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Letter to the Editor

Title:

Haddon Matrix for Kidney Transplantation during COVID-19 Pandemic: A Problem Solving Framework for Present and Future

(Running Head: **Haddon Matrix: Transplant and COVID-19**)

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Reprint Request

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COVID-19, Coronavirus disease 2019

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To the Editor

Novel coronavirus disease 2019 (COVID-19) pandemic is a public health emergency with several million worldwide and a quarter of a million and soon half a million deaths including a third in the United States alone (as of May 10, 2020).¹ It affects kidney transplantation and has caused

mortality in waitlist dialysis and transplant patients.^{2,3} This inevitably raises questions about the practicality and direction of transplant surgeries during this critical period.

Haddon matrix is a framework used for injury prevention and response strategies (table 1). It has also been used with previous pandemics including influenza and SARS^{4,5}, and may be applied to transplantation during the current COVID-19 pandemic. The matrix investigates host and environmental factors (physical and sociocultural) during three time points: pre-event, event, and post-event.⁶ The proposed application of the Haddon matrix during current COVID-19 pandemic by considering host, agent (SARS-CoV-2), and environmental factors from pre-transplant through post-transplant periods is shown in the table 1.

The Haddon matrix paradigm primarily guides providers to identify strategies to minimize COVID-19 infections amongst their transplant patients. In a broader context it can be applied to the transplant community at large and facilitate strategic relationships between transplant centers. For example centers located in highly impacted areas will have reduced healthcare resources and transplantation may be temporarily halted while healthcare resources are pooled for critically ill patients.⁷ A strong relationship with a center that has not yet been affected or has overcome the largest anticipated spike may allow some patients from the struggling center to be transplanted at the sister facility rather than waiting for their center to re-open.

The risk of death from COVID-19 versus the risk of remaining on dialysis for patients with ESRD must be carefully considered.⁸ Although highest fatality from COVID-19 is among individuals aged ≥ 85 years (10-27%), the mortality ranges from $<1\%$ to 1-3% among persons aged 20–54 and 55-64 years, respectively.⁹ Additionally, under detected cases likely overestimate reported fatality. In comparison the mortality of patients with ESRD is 20-25% after 1 year of dialysis and their survival rate at 5-years is only 35%.¹⁰ Notably kidney transplant waitlist candidates are generally healthier (even pre-transplant) than the overall dialysis population and do not have as high mortality at 1 year or low survival rate at 5-years on dialysis. Despite this transplant still significantly reduces their overall mortality. In the setting of an evolving pandemic with little information on current kidney transplant outcomes, the decision to postpone transplantation should be based on other factors. These include availability of healthcare resources, the risk of infection to the patient, the extent of community spread, the risk of transmission to healthcare providers, and the availability of suitable transplant candidates.

Although applying the Haddon matrix framework to transplantation can be helpful, some unmodifiable factors including our limited understanding of SARS-CoV-2 may limit its' utility in efforts to prevent and control COVID-19. SARS-CoV-2 is highly contagious and has a wide spectrum of clinical presentations making it difficult to detect all cases when screening occurs by symptoms in each transplant phase. The accuracy of the diagnostic methods for SARS-CoV-2 both RT-PCR and antibody testing in transplant recipients needs further study.¹¹ Moreover, prioritized healthcare resources for emergency or critically ill patients during the pandemic may decrease the number of kidney transplantations and may further limit availability of resources to optimize the control of COVID-19 in immunosuppressed patients during the post-transplant phase. Implementation of the Haddon Matrix cannot be achieved unless it is integrated into an institutions policies and procedures that can be modified as this disease continues to evolve. ⁴

Applying this matrix is a dynamic process and by its nature requires the provider to re-visit and re-evaluate the ever-changing situation. The information gathered during this pandemic will help pre-emptively identify future problems and better prepare the transplant community for future unprecedented infectious outbreaks.

Key words:

coronavirus disease 2019, COVID-19, end-stage renal disease, Haddon matrix, public health, renal transplantation

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Important Disclosure

KKZ serves as a physician in a US Department of Veterans Affairs medical centers with or without compensation or are part- or full-time employees of a US Department of Veterans Affairs medical centers. Opinions expressed in this paper are those of the authors' and do not represent the official opinion of the US Department of Veterans Affairs.

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Authors Contribution statement

E.T. participated in designing of topics and detail of manuscript, writing of the manuscript, and preparing the table. U.G.R., A.J.F., H.I., D.C.D., and K.K.Z participated in editing and reviewing of the manuscript.

Table 1. Application of Haddon matrix to organ transplantation during COVID-19 pandemic

Event dimensions	Epidemiologic dimensions	Host factors	Agent	Environment	
				Physical	Sociocultural
<i>Pre-transplantation</i>	<ul style="list-style-type: none"> - Minimize organ contamination and shipping - Minimize recipient travel - Provider training in infection control - Individualized donor selection to minimize anticipated DGF necessitating post-transplant dialysis - Recipient selection to minimize anticipated DGF - SARS-CoV-2 screening in donors and recipients 	<ul style="list-style-type: none"> - Contagiousness of COVID-19 viruses - Virulence of COVID-19 viruses 	<ul style="list-style-type: none"> - Infection control infrastructure - Availability of donor and recipient COVID-19 testing - Availability of PPE - Plan for increased capacity for COVID-19 cases 	<ul style="list-style-type: none"> - Societal attitudes toward COVID-19 - Provider adherence to infection control policies - Resource allocation and prioritization 	
<i>Transplantation</i>	<ul style="list-style-type: none"> - Underlying co-morbidities - Healthcare providers' practice - Risk communication to patient and staff 	<ul style="list-style-type: none"> - Mode of COVID-19 transmission during peri-transplantation 	<ul style="list-style-type: none"> - Capacity to quarantine if indicated - Designated area for COVID-19 cases - Medical equipment and potential effective antiviral therapies 	<ul style="list-style-type: none"> - Practical and ethical considerations for organ transplantation - Budgets for resource utilization - Patients and family adherence to infection control policy - Appropriate communication about COVID-19 to patients and providers 	
<i>Post-transplantation</i>	<ul style="list-style-type: none"> - Post-infection management and surveillance 	<ul style="list-style-type: none"> - Persistent COVID-19 in the environment - COVID-19 virus mutation - Research pertaining to treatment, immunization 	<ul style="list-style-type: none"> - Post-infection decontamination - Patient transportation availability 	<ul style="list-style-type: none"> - Psychological support - Financial support for transplant centers and hospitals affected by COVID-19 - Support for patients and their communities affected by COVID-19 	

COVID-19, coronavirus disease 2019; DGF, delayed graft function, PPE, personal protective equipment, SARS-CoV-2, severe acute respiratory syndrome coronavirus 2