disruption of a criminal career earlier in its cycle, which can prevent future victimization and associated costs. This warrants an examination of the ethical balance between the individual right to privacy and autonomy, versus the public's right to personal safety and integrity, not to have harm inflicted on them by an individual.

2. Cases versus patients

In medicine, the patient is the recipient of treatment from medical health professionals. In forensic science, the case receives analysis from forensic scientists. More accurately, evidence collected in the case from a crime scene, as well as samples from known sources such as suspects (alleged perpetrators) and complainants (alleged victims), and submitted by investigators to the forensic laboratory. Analysis is completed, reported and testimony in court is provided as necessary. Cases are parallel to patients; however, the victim is not being treated, but rather the entirety of the body of evidence, including victim, scene(s) and suspect(s) evidence are considered for probative value and forensic laboratory testing. The body of evidence represents the case history and the symptoms, to be resolved with analysis. The primary goal of the crime lab is to maximize the value of evidence.

Identification of substances at the crime scene compared to known standards may be sufficient to maximize evidence value in some forensic disciplines, such as controlled dangerous substances (drugs). Alternatively, in fields such as latent prints, DNA, trace evidence and firearms, comparisons of crime scene evidence to known sources are necessary to make associations. This combination of identification (what) and comparison (who) advise the finder of fact, the jury, as they deliberate to determine the outcome of a case. In North America, the vast majority of cases are subject to plea bargain; hence the final product may be a lab report rather than court testimony.

The case is central to the mission of a forensic laboratory, much as the patient is central to the mission of a hospital, doctor's office or clinic. Health of the public is parallel to public safety and defense of rights. These rights, as in right to health, include the cross section of society, to include the complainant, suspect, and society's right to public safety and protection by law and public policy. These rights extend to include suspect's rights to protection from wrongful accusation, imprisonment and protection from violation of right to privacy, which may be overridden if one is found guilty of committing a crime. As in medicine, there is a push and pull over what should be done on a case. Every redundant examination or analysis not adding evidential value that is performed on the case at hand is not done on the next case awaiting analysis.

The products of the forensic lab are testimony, the laboratory report, and the case and accreditation related documentation that supports the report and testimony. Investigative aids frequently result from laboratory analyses, which are used by investigators to corroborate or deny theories surrounding the circumstances and perpetrator of a crime. Based on independent scientific evidence, objective forensic data and interpretation have become a gold standard for investigation and prosecution. While any tool in human hands is not perfect and must be subject to continuous improvement, without forensic evidence what frequently remains is eyewitness testimony. Human beings by nature have points of view and biases, which potentially impact witnesses, investigators and scientists. Herein lies the value of reliance on the neutrality of scientific data and principles upon which to base sound decision making. As a result, investigations and courts have come to increasingly rely on objective forensic evidence to include and eliminate suspects and develop case theories.

3. Investigators and justice system as surrogates, justice system and public as stakeholders

The investigator and justice system are the human embodiment and voice of a case. They represent the best interests of the case, looking to determine the best treatment in pursuit of justice or the best health outcome for the case. Despite the adversarial nature of the justice system, investigators and justice system officials act as surrogates. Investigators evaluate evidence and determine whether there are forensic analyses that can benefit their cases and thereby advocate for their cases when they submit them. If there is a lack of training, awareness, or an excessive backlog, a choice may be made against lab submission, much like not seeking treatment for illness. Lack of forensic laboratory resources to conduct necessary case-work is akin to lacking medical coverage, Medicare/Medicaid (United States) or universal healthcare (Canada, England, Germany, Australia, New Zealand).

The forensic lab is very reactive, only conducting analysis on a case once it is submitted. Again, this is not unlike hospitals and doctors' offices. There is no forensic laboratory outreach when a crime is committed or when a patient falls ill. The surrogate must recognize the need for service and represent the needs of the case. The forensic laboratory outreach takes place in the form of training, making investigators aware of the value of forensic evidence, how it is recognized, collected, preserved and submitted. This is much like community health education. A case lacks the ability to speak for itself. Victim advocates in the United States such as the National Center for Victims of Crime, the Rape, Abuse and Incest Network, and Mothers Against Drunk Driving are now speaking for cases, and have a very valid and loud voice. This increased awareness on the part of advocates is motivational to investigators and legislators alike, resulting in movements such as the forensic analysis of all sexual assault cases.

Defense attorneys are a special case as a user of the forensic
laboratory report, as they do not appear until an individual is named as a suspect. They do not submit a case, investigate the case, nor bring charges, but rather serve as a check to ensure the suspect’s rights are maintained. Defense attorneys only become involved in a case when a suspect engages them or charges are brought. Judges may be involved at an earlier stage, in adjudicating probable cause for search warrants and other issues that require judicial oversight prior to charges being filed against a defendant. At court, judges are involved in interpretation of law and ensure due process, however it is the finder of fact, who make the decision of guilt or innocence in most trials. In the United States, this is the jury rather than the judge, unlike many other court systems such as Europe. Even in the United States there is variation, as some suspects may choose trial by judge alone. Hence, stakeholders are the complainant, suspect, families, the justice system and society at large. While each stakeholder may care greatly about the treatment of the case, decisions on the investigation, charges and direction of the case forensic analysis and investigation is out of their hands, but rather falls squarely with investigators and prosecutors. As many investigators and prosecutors do not possess a background with scientific or forensic training, this places forensic scientists in a position of responsibility to guide their forensic analyses and act as stewards for the cases and samples entrusted to them [3–5].

4. Parallels between medicine and forensics

There are a number of direct parallels between medicine and forensics. Treatment of a patient corresponds to analysis of a case. Documentation must be provided for all data supporting interpretations and findings. The forensic case file is akin to a medical file or a patient’s file, with a notable difference being patient files are always limited to one patient, whereas case files frequently contain information regarding the potentially multiple victims and suspects. Both medicine and forensic science are increasing impacted by tremendous developments in the biological sciences unlocked by DNA analysis and information and imaging technology. Both diagnosis of disease and investigation of crime have greatly benefited by advances in instrumental technology and the advent of computerized databases. The vast majority of forensic laboratories maintain accreditation. There are a number of accreditation providers within the US and internationally who provide forensic science specific accreditation programs [6–11]. Accreditation dictates adherence to use of best practices and standards, which correspond to the standard of care practiced in medicine. Audits ensure both documentation and practice of sound scientific application of principles and technique, which have been validated to demonstrate fitness for use.

Forensic analysts determine how to maximize the evidentiary value of evidence. They must treat the evidence in the optimal manner to prevent deleterious change, collecting and preserving samples. Analyses must be ordered beginning with the least destructive and most probative, subsequently progressing to those that consume sample. Each case may have many items, so those with the most associative value must be analyzed first. This may result in a layered analysis, where a small subset of items is analyzed to provide a timely response to direct investigations and limit redundant testing. The value of forensic investigative intelligence is perishable, that is it diminishes with time. Therefore, timeliness is a significant component of evidential value. Investigative resources are disproportionally expended at the earliest stages of the investigation and are frequently less focused while they await direction from a forensic report [2].

Investigators and forensic scientists must determine when case analysis is finished, as in the value of evidence has been maximized. However, as many more items are collected at the crime scene than need be analyzed, decisions must be made when associations between a suspect and a crime scene, or a suspect and a victim, are complete. There may be much more evidence that is available for examination, however with a reportable DNA profile, fingerprint or firearms evidence, which includes the suspect with a high level of weight, redundant analyses may add little additional value to the case. These redundant analyses expend valuable resources, which are better applied to the next case awaiting analysis. Conducting redundant analyses on the instant case is akin to medical futility.

The analogy between cases and patients includes principles of looking after their best interests, which is beneficence. Similarly, a doctor or forensic analyst must practice non-maleficence, which is doing no harm. Treatments and analyses alike consume resources and hence must be applied judiciously where they will provide the most benefit. While cases cannot speak for themselves, law enforcement investigators serve as surrogates in much the same ways as medical surrogates do. While one could argue that regardless of the outcome the investigative mission is to solve all cases, it can certainly be said that criminal investigators look after the best interests of the case at hand. They seek to bring resolution to the case, also maximizing the value of evidence, determining when the investigation is complete, working with prosecuting attorneys to determine which charges will be laid, if any.

Each criminal case represents an alleged major breach of societal ethics. The rights of an individual, the victim, have been infringed upon by a perpetrator in many of the worst ways imaginable. The focus here will be the ethics of the forensic scientist, rather than the crime affecting the case or the disease afflicting the victim.

In the United States, like many other countries, the distinct majority of forensic analysts are employed by government crime laboratories, which are housed within a law enforcement infrastructure, including police and sheriff’s departments, DA’s offices, bureaus of investigation, or justice departments. Forensic science service providers (FSSP) exist at federal, state and local levels. A majority are independent of law enforcement, reporting through the attorney general’s or mayor’s offices, such as in the State of Virginia or Washington, DC. While each FSSP typically have codes of ethics or rules of conduct for employment, there are few specific codes for forensic scientists.

In many fields where there is a high expectation of ethical performance of its professionals, such as medicine and law enforcement, oaths are sworn to uphold the highest standards of integrity and practice. There are no oaths taken in forensic science. While there are emerging codes of ethics [1], these codes focus heavily on testimony and credentials and less on the personal duties and minuitia of integrity. Integrity and honesty are largely assumed in the forensic field as science is highly structured, with accreditation, policies and procedures providing a very wide-ranging series of layers of administrative, scientific, quality and procedural manuals governing virtually every activity. Here there is an opportunity for forensic scientists to benefit from a richer understanding of the ethical underpinnings of these rule sets. With greater understanding of the ethical concepts which undergird policies and procedures, the goal of good ethical judgements and decisions can be achieved.

5. Ethical streams

There are three general streams of normative ethics, which is the study of “what should be” from an ethical standpoint. The three schools of ethics are virtue ethics, consequentialist ethics, and deontological or duty-based ethics [11]. Virtue ethics is to aspire to a set of values such as honesty and integrity. Virtue ethics is influenced by Aristotle, who posited that many ethical choices exist
between a continuum of two competing excesses, with the perfect choice being a balance between these polarizing forces [12]. Aristotelian ethics stress virtue and are transportable to any situation, however inherently lack the specificity normally associated with legal and scientific endeavors. Among Aristotle’s teaching was seeking the excellent mean between two ethical extremes, such as feast or famine, or gluttony versus starvation. Aristotle’s proposition of balancing polarizing interests has a direct application on forensic science, balancing individual right to privacy with the common interest of public safety. Virtue ethics, which is embodied by wise decision-making by individuals with integrity and of good character, generally guides decisions made within crime labs. Good character and integrity are certainly features that will enhance ethical decision-making, however lack structure and direction as to how to deal with specific situations, other than general concepts such as beneficence and non-maleficence.

Consequentialist (teleological) ethics is based on the outcome of the ethical choice determined by the goodness of the outcome. John Stuart Mill was an influential figure in Utilitarianism, supporting the greatest happiness principle in which man’s purpose was to support happiness and the greatest good derives from the greatest joint happiness or utility [13]. The forensic approach dictates that the one opportunity to obtain evidence at the crime scene is maximized: all evidence is collected, which is deemed potentially probative. As the investigation unfolds, a subset of that evidence is analyzed. Just because it is collected does not mean that it will be analyzed, as every redundant analysis performed on the instant case is one less examination on the next more valuable case in backlog. As in medicine, resources are limited and must be applied where they are of benefit. A global duty to beneficence across the body of casework begets utilitarianism. Every examination done on this case is an examination not done on the most important case in backlog. Therefore, forensic scientists must practice a balance of optimizing forensic significance in each case, while not wasting resources. Mill’s Utilitarian approach fits the forensic model quite well.

Inappropriate examinations, like futile or inappropriate treatments, must be pushed back against be they from investigators, internally, from prosecuting attorneys or justice system officials. Inappropriate examinations consume time and energy that must be spent on probative analyses, however they do worse, diluting the valuable analyses performed on the instant case with distracting data. An example would be multiple analyses of many different types of drugs found in a single criminal case, where frequently only the greatest charge will be dealt with in court. Scientists, investigators and justice system officials should not wade through data to get to probative results. All treatments given to a patient or case should be beneficial as there are frequently undesirable side effects which must be minimized.

It is very noteworthy that exculpatory evidence must always be analyzed. Independence and objectivity of scientific evidence dictates that the analyst and their examinations are neutrally positioned, not predestined to support defense nor prosecution hypothesis prior to analysis of the evidence. Selection of items for analysis must be done in good faith, with probative items likely to provide both inculpatory and exculpatory evidence submitted and prioritized for examination.

The third stream is Deontological ethics, which is based on whether the ethical choice “is it right” rather than individual virtues (virtue ethics) or consequences (consequentialist ethics). What is right is based on duties. Emmanuel Kant provided two “categorical imperatives” in duty based ethics, which are that each individual is treated as an end unto themselves rather than a means and thereby treated with respect; and secondly that each ethical choice is made as if it were universally applied [14]. Each approach to ethics comes with advantages and disadvantages in how well they fit a particular ethical dilemma in providing guidance towards an optimal solution. While these ethical frameworks apply very well to individuals in guiding their conduct, they do not provide specific guidance or structure. They do provide opportunity for sound ethical reflection, which improves judgements in value laden situations.

As in many fields, there are aspects of each of the three streams of ethics applied in forensic science, although not formally. Much of forensic science ethics guidance falls under general virtue ethics, with high expectations of personal and institutional ethics of formidable public institutions and law enforcement agencies. This also accompanies Principilism, providing ethical guidance along general lines reflecting bioethical equivalents of autonomy, beneficence, non-maleficence, and justice [15].

6. Beneficence, non-maleficence, autonomy and justice

Providing a more descriptive framework for ethics to be practiced, compared to a universally accepted set of principles, provides clearer guidance as to what should be strived for and upheld. In medical bioethics these principles are autonomy, beneficence, non-maleficence, and justice [15]. The principles of beneficence and non-maleficence apply to forensic casework much as they do to patients in healthcare. Beneficence indicates forensic scientists do the best for the case, which includes providing the most evidentiary value based on objective scientific analysis and data. Non-destructive methods are used prior to those that consume the sample, such that the net result of the entire panel of forensic testing provides the most probative value to investigators, prosecuting attorneys and eventually the justice system. Sample is not consumed unnecessarily, providing the opportunity for retesting by prosecution, investigators and defense alike should the need arise.

Non-maleficence dictates that the forensic scientist does the case no harm. Exhibit items are to be protected from deleterious change, and evidence value is preserved for retesting, both by defense or for future use. The analytical plan consists of layered analyses from most probative first to least probative, the least consumptive to most consumptive, and reports are provided such that analyses may be terminated once conclusions are reached, without examining redundant evidence.

The principle of autonomy relates to the rights of the individual to have personal autonomy and freedom of choice, which is to have their opinion regarding what is best for themselves rule the day. Each individual has the right to determine their own fate, when those decisions pertain to them without direct adverse impact upon others. Understandably, in healthcare decisions, what the patient wants regarding their own treatment options within the standard of care is of primary concern. Respect for autonomy requires, at a minimum, acknowledgment of an individual’s right to have opinions, to make choices, and to take actions based on personal goals and values [15]. Autonomous choices have three central characteristics: they are adequately informed, they are voluntary instead of coerced, and they are rational [15].

Autonomy is an ethical concept in which the treatment decisions of the patient are respected. The parallel in forensic science is doing what is right for the individual case to solve it, equivalent of bringing it back to health, in providing closure and resolution through identifying evidence and providing associations. Death equates to a case that remains unsolved or has forensic evidence destroyed before its value is unlocked. The lack of treatment corresponds to a backlog, or worse, to a case with forensic evidence that is not submitted. In a just society, resources would be tailored to the sick rather than “here are the resources you have, now do the best you can with them.” However, more often than not, this is the
reality in government as resources are finite and often immobile between initiatives. There are likely to be political and economic limitations on the tax burden that society is willing to accept. Unfortunately, just as in medicine there exists inequities in forensic science. There are have and have not patients as well as have and have not jurisdictions.

Justice is the desired outcome of forensic science, providing objective data based evidence to support the fact finders’ quest for truth and justice. In medicine, justice has a wide variety of interpretations and applications, ranging from fair treatment of individuals to the equitable distribution of health-care resources. Justice implies doing what is right, which entails not only doing what is right for one but what is right for all. The challenge of finding this balance between the rights of individual versus rights of society is not determined within the concept of justice, however it is the subject of considerable debate. John Rawls grappled with the issue of distributive justice, including a variation on the social contract with the resulting concept of justice as fairness [16,17]. Rawls theorized that “society should be structured so that the greatest possible amount of liberty is given to its members, limited only by the notion that the liberty of any one member shall not infringe upon that of any other member.” [17]. Through the discussion of autonomy, beneficence, non-maleficence and justice; a concept is missing that balances the rights of the many versus the right of the individual. In healthcare, autonomy and the right of the patient are paramount. Their quality of life and life span are the most critical factors in their decision-making process regarding treatment options. In forensic science while each case is important, there is a focus that needs to be placed on the entirety of cases, much like healthcare and policy decisions must focus on the entirety of patients and the health of society, versus health of the one.

7. Proportionality

An ethical concept that can fill this void to balance the rights of individual versus society is proportionality. Proportionality is the tradeoff between two competing interests, both of which have merit. Proportionality dictates to do as much good as possible while doing as little harm as is necessary [18]. The doctrine of double effect, where doing one thing virtuous causes another unforeseen but negative outcome, is an example of proportionality. The good thing justifies or outweighs a concurrent bad thing. Aristotle’s excellent mean between two extremes is another illustration of proportionality. The competing interests of the safety of society versus the rights of the individual require an analysis of the benefits and risks of extreme positions. The goal is to find the appropriate balance that attains the most good while minimizing the potential negative consequences or side effects.

The principle of proportionality applies an aspect of consequentialism in looking at the outcome, however the key is the balance. If society practiced entire individualism, then murder, anarchy, and “anyone could do whatever they wanted” would be the order of the day. However in the crime of murder, one individual’s rights are entirely violated by another. Each person’s rights are directly competing against each other. One individual’s right to personal safety and security collides with the individual’s right to choose their own behavior. Behavior is restricted when it negatively impacts the rights of another. Societal right to safety is worth some compromise of the personal right to autonomy or privacy. This right to privacy is breached with appropriate cause on a regular basis. Individuals are searched before they travel on an airline, acknowledging the breach of privacy is the price for protection from terrorist acts.

With full privacy as one extreme, there would be no lawful search and seizure. The second extreme is to permit no privacy in favor of the full expression of the right of society to safety. This extreme would permit law enforcement agencies to search at will without cause and place information on every individual into databases, revealing all. There would be no unsolved cases with evidence lacking a suspect. In viewing these extremes, there is a missing right or ethical concept to counter individual autonomy, to guide the location of the balance between these two opposing interests of autonomy versus public safety. Individual choices should not override all things at their expense, nor should the quest for public safety.

The concept of proportionality applies to more than the global application of overarching forensic policy on privacy and public safety. There is also an application on the case level. The question of how many resources are applied to the instant case at the expense of the cases awaiting service haunts healthcare as it does forensic policy. There is significant individual versus societal aspects of utilitarianism in providing the optimal quality of life through overall health for the resources available. Challenges include optional surgery for the rich, akin to excessive attention to the instant high-profile media driven criminal case while other cases sit in piles as backlog.

Policies and lawmakers are increasingly recognizing the rights of society to be provided with safety from preventable crime. With increasing frequency, US states are passing laws dictating that all sexual assault cases be analyzed forensically [19]. Attention must be given to the rights of minority victims as they are disproportionately the greater number of victims [20,21]. With a focus on the right of society and of the victims to not be victimized through the early apprehension of perpetrators, forensic tools such as partial matching, familial searching, and genealogical searching increase investigative power of DNA databases. This trend is shifting the balance towards the rights of potential victims to be provided safety from serial perpetrators.

Proportionality applies to economics models of capitalism versus socialism. In capitalism, the mass leverage of individual self-interest allocates resources wisely. What is good for the one acts to allocate resources according to need, thereby moving resources for the many most economically, as it is driven by pursuit of maximum utility and thereby maximization of profit. Socialism seeks to directly benefit the many by allocation of resources across society. This allocation however is performed by the few and thereby hinges on their prudent decision-making versus the individual choices of many in capitalism. Once again, the individual is balanced against or with society. Various societies and countries select where they choose to locate themselves along the spectrum of balance according to rights of the individual versus rights of society. All recognize that along Aristotelian lines, the extremes result in anarchy with total individual rule versus full socialism or communism. Communist societies to date ironically do not often reach philosophical goals due to choices made by an elite ruling class, thereby resulting in totalitarian regimes. Conversely, rather than utilize true no holds barred capitalism, many first world countries strike a balance with systems that have aspects of socialism in publicly funded education systems, healthcare and social assistance combined with a free enterprise business model. A balance of the rights of the few is struck between rights of the many.

A direct example of proportionality in healthcare is manifested by immunization. Herd immunity protects both individuals and society from the tragedy and costs of disease, however denies the rights of individuals to opt out of injections. Once the rights of individuals are permitted to operate by opting out, the system begins to crumble as now individual infections result that multiply through communicable infection, thereby jeopardizing the right to health of both individuals and all of society. Costs to contain
outbreaks also spiral accordingly. The risk to the individual in obtaining the injection in most cases is slight relative to the great cost of a fatal infection, particularly given the infectious nature that multiplies the risk logarithmically relative to its original size to threaten the greater society. Therefore, there is ample evidence to support a legislated denial of choice to opt out, denying individual's capacity to choose and not respect individual autonomy, choosing in favor of global health and safety from preventable dangerous infectious diseases. Here there is a direct comparison to serious serial predators who inflict a disproportionately negative impact on society through their recidivist crimes.

**8. Objectivity**

Objectivity is a key feature of forensic science that is unique relative to medicine. Thankfully, only in limited cases is medicine played out before the criminal judicial system. Forensic scientists must be unbiased, impartial and neutral; loyal to the data and scientific method. As in all areas of natural science, results must be reproducible and based on sound scientific principle. This is particularly true in the adversarial justice system. Interpretations and conclusions must be the same regardless of whether they benefit the prosecution's or defense's theories regarding the matter at hand before the courts. The forensic scientists' role is to provide understandable, valid and accurate results to the finder of fact. These results and interpretations must be appropriately weighted, so the strengths and weaknesses of evidence can be clearly understood and incorporated into the juries' decision making. This objectivity and neutrality serves victims, suspects and public safety alike by providing a clear picture of factual evidence, upon which others can deliberate. Forensic science knows no side besides truth.

**9. Recidivism**

The concept of recidivism dictates that a small number of high achieving criminals perpetrate the same crimes over and over upon new victims, thereby creating an oversized footprint of damage upon society. The number of crimes committed by relatively small numbers of high producers mounts over their criminal career, lending the opportunity for savings with early intervention. There is much potential to disrupt this cycle much earlier in a criminal's career, saving many victims and corresponding damages, as well as investigative and judicial system resources [2]. The huge cost of crime exposed to victims and society by recidivist criminals is parallel to the high cost of health and health-care. Detrimental costs of disease and poor health indicate a proactive or balanced approach be considered along with the rights of the individual.

The concept of community-based policing and utilizing objective forensic evidence to stop a criminal earlier in their career to prevent future recidivist crimes [22] is like preventative medicine. Early immunization imposes on the rights of the individual's autonomy and privacy to have an injection; however, the herd immunity prevents the spread of further infection through that early intervention and proactive initiative. The cost of preventable crime builds as does the cost of disease if unchecked and able to spread. The tools of technology and databases have enabled crimes without suspects to have suspects developed, however it requires choices that impose on individuals' rights to place an individual in a database.

The balance provided by proportionality, when observed from a utilitarian perspective, provides a solid argument for striking a mean in support of victims and their rights not to be victims. As immunization protects the right of the uninfected from those that would spread disease, so too is there a duty for the individual to take preventative steps as part of their duty to society. In the case of crime, where the criminal does not take on that responsibility personally, society is able to make informed choices in the form of law enforcement, where policing and law find and define the balance for them.

New objective tools of forensics have provided a unique opportunity that comes with ethical concerns. These concerns must be met, however, balanced against cost of crime and the benefit of individual rights and freedoms. An ethical framework that provides the structure to weigh concepts of autonomy and justice exists in proportionality, to find the optimal balance of cost and benefit for all of societies' participants. The role of forensic scientists and the investigators they serve is to enact the laws and public policy provided to them. A challenge for upper level creators of policy and law are to understand the opportunities provided to solve and prevent crime, balanced against rights to privacy from unreasonable search and seizure. With appropriate provision of information, options, and evaluations, choices can be made to find the appropriate balance. However, lacking this iterative process, the opportunity is missed, or worse uninformed process of rights on rights of potential victims or individual rights.

**10. Ethics in forensic science practice**

Forensic scientists in many accredited US forensic laboratories are bound by accreditation requirements to follow Guiding Principles of Professional Responsibility for Forensic Service Providers and Forensic Personnel [1], or alternatively follow various versions of ethical guidelines set out by other authoritative bodies [23,24]. The focus of the specified ethical principles is on scientists practicing forensic science with integrity, being true to data, use of appropriate science and providing proper testimony. Little is said in the ethical guidelines regarding how to approach ethical dilemmas in the crime laboratory and the use of ethical frameworks to resolve issues. Rather, accreditation and policy frameworks dictate use of quality systems as a means to identify and prevent ethical issues. These issues are addressed through policy and procedures via corrective actions and conducting of root cause analyses as a component of the corrective action procedure. Corrective actions are reviewed by auditors under the auspices of accreditation. The result is a structured process that is fit for quality issues, however ethical issues are most commonly dealt with via the employer’s human resources policy. While this practice serves the purpose in a structured policy and procedure driven regime, it does not promote a deeper level of ethical understanding or thought process, which would lead to sounder and more dynamic ethical decisions by forensic scientists.

There is currently no single overarching organization providing universal oversight to forensic laboratories. The American Society of Crime Laboratory Directors is a volunteer organization of crime lab members. It has approximately 680 members and represents 400 crime laboratories in the US as well as number of foreign countries [25]. Other professional organizations such as the American Academy of Forensic Science, the International Association for Identification, the Association of Firearms and Toolmark Examiners, the Society of Forensic Toxicologist and a host of local and regional associations provide exchange of scientific information. As independent non-profit volunteer organizations, they do not have any regulatory or operational authority. They each have ethical policies; however their control is limited to their members and actions limited to loss of membership privileges or membership itself.

There are independent forensic laboratories at all levels of government, including federal, state and local labs. Ninety-five percent of forensic analysis is performed in State and Local forensic laboratories. The Organization of Scientific Area Committees (OSAC) is hosted at the National Institute of Standards and
Technology and is provided oversight by the Forensic Science Standards Board. The OSAC is responsible for developing forensic standards, however an ethical standard is not included at this time.

Forensic scientists deal with cases that have very high stakes involving public safety and the impact on the rights of the accused. The level of specialization is increasing along with the ever-quickening pace of technological change across the various forensic disciplines. There is increased division of labor and long training times to ensure competency. Priority of forensic analytical work is often dictated by court dates and investigative demands, producing a mix of high pressure and a high cost of errors. Therefore, the corresponding impact of ethical wrongdoing on the part of the forensic scientist is particularly high. It should be noted that forensic scientists are salaried government workers, hence there is no economic incentive to modify or falsify results. Despite this lack of monetary incentive, ethical lapses occur in crime laboratories.

The most significant of these is involving the practice of Drylabbing. Drylabbing is a practice where reported conclusions are not substantiated by data; essentially the report is a false identification or inclusion [26]. This has occurred in the case of Annie Doukan [27], and most recently Sonia Farak [28]. Both Massachusetts labs where the analysts worked were not accredited, hence lacked checks and balances to detect and prevent malfeasance early after commission of the first offenses.

Crime labs were closed in Detroit in 2008, Nassau County NY in 2011 and St. Paul MN in 2012, because of lack of a suitable quality system rather than errant forensic scientists [29]. Close examination of 133 wrongful conviction cases revealed 3 cases where forensic science was the sole contributing factor and only 2 exonerations, which occurred after 2000, both in 2003 [29]. Eighty-eight percent of the 409 publicly-funded crime labs are accredited, which includes validation of test methods, requirement for extensive training, testimony monitoring, and demonstrates analysis is reliable, accurate and fit for its intended use [30]. In the absence of objective forensic science, the alternative is frequently eyewitness testimony. While there is debate on the magnitude of the quality issue, forensic laboratories are placed in a position of public trust, where their objective science-based findings carry significant weight. Therefore, forensic laboratories must earn and demonstrate that trust. While it is critical to be accurate with the original results, it is even more important to have the mechanism to recognize and correct errors when issues do surface. In accredited laboratories, mandated quality assurance through corrective action procedures fills this vital role. Here again lies opportunity for development of a more robust ethical platform to inform and drive decision making, as well as guide corrective actions and continuous improvement.

The National Research Council of the National Academies study on forensic science examined issues in forensic science including ethics [31]. The study noted that many forensic organizations “have codes of ethics or codes of professional practice imploiring members to act with honesty, integrity, and objectivity; to work within the bounds of their professional competence; to present testimony and reports in a clear and objective manner; and to avoid conflicts of interest and potential bias, among other things. The codes that do exist are generally comprehensive, but they vary in content. As a consequence, there is no single code of ethics to which all members of the forensic science profession a subscribe.” [31] The study deferred to ASCLD/LAB (American Society of Crime Laboratory Directors/Laboratory Accreditation Board), which was developing a code of professional responsibility at that time, however in Recommendation 9 advised that a national code of ethics be established and recommended to explore mechanisms of enforcement for those forensic scientists who commit serious ethical violations. This code was subsequently made a requirement for each crime laboratory to adhere to as a prerequisite for accreditation, along with annual ethics training [1]. Various forensic organizations, including the American Society of Crime Laboratory Directors (ASCLD), have developed and enforce a Code of Ethics [23,24,32].

Accreditation, certification, licensing and commissions are used in a wide variety of combinations across the US to provide checks on forensic ethical issues. Ultimate responsibility for oversight of ethics rest with individual entities employing the scientist, and each typically has their own employment codes of conduct. Hence there is wide variation from entity to entity. Individual licensing and certification are directed towards the individual scientist or proprietor, while accreditation is the mechanism used to ensure the entire forensic laboratory maintains a quality system that encompasses ethics and corrective action mechanisms.

Some US states have chosen to employ commissions to provide oversight for forensic laboratories. Ten states including New York have legislatively created a commission to provide oversight to state and local forensic laboratories [33]. Challenges for establishing an oversight body include balancing the wide variety of stakeholders with the specific forensic experience required to provide knowledgeable and informed opinion. One might question the practice of including users of the products of forensic laboratories such as prosecutors and defense attorneys on a commission overseeing heart surgeons, where a high level of specialized medical education and training would be necessary to provide direction. The level of expertise needed to appropriately judge the surgeons might typically fail to individuals with requisite medical backgrounds, to include those who had set foot within a hospital, completed extensive medical training and had practiced similar surgery. Alternatively, commissions with a wide variety of stakeholders contract with accrediting bodies or panels of experts to provide more detailed investigation or perform audits, including those required for accreditation. In the New York Commission model, there is special consideration for DNA forensic expertise, where the DNA subcommittee can provide binding recommendations to the Commission. A position statement by ASCLD indicates preference for a significant proportion of commission members to have forensic experience to ensure appropriate frame of reference and expertise to provide guidance [34]. Similar to medical clinical Bioethics Committees, there are fundamental background educational, training and competency requirements that should be met by various members and the committee content as a whole to provide appropriate decision making [35].

11. Forensic specific differences

As much as there are similarities and direct parallels in medical bioethics and forensic science, there are a number of noteworthy differences that require special attention. Medical professionals may end up involved in legal matters or criminal cases and may on occasion provide expert testimony in court, however aside from forensic pathologists and sexual assault nurse examiners, this is a rare occurrence relative to forensic scientists. The forensic laboratory has three main products. These are court testimony, forensic reports and the case record and associated documentation that in turn supports testimony and reports. Requirements for ethical conduct include training, monitoring and ongoing improvement of testimony to ensure it is unbiased, objective and neutral, provides accurate and full disclosure and gives the appropriate weight to findings and interpretations.

There are also significant differences in the flow of forensic casework versus patients. Forensic cases can back up and the case suffers and cost escalates, however there are only an investigator and prosecutor as advocates. This contrasts to a patient suffering or dying who can self-advocate, or family and friends who can act on the patient’s behalf. Storage lockers and evidence vaults can hold a
very large number of evidence from criminal cases, which can easily grow cold without adequate resources for appropriate forensic analysis.

The field of forensic science often suffers from low pay and lack of recognition despite high and increasing demands. Notably the threat of lawsuits against forensic scientists is low as most staff are salaried employees and frequently indemnified by employers except in the case of malfeasance. There are relatively few individual proprietors in forensics as the vast majority of forensic case analyses are conducted in government funded crime labs with multiple staff due to centralization and large demand for services. This permits systemic quality measures such as accreditation to provide oversight for quality where multiple examiners are working at a single facility, rather than stand-alone proprietors who require individual certification and licensure.

The nature of the adversarial legal system significantly impacts forensics. While forensic analysis is based on data and scientifically proven principles and validated methods, the role of the defense attorney is to represent their client. In that representation, they must seek to limit the impact of inculpatory evidence, which includes forensic associative evidence. This means at times rigorous and at times confrontational cross examinations, which further heightens the stress placed on scientists.

The most common forensic business model in the US is primarily governmental under law enforcement with a lesser number of FSSPs under Attorney General or prosecutors’ offices. This contrasts to the private business model common in US healthcare. In many countries, there is a blend of public and private healthcare providers, however few cases are processed by private forensic laboratories by non-law enforcement entities. As forensic science is taxpayer-funded, resources are inherently limited as few taxpayers are looking to pay increased taxes. Increase in technology and demand for forensic analyses does not correspondingly increase the supply of analyses, but rather is limited by the availability of resources. Case evidence stores much more easily and quietly than patients. The government non-user pay system versus a private pay system for major crimes against the person and lab resources. This unfortunatel results in case backlogs where the demand for case analysis outstrips the supply of analyses, as well as hampering timely analysis for investigative leads.

Unlike many health institutions, there are currently no specific ethics committees in forensic science. Corrective actions are initiated whenever errors or issues occur, with policies for containment, root cause analysis, correction, prevention and follow up to prevent reoccurrence. Quality managers, technical leaders and laboratory directors typically provide oversight and guidance to corrective actions. When issues involve an ethical component, crime laboratories often refer to an independent part of their organizations or an outside body, such as an internal affairs department or professional standards bureau. Independent oversight is also provided by the Inspector General’s Office, which can conduct independent investigations as they deem appropriate. Human resource sections and legal counsel departments also become involved depending on the nature of the ethical issue. Forensic laboratory staff typically have limited formalized training in ethics. This existing structure further highlights the opportunity for a more robust ethical structure.

12. Ethical issues

Many ethical issues relate to the practical application of resources within policy, scientific and legal constraints and maintaining a quality system to detect and prevent issues in forensics. Backlogs are a byproduct of an imbalance between case output relative to demand for analysis. With increasing forensic technology and public expectation, there is greater capability for probative findings and suspect development, which is driving demand for case analysis upward. Use of forensic databases permits a suspect to be located where investigators had no leads previously. Limited resources to match that demand results in a backlog. While a case may only take 5 days to provide analysis, interpretation and report, it may sit for 95 days waiting in line until work begins. The resulting turnaround time may be 100 days, but most of that time was spent awaiting its turn for analysis to begin.

The current elasticity of demand for forensic casework is negative 1.29, which means that for every case in the backlog that is completed, 1.29 cases come in to replace the 1.00 completed. This increased demand prevents analysts from getting to the case in a timely fashion. While this slowed result stems from resource issues, where output does not match input, building infrastructure takes time. Slow response time negatively impacts justice and public safety in the instant case, but also misses solving subsequent cases by the same perpetrator and their associates (gang or otherwise). There is also a negative impact on the victim in delaying denied justice, or the incorrectly accused by denying exculpatory evidence.

The increased pressure to perform casework analyses demanding the highest level of quality as required by the criminal justice system, under resource constraints and resulting backlogs, increases the risk for ethical issues. When pressure to produce is great, there are greater temptations to take shortcuts that jeopardize quality. Therefore, a rigorous corrective action program that seeks not to blame the individual for unintentional issues, but encourage reporting and correction, is proactive. This supports early and widespread notification, stopping and controlling the issue, documentation, root cause analysis, correction and continuous improvement. Culture within the organization must support self-reporting, which is buoyed by praise rather than blame, for locating and correcting issues detrimental to quality.

Conducting the most beneficial analysis in the right order maximizes the probative value or health of each case. The analyses or treatments selected for each case must be appropriate, within the “standard of care” to borrow the medical term. Best practices and techniques must be used, as practiced within an accredited environment. Forensic laboratories should practice non-malefice by preserving evidence, not consuming all evidence where possible, and only conducting probative analyses. Preservation of remaining evidence permits retesting as technology improves, but also retains the capability of defense retesting. Excessive analyses are not conducted, as they represent a utilitarian ethics waste of resources or futility. Good stewardship of resources applies to existing analysis on cases in hand as well as and newer technology, balancing validation and use of new technology against current proven technology.

From a utilitarian perspective, forensics not only provides objective data to assist the finder of fact in criminal cases, it provides a significant economic return on investment. Expenditures on no-suspect sexual assaults, which cannot be solved via traditional investment, reveals an estimated return on investment is over $35 of cost of crime savings for every dollar spent on forensic DNA [2]. The cost of violent crime is very high, to both the victim, healthcare, employers and society with the estimated cost per sexual assault over $111,000 [2]. Analysis of crime scene samples cannot be solved without comparison to known samples, such as DNA databases. The cost benefit of each addition to the DNA database provides an estimated societal benefit of between $1500 and $20,000 [39]. Objective data, which include or conclusively eliminate suspects,
provides tremendous public safety, rights protection for the wrongfully accused, as well as economic benefit.

Crime laboratories must balance privacy and transparency. While a case is under investigation, case-specific information is closely held on a need to know basis, much like a patient’s medical information. Once that case goes to trial, however, all information pertinent to the report and case file is subject to full disclosure. Rosario ruling applies to providing disclosure \[40\], while Brady \[41\] and Giglio \[42\] precedents apply to disclosing ethical issues relating to witnesses, ensuring ethics of employees and a system of disclosure of any relevant information. Appropriate levels of transparency are critical to maintaining the public trust, while at the same time respecting privacy by limiting the scope of transparency to those involved in the instant case.

Any human endeavor is only as good as those who employ it and the systems they utilize. If unbridled, fire can burn down houses, however if controlled along with appropriate checks and balances, can be harnessed to heat a home. With adherence to guidelines for ethics provided through appropriate ethical standards \[1,32\] and use of appropriate quality standards including corrective actions, root cause analysis, and accreditation; maximum benefit can be derived while mitigating risk. A deeper understanding of ethical issues provided through establishment of a sound ethical framework will assist in mitigating this risk.

13. Conclusion

A crosswalk between Medical Bioethics and Forensic Bioethics culminates in the formation of a “standard of care” for forensic casework. This standard of care begins with accreditation, which ensures a level of uniformity of best practices and oversight. Accreditation should be mandatory for all forensic laboratories to ensure use of best practices, documentation, corrective action, root cause analysis, scientist qualifications including training, competency, and proficiency testing; case review, auditing and oversight. Samples of evidence must be protected from deleterious change, while their evidentiary value is maximized.

Optimization of evidentiary value occurs on a case by case basis, but also within the entirety of the cases at hand. Within a case, this is best achieved through layered analysis from least to most consumptive testing, with perishable analyses conducted first. Timely analysis and reporting on a subset of probative samples permits quicker response and in many instances, limits further redundant testing. Sample and case prioritization ensures optimal expenditure of resources across the body of cases. Structured analysis in DNA for example, would first target obtaining a CODIS profile for searching, and then depending on the results and case severity, progress logically through consideration of familial searching and finally genealogical searching if warranted. Resources should be tailored to the need to ensure a timely turn-around time for analysis to optimize public safety and interrupt criminal behavior at the earliest opportunity, to prevent future victims from recidivism and improve rehabilitative efforts.

Key forensic ethical tenants include autonomy, beneficence, non-maleficence, justice, objectivity, and proportionality. Scientists should be free from undue pressure to ensure impartiality, objectivity and an open mind, so data drives unbiased interpretations and conclusions. Scientists must be aware of limitations and clearly qualify results as necessary. Self-reporting of unintentional issues must be encouraged and blame free. Initial and ongoing training must be fit for purpose, with competency testing demonstrating ability prior to engagement in casework, and proficiency testing conducted at regular intervals to ensure continuous competence and quality. Technical review of casework by an independent qualified examiner should be conducted on all cases as a safeguard against incorrect inclusion or elimination. Reports and testimony must be understandable, accurate and transparent. Scientists’ expertise, training and capability must be accurately represented. Full disclosure of instant case related information must be provided to only those impacted by the case to ensure appropriate disclosure while protecting privacy.

Victims’ right to know the status of the forensic analysis of their case, particularly in the case of sexual assault, should be considered. Testing for all cases of sexual assault should be conducted, as an investigator is better with a laboratory report than without. Objective data from forensic analysis supports the right of society and the victim, the wrongfully accused and public safety alike.

The principle of proportionality provides guidance in dilemmas where rights are overlapping, to find the optimal balanced solution while respecting the rights of each party. Alignment of policy and procedure along these ethical tenants will ensure a congruence that improves decision making at all levels, including those of the forensic scientist facing daily ethical issues. This project is just a start in the very large task of building the foundation for forensic ethics. Much more can be done to elucidate ethical principles, to guide the forensic scientist to better inform their decisions and the policy maker to direct forensic scientists and their laboratories.

Conflicts of interest

None.

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